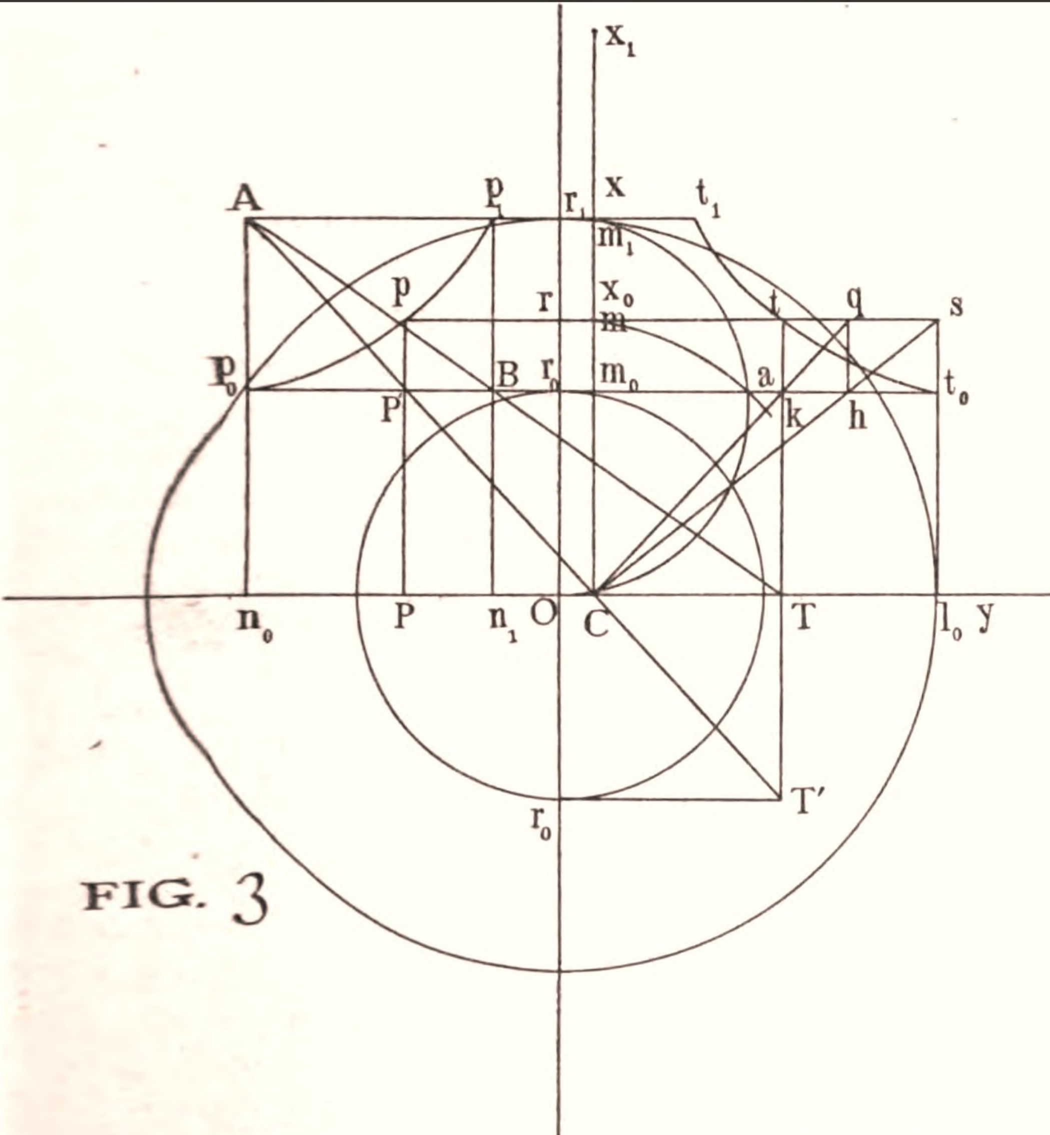

FIG. 3

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☞ All communications relating to this publication should be addressed Editor *Journal U. S. Artillery*, Fort Monroe, Va.

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JOURNAL

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VOL. IV. No. 1 JANUARY 1895. WHOLE No. 14.

GEOMETRICAL CONSTRUCTION OF GUN STRAINS.

BY A. G. GREENHILL, PROFESSOR OF MATHEMATICS IN THE ARTILLERY COLLEGE, WOOLWICH, ENGLAND.

Artillerists are indebted to the various *Notes on the Construction of Ordnance*, by Captain Rogers Birnie, Captain William Crozier, and other writers, for the most complete treatment of the strains and stresses in the metal of a gun, constructed on the modern principle of building up with jackets and hoops, applied with appropriate shrinkage.

The theoretical treatment of the subject in these articles is elegant and complete; and, moreover, the formulas are applied numerically to calculations in reference to existing designs of ordnance, so that a comparison between theoretical prediction and the experimental results can be immediately carried out.

Looking, however, at the great arithmetical complication of the algebraical formulas employed, it has struck me that a geometrical presentation of the theory might be acceptable to the gun designer, especially as the theoretical results concerning the strength of the various parts of a gun are now invariably exhibited in a graphical form on the working drawings.

It will be surprising to see how readily the algebraical formulas can be translated geometrically on the drawing by means of a few straight lines and circles; so that I anticipate that this geometrical method will soon be as universal with gun designers and constructors as the methods of Graphical Statics are at the present day with the bridge builder and the engineer.

1. The fundamental essential problem in our subject is the determination of the distribution of radial pressure and circumferential or hoop tension in the material of a homogeneous metal tube, subject to given arbitrary pressures, applied at the interior and exterior surfaces.

In the Metric System the units usually selected are the centimeter as unit of length, and the kilogramme per square centimeter as the unit of pressure, this pressure being practically the same as the normal atmospheric pressure; the pressure of powder gas is in continental treatises usually estimated in atmospheres, of one kilogramme per square centimeter.

But the units employed in the *Notes on the Construction of Ordnance* are, I observe, the British units of the inch as the unit of length, and the pound or ton on the square inch as the unit of pressure; but we must observe carefully whether the *long* ton of 2240 lbs., or the *short* ton of 2000 lbs., is intended. In the following it is the long ton, of 2240 lbs., which is employed.

2. Suppose then that a tube of homogeneous steel, of internal radius r_0 inches, and external radius r_1 inches, is exposed to a steady pressure of p_0 tons/in^2 (tons per square inch) on the inner surface, and to a steady pressure of p_1 tons/in^2 on the outer surface.

If the tube is supposed cut in two by any diametral plane, the resultant thrust of the applied external and internal pressures on an inch length of either half is a force of

$$2p_0r_0 - 2p_1r_1 \text{ tons,}$$

tending to separate the two halves; and this force must be balanced by an equal force, which is supplied by the tension of the circumferential fibers of the metal.

Then if T denotes the average tension, so that

$$T(r_1 - r_0) \text{ tons}$$

is the resultant pull of the fibers across either section of the tube,

$$T(r_1 - r_0) = p_0r_0 - p_1r_1 \qquad (1)$$

a fundamental equation in the theory of this subject.

3. If we adopt the notation of the Integral Calculus, and denote by t the tension, in tons/in², of any intermediate circumferential fiber of radius r inches, then the resultant pull of the fibers across inch length of a cross section is expressed analytically by

$$\int_{r_0}^{r_1} t\,dr$$

so that equation (1) may be written

$$\int_{r_0}^{r_1} t\,dr = T(r_1 - r_0) = p_0 r_0 - p_1 r_1 \qquad (2)$$

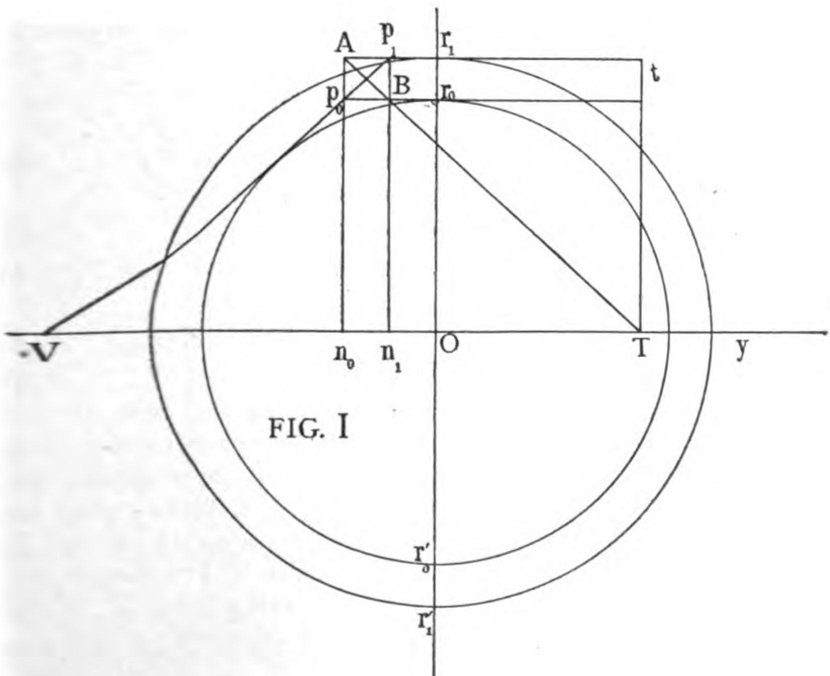


FIG. I

4. Where, as in the cylindrical shell of a steam boiler, the thickness $r_1 - r_0$ of the metal is small compared with the mean

radius, $\frac{1}{2}(r_0+r_0)$ or $\surd(r_0 r_.)$, the difference $t-T$ between the *actual* tension t and the *average* tension T of any fiber is insignificant, so that equation (1) serves for such practical purposes.

5. The value of T is immediately laid off graphically by drawing the second diagonal AB of the rectangle $p_0 p_1$, in fig. 1, in which the lines $r_0 p_0$, $r_1 p_1$ represent to an appropriate scale the applied internal and external pressures p_0 and p_1 at the radii r_0 and r_1.

(The use of the same letter to denote an algebraical quantity and a corresponding spot on the diagram need not lead to confusion; and it is convenient for economy of notation, because the large number of quantities to be distinguished in this subject would otherwise speedily exhaust our stock of available letters).

If this diagonal cuts the line Oy through the center O perpendicular to $Or_0 r_1$ in T, then OT represents to scale the quantity T; for if $p_0 n_0$, $p_1 n_1$ are drawn perpendicular to Oy, then the rectangles $p_0 n_1$ and $p_1 t$ are equal: and, therefore, the rectangle $r_1 t$ is equal to the difference of the rectangles $p_0 n_1$ and $p_1 r_0$, or is equal to the difference between the rectangles Op_0 and Op_1; and this translated into an algebraical equation, shows that

$$(r_1-r_0)OT=p_0 r_0-p_1 r_1, \tag{3}$$

so that, according to equation (1), the line OT represents the algebraical magnitude T.

6. If $p_1 p_0$ cuts OT in V, then

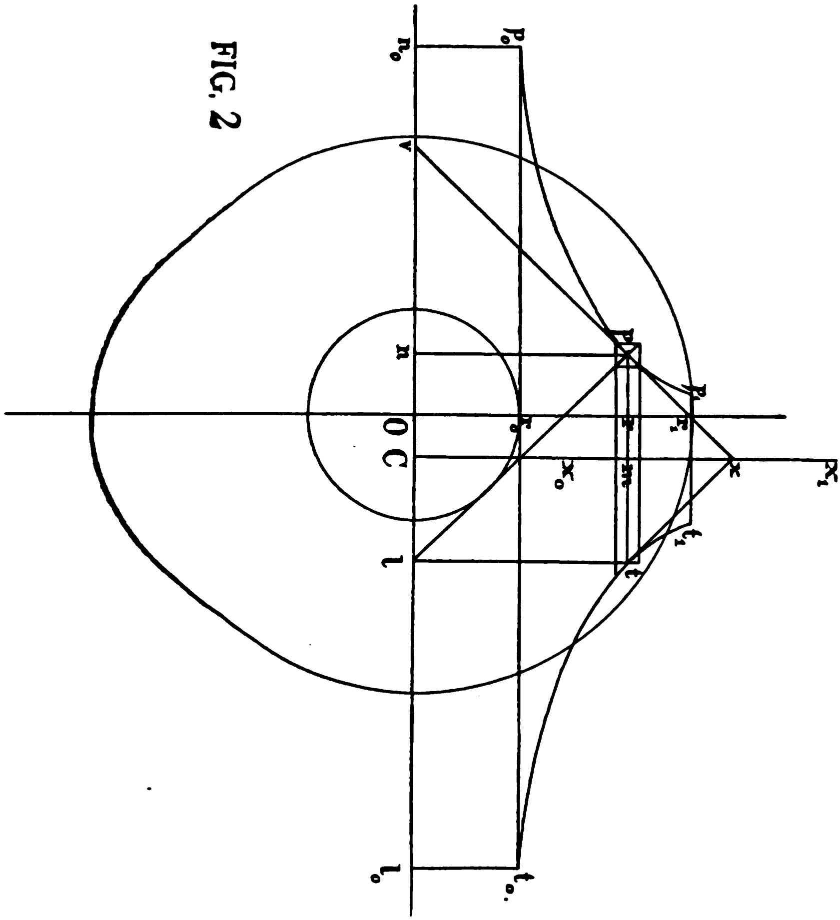
$$n_0 V=n_1 T \tag{4}$$

But now suppose that r_0 and r_1, instead of being the inside and outside radii of the metal tube, are the inside and outside radii of a thin cylindrical portion in the interior of the metal; the preceding relations still hold, and now $p_1 p_0$ is ultimately the tangent to the curve representing the radial pressure p in the metal at any radius r, while the average tension T becomes the actual circumferential tension t, when the points n_0 and n_1 come into coincidence at n (fig. 2), so that the last equation (4) proves that

$$nV=pt \tag{5}$$

or the subtangent nv of the curve of radial pressure is equal to the line pt, representing the sum $p+t$ of the radial pressure p and circumferential tension t at any intermediate radius r of the metal.

FIG. 2



Thus given the curve of p, the curve of t can be derived, and *vice versa*.

7. This geometrical result is the graphical interpretation of the differential equation

$$t = -\frac{d}{dr}(pr)$$

$$\text{or } t + p = -r\frac{dp}{dr} \qquad (6)$$

obtained by the differentiation with respect to the upper limit r in the equation

$$\int_{r_0}^{r} t dr = p_0 r_0 - pr \tag{7}$$

which is the form taken by equation (2) when the upper limit r_1 is replaced by r, so as to make the equation applicable to the portion of the tube bounded by the internal radius r_0 and externally by any intermediate radius r.

So, also, for the portion of the tube bounded internally by the intermediate radius r and by the external surface of radius r_1, the equation becomes

$$\int_{r}^{r_1} t dr = pr - p_1 r_1 \tag{8}$$

and now a differentiation with respect to the lower limit r will lead to the same result of equation (6).

8. By appropriate winding tension in the system of wire gun construction the curve of circumferential tension t can be made to assume any desired shape, while the shrinkage between the hoops in built up ordnance can be adjusted so as to make the tension t assume definite assigned values at the surfaces of contact of the coils, and thus realize a given curve of t in a discontinuous manner.

But in the separate hoops the tension t and radial pressure p are connected by certain definite relations, depending on the elasticity of the metal.

9. To avoid introducing at this early stage the complicated relations connecting the *strains* and *stresses* in the interior of an elastic solid, it is usual in this subject to assume at the outset that the general state of stress in the interior of a homogeneous cylindrical tube, due to arbitrary internal and external applied pressures, may be realized by combining in appropriate proportions two simple states of stress—

I. The state imagined by Peter Barlow, in which the radial pressure p and the circumferential tension t are equal at any radius r; the metal is then squeezed radially and stretched circumferentially to an equal extent, so that the cubical compression is zero, and there is no change of volume.

This is the state of stress realized in the electrical field, in which the tension along the lines of force is, according to Maxwell's theory, accompanied by an equal pressure at right angles to the lines of force.

II. The state of stress, introduced by Rankine as complementary to the Barlow stress, in which the radial pressure and the circumferential pressure are equal, or in which

$$p=-t, \text{ or } p+t=0.$$

This is a hydrostatic stress, and would be realized in homogeneous metal if exposed to uniform external pressure p; as for instance if enclosed in the water in a hydraulic press.

10. In each of these states of stress the curves of radial pressure p and circumferential t are symmetrical with respect to each other; so that in the general case, obtained by combining the two simple states I and II (Barlow's and Rankine's) in varying proportions, this state of symmetry will still exist; in other words, the curves of p and t are reflexions of each other in a median line of symmetry Cm (fig. 2) when we consider the state of stress in the interior of a homogeneous tube.

According to equation (5) then,

$$nv=pt=2pm \tag{9}$$

and this is a characteristic property of a curve in which the ordinate pm varies inversely as the square of the abscissa Cm.

This curve is called a Barlow curve; for in Barlow state of stress Cm coincides with Or, and now

$$p=t=\frac{a}{r^2} \tag{10}$$

where a is some constant.

11. The direction of the tangent at any point of a Barlow curve is of great assistance in drawing the curve with accuracy; the tangent can be laid down according to equation (9), or else the point x in which it meets the axis Cm produced can be determined by making

$$mx=\tfrac{1}{2}Cm; \tag{11}$$

this method is generally easier of application, and has the advantage of giving at the same time the tangent xt at the corresponding point t of the curve of circumferential tension.

12. This result of equation (10) follows analytically from equation (6) by putting $p = t$, when

$$2p = -r\frac{dp}{dr}$$

$$\text{or} \quad \frac{1}{p}\frac{dp}{dr} + \frac{2}{r} = 0 \qquad (12)$$

and, integrating,

$$\log p + 2\log r = \text{constant}$$

$$\text{or} \quad \log pr^2 = \text{constant},$$

$$\text{or} \quad pr^2 = \text{constant} = a, \text{ suppose.}$$

But if $p = -t$, then equation (6) becomes

$$\frac{dp}{dr} = 0, \text{ so that } p = b, \text{ a constant.}$$

13. The addition of the Rankine state of stress is now interpreted geometrically by merely sliding the Barlow curves for p and t the same distance b to the right or to the left, so that the axis of the Barlow curves assumes some new position Cm; and now in the general case

$$t = \frac{a}{r^2} + b \qquad (13)$$

$$p = \frac{a}{r^2} - b \qquad (14)$$

and the two disposable constants a and b can be determined from two arbitrary conditions; for instance, from given applied internal and external pressures p_0 and p_1 at the internal and external radii r_0 and r_1; or, as is usual in the calculations of the pressure which a built up gun will stand, from the given external pressure p_1, and the given internal pressure t_0, and then

$$p_0 - p_1 = a\left(\frac{1}{r_0^2} - \frac{1}{r_1^2}\right)$$

$$t_0 + p_1 = a\left(\frac{1}{r_0^2} + \frac{1}{r_1^2}\right),$$

so that

$$\frac{p_0-p_1}{t_0+p_1}=\frac{r_1^2-r_0^2}{r_1^2+r_0^2}$$

$$\text{or}\quad p_0=\frac{r_1^2-r_0^2}{r_1^2+r_0^2}\left(t_0+p_1\right)+p_1, \qquad (15)$$

the formula most generally useful in gun designs.

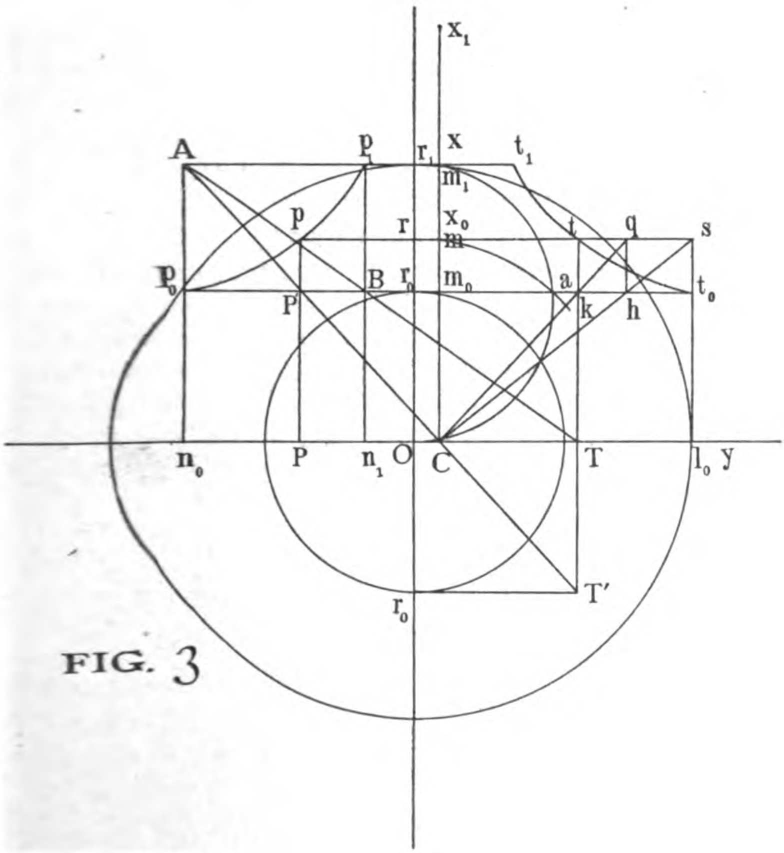


FIG. 3

14. It will be noticed that a and b may assume negative values; but a cannot be negative and b positive, because this would make p negative, a result which never occurs in practice.

The radial pressure p is thus always reckoned positive, but it is usual in this subject to reckon the circumferential stress as positive when it is a tension t; this is contrary to the methods employed in a systematic treatment of the subject of Elasticity, where it is important to adhere to one system, usually to reckon tension as a positive stress and pressure as a negative stress; although this method is reversed in Hydrostatics where a pressure is reckoned as a *positive* stress, and a tension (as in Capillarity) as a negative pressure.

These troublesome considerations of positive and negative signs are however avoided completely in the geometrical treatment which it is our object to develop in the present paper.

15. Taking the Barlow curves p_0pp_1 and t_0tt_1 (fig. 3), symmetrical with respect to the axis Cm, in which

$$pm \cdot Cm^2 = tm \cdot Cm^2 = a \tag{16}$$

a simple geometrical construction will give the position of any point t corresponding to the radial distance Cm, supposing the curve to start from any point t_0 corresponding to radius Cm_0. Draw the straight line through t_0 parallel to Cm, cutting pm produced in s; join Cs, cutting m_0t_0 in h; draw hq parallel to Cm, cutting ps in q; join Cq, cutting m_0t_0 in k; draw kt parallel to Cm, cutting ps in t. Then t will be the required point on the Barlow curve t_0t; for

$$\frac{mt}{mq} = \frac{m_0k}{mq} = \frac{Cm_0}{Cm},$$

$$\frac{mq}{m_0t_0} = \frac{m_0h}{ms} = \frac{Cm}{Cm},$$

and, therefore, multiplying these equations,

$$\frac{mt}{m_0t_0} = \left(\frac{Cm_0}{Cm}\right)^2$$

$$\text{or} \quad mt \cdot Cm^2 = m_0t_0 \cdot Cm_0^2, \tag{17}$$

the required relation.

A repeated application of the process, required for subsequent purposes, is shown in fig. 4.

16. We notice incidentally that

$$mq \cdot Cm = m_0t_0 \cdot Cm_0, \tag{18}$$

so that q lies on the hyperbola starting from t_0, and having Cm, nC as asymptotes; this construction of the hyperbola is useful in the theory of the wire gun.

17. According to equation (2)

the area $m_0 t_0 t t_1 m_1$ = rectangle Cp_0 — rectangle Cp_1

$$= \text{"} \quad Ct_0 - \quad \text{"} \quad Ct_1$$

$$= p_0 r_0 - p_1 r_1$$

$$= \frac{a}{r_0} - \frac{a}{r_1};$$

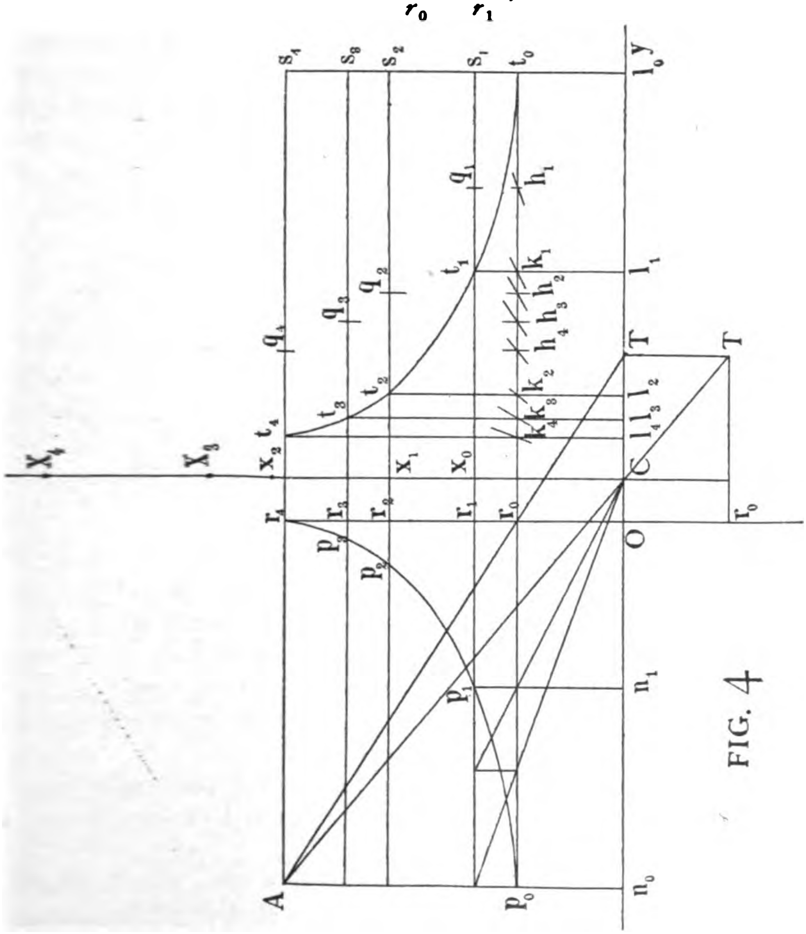


FIG. 4

so that if mt represents the *mean* ordinate of the area $m_0 t_0 t t_1 m_1$,

$$mt = \frac{\frac{a}{r_0} - \frac{a}{r_1}}{r_1 - r_0} = \frac{a}{r_0 r_1}$$

and then

$$Cm^2 = Cm_0 \cdot Cm_1, \quad mt^2 = m_0 t_0 \cdot m_1 t_1, \tag{19}$$

or Cm, the radius of the mean tension, is the geometric mean of Cm_0 and Cm_1, and is therefore laid off geometrically by describing the circle on Cm_1 as diameter, cutting $m_0 t_0$ in a, and striking the circular arc am, with C as center; this will be found useful in the sequel, especially for the geometrical determination of the center C of the Barlow curves for given data.

18. Suppose, for instance, that the internal and external pressures p_0 and p_1 are given: drawing the second diagonal AB (fig. 3) of the rectangle $p_0 p_1$, this will cut OC in T, such that Tt is parallel to Or, the ordinate rt representing the *mean* tension T.

But now

$$CT = \frac{a}{r_0 r_1}, \quad Cn_0 = \frac{a}{r_0^2},$$

so that

$$\frac{CT}{Cn_0} = \frac{r_0}{r_1},$$

and therefore AC produced cuts tT produced in a point T', such that

$$\frac{TT'}{An_0} = \frac{r_0}{r_1};$$

and since $An_0 = r_1$, therefore, $TT' = r_0$.

To determine therefore the center C for given p_0 and p_1, draw the diagonal ABT cutting Oy in T; draw tTT' parallel to Or, making $TT' = Or_0$; then AT' will cut Oy in C; and C being thus determined, the points t_0, t_1 are the reflexions of p_0, p_1 in the line $Cm_0 m_1$; and the curves $p_0 p p_1$, $t_0 t t_1$, can be constructed geometrically by the preceding process.

19. When p_0 and t_0 are given, or p_1 and t_1, the points m_0 and m_1 are the middle points of $p_0 t_0$ and $p_1 t_1$, and thence the axis Cm of the Barlow curves is determined.

Suppose for instance that r_0, p_0, and t_0 are given, and that the value of r_1 is required for which $p_1 = 0$: this is the problem required in the determination of the requisite thickness $r_1 - r_0$ of a tube (a steam pipe for instance) of given internal diameter $2r_0$, to stand a pressure p_0 without straining the metal beyond a certain working tension t_0.

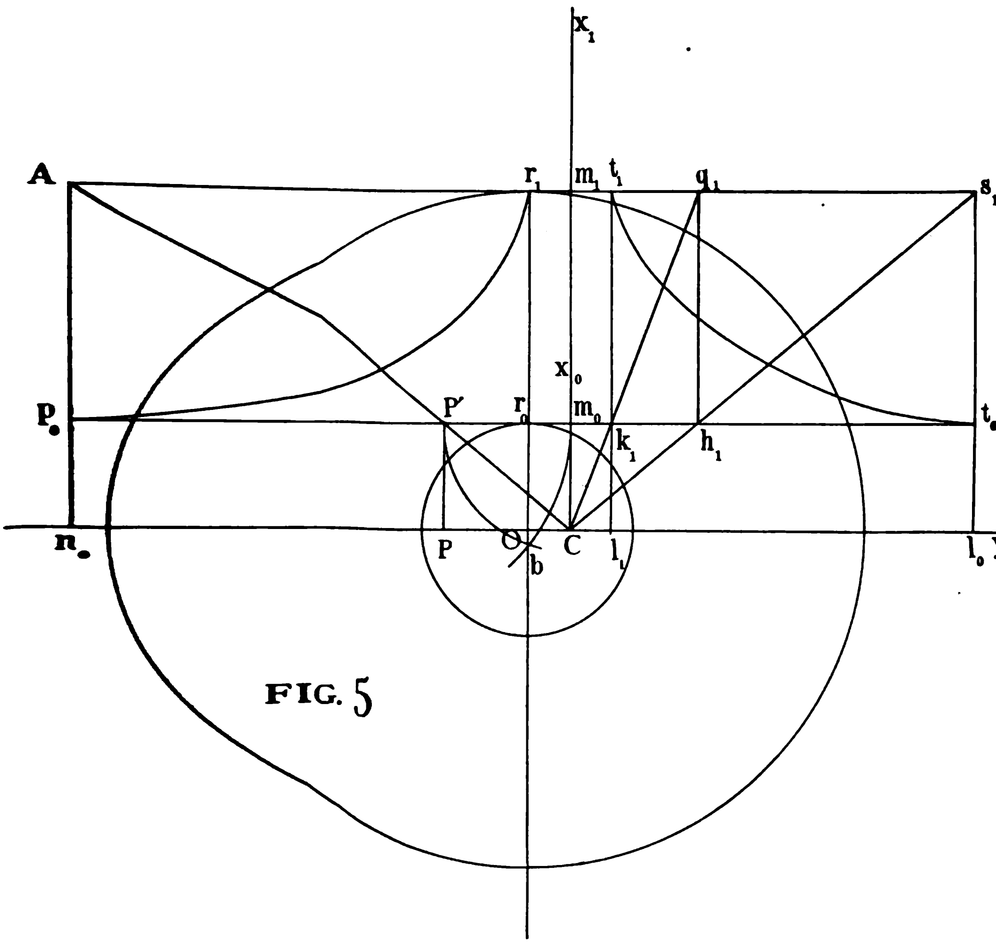


FIG. 5

Having drawn Cm_0 passing through m_0, the middle point of $p_0 t_0$ (fig. 5), take CP the geometric mean of CO and Cn_0, or $m_0 P'$ the geometric mean of $m_0 r_0$ and $m_0 p_0$, so that Pr' is parallel to Or; then CP' produced will meet $n_0 p_0$ produced in a point A, such that Ar_1 drawn parallel to OC will cut off the required outside radius Cr_1; this follows from the preceding theory.

20. But the problem of most frequent occurrence in the design of a built up gun is that in which the data are p_1 and t_0; and now from equation (15)

$$\frac{p_0 - p_1}{t_0 + p_1} = \frac{r_1^2 - r_0^2}{r_1^2 + r_0^2}$$

$$\frac{Ap_1}{Bt_0} = \frac{r_1^2 - r_0^2}{r_1^2 + r_0^2}$$

$$= \frac{\frac{r_1^2}{r_0} - r_0}{\frac{r_1^2}{r_0} + r_0} \text{ or}$$

$$= \frac{r_1 - \frac{r_0^2}{r_1}}{r_1 + \frac{r_0^2}{r_1}} \qquad (20)$$

Make $OE = \frac{r_0^2}{r_1}$, $OF = \frac{r_1^2}{r_0}$ (fig. 6); this is done geometrically by drawing the tangent $r_1 e$ to the circle $r_0 e$, or by drawing the circle on Or_1 as diameter, cutting the circle of radius r_0 in e, and drawing eE parallel to OC; and by drawing the tangent fF at right angles to the radius Of of the circle $r_1 f$ at the point f where it is cut by the line $r_0 t_0$; and then e in the point where the radius Of cuts the circle $r_0 e$.

Then

$$\frac{Ap_1}{Bt_0} = \frac{Fr_0}{r_0 F'} \text{ or} = \frac{r_1 E}{Er'_1}$$

r'_1 being the reflexion of r and F' of F in the line OC; so that, if $t_0 D'G'$ is drawn parallel to Or, cutting the lines through r'_1 and F' parallel to OC in D' and G', then $G'B$ produced will meet

FG drawn parallel to *OC* in *G*, such that p_0AG is parallel to *Or;* or *D'D* drawn through *D*, the point of intersection of *ED* parallel to *OC* and p_1B produced, will pass through *A;* and thence the position of the required point p_0 or the value of the internal pressure p_0 is determined.

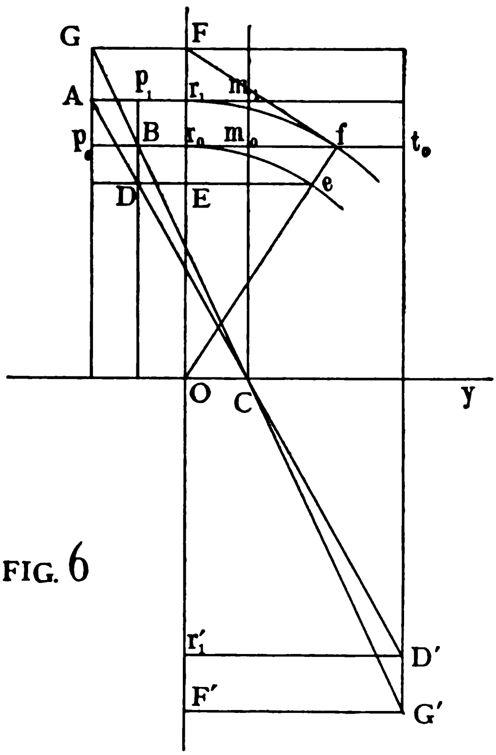


FIG. 6

These two methods of determining p_0 are given, and the one most appropriate to the scale of the diagram is to be employed.

21. The center *C* of the corresponding Barlow curves is determined as the point where *GG'* or *DD'* cuts *Oy;* or, as before (in fig. 3), by producing *AB* to meet *On* in *T*, drawing *TT'* parallel to *Or* to meet $r'_0 T'$ parallel to *On* in *T'*, and joining *AT';* then *AT'* will cut *On* in *C;* and t_1 will be determined as the reflexion of p_1 in axis *Cm* of the Barlow curves.

22. In applying these geometrical methods to a built up gun,

in which the external radii of the various hoops or jackets are denoted by $r_n, r_{n-1}, r_{n-2}, \ldots$ in descending order towards the interior, and in which the maximum allowable tension at the internal radii $r_{n-1}, r_{n-2}, \ldots$ are denoted by $t_{n-1}, t_{n-2}, \ldots$, we start at the outside surface at which the radial pressure p_n is zero, and thence from the data $r_n, r_{n-1}, p_n = 0$ and t_{n-1} we determine as above, in fig. 6, the value of p_{n-1}, and also t_n.

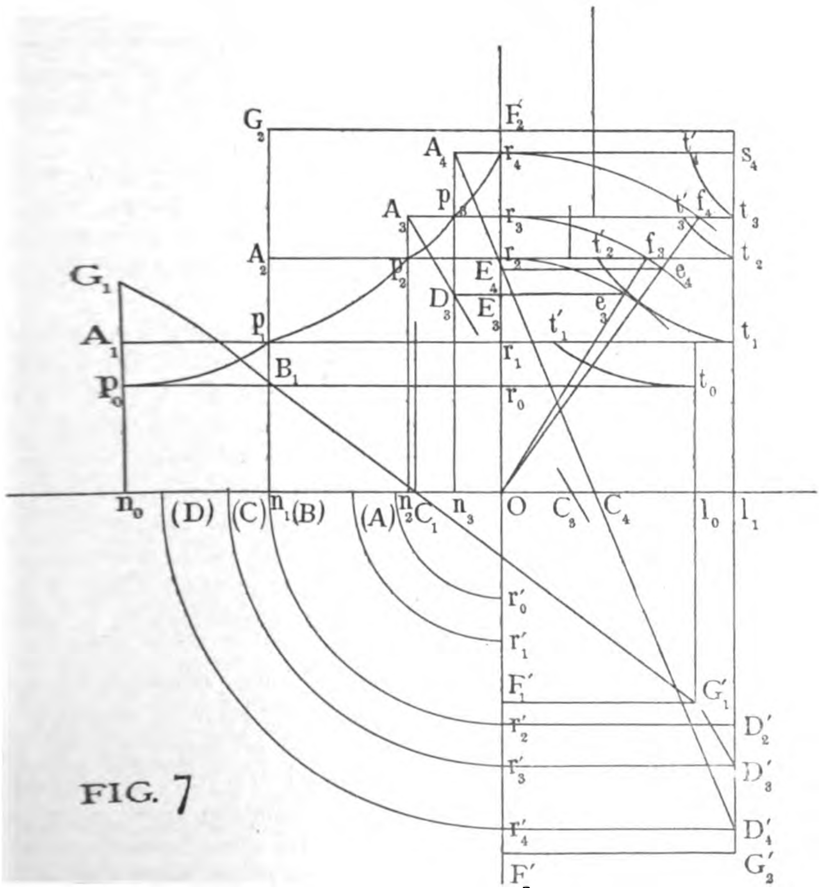


FIG. 7

In the next hoop, bounded by r_{n-1} and r_{n-2}, the data are p_{n-1}, just determined, and t_{n-2}; and thence p_{n-2} is determined; and so on, until at last the value of p_0 is determined, which is therefore the maximum allowable pressure in the bore of the gun or powder chamber, of caliber $2r_0$, subject to the condition that the maximum allowable tension in the metal of the various cylindrical tubes, proceeding upwards, is limited to $t_0, t_1, t_2, \ldots t_{n-1}$.

The values of $p_{n-1}, p_{n-2}, \ldots p_0$ have hitherto been calculated from the gunmaker's formula (15), but as the arithmetical labor is considerable, the above geometrical construction is proposed as a substitute, or as a check upon the calculations.

The method is shown in fig. 7, as applied to the powder chamber of the 8-inch B.L. rifle, described in *Notes on the Construction of Ordnance*, No. 31, by Lieutenant Rogers Birnie, Jr., Ordnance Department.

Here $r_0=4.75$, $r_1=7.0$, $r_2=11.0$, $r_3=13.15$, $r_4=15.75$, which we have changed to the nearest round numbers, 5, 7, 11, 13, 16; and we have taken $t_0=15$, $t_1=t_2=t_3=18$, tons/in², in accordance with the usual rules laid down for British ordnance (*Treatise on Service Ordnance*, 1893: Part V, Chapter II).

23. These stresses in the hoops of the gun when in action, called the *firing stresses* and sometimes distinguished by capital letters, P and T, are those which concern the artillerist when calculating the extreme powder pressure allowable and the greatest amount of energy that can be delivered from the gun.

But the gunmaker has to work to the stresses which are left in the gun when in a state of repose, in order to calculate the requisite amount of shrinkage for securing the *initial* stresses in a state of repose, such that when the gun is fired the firing stresses called into action should satisfy the conditions laid down by the artillerist.

24. It is assumed that the *initial stresses* become converted into the *firing stresses* by the superposition of the state of stress induced by the maximum allowable powder pressure p_0 in the gun, considered as a homogeneous cylinder in a state of repose; or that the *initial stresses* may be deduced from the *firing* stresses by deducting the *powder stresses* set up in the gun, considered as a homogeneous cylinder, by the application of the internal pressure p_0.

These powder stresses can be laid off geometrically in the manner previously explained, the stresses at the surfaces of separation of the hoops being used as the chief guiding points; the method is illustrated in fig. 4 for the 8-inch B.L. rifle; while the initial stresses, obtained by deducting the powder stresses of fig. 4 from the firing stresses of fig. 7 are exhibited in fig. 8.

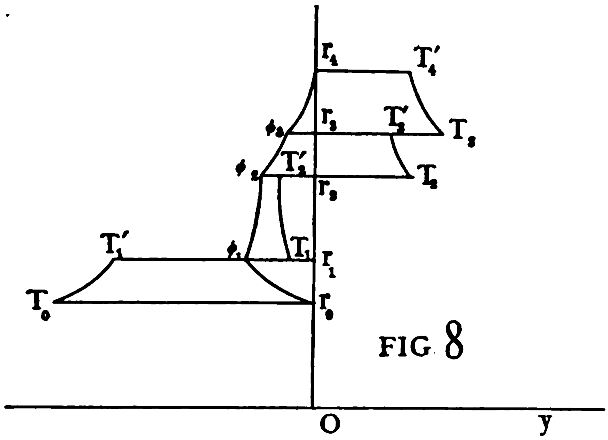


FIG 8

25. Distinguishing, by means of an accent, the circumferential tension t'_n at the outside surface of a tube, jacket, or hoop, from the tension t_n at the inside surface of the hoop in contact over the cylindrical surface of radius r_n, then the difference, $t_n - t'_n$, is the same whether we consider the firing stresses or the initial stresses.

This difference of tension is due to the shrinkage pressure p_n, which again is due to making the two parts in contact to have a slight overlap before assemblage, by heating of the outside hoop: so that, as manufactured in the lathe, the inner radius of the outer cylinder is a slight amount u_n less than r_n, and therefore the radius is made $r_n - u_n$; while the outside surface of the inner cylinder has the radius made $r_n + u'_n$, exceeding the radius r_n when assembled by u'_n.

The amount of total overlap before asssemblage $2(u_n + u'_n)$, called the (*absolute*) shrinkage, is denoted by ${}_nS_{n+1}$, while the absolute shrinkage divided by the diameter $2r_n$, or $\frac{u_n + u'_n}{r_n}$, is called the *relative* shrinkage; and it follows from the theorems of Elasticity (given below in § 34) that

$$ {}_{n}S_{n+1} = 2r_n \frac{t_n - t'_n}{M}, \qquad (23) $$

or the relative shrinkage

$$ = \frac{t_n - t'_n}{M}, \qquad (24) $$

where M denotes Young's modulus of elasticity.

26. Taking $M = 12{,}500$ (tons/in²), as an average value, the shrinkages of the 8-inch B.L. rifle are given by

$_{1}S_{2} = 0.014$ inches, or 14 thousandths,
$_{2}S_{3} = 0.019$ inches, or 19 thousandths,
$_{3}S_{4} = 0.007$ inches, or 7 thousandths.

The final expansion of the outside diameter $2r_n$

$_{4}S_{5} = 0.016$ inches, or 16 thousandths.

An interesting diagram in *Notes on the Construction of Ordnance* No. 31, by Lieutenant Rogers Birnie, shows the changes of diameter of the various parts at successive stages of the assemblage.

27. The parts of the mathematical theory of Elasticity as required by the gunmaker in the theory of Gun Construction may be presented in a condensed form as follows:

When a piece of metal is pulled, as for instance a test piece of steel in a testing machine, it is found that the *extension*, measured by the ratio of the *elongation* to the original length, is proportional to the *tension*, which we measure in tons per square inch of cross section.

The doubling the tension doubles the extension; and so on in proportion, provided the elastic limit is not exceeded.

This experimental law is called Hooke's Law, and it is the axiomatic foundation of the Mathematical Theory of Elasticity; expressed in an algebraical form, if a pull of T tons in a bar of K in² cross section stretches the length from L to $L+l$, then the tension $\frac{T}{K}$ tons/in² and the extension $\frac{l}{L}$ are, by Hooke's law, connected by the relation

$$ \frac{T}{K} = M \frac{l}{L}, \qquad (25) $$

where M denotes a constant number, of tons/in², called Young's modulus of elasticity of the material; for steel it is found that a good average value is

$$M = 12{,}500,\ \text{ton/in}^2,$$

28. In this case the test piece in the testing machine is subject to a single tension, and a certain amount of lateral contraction takes place; but now consider the strains which take place in a small brick shaped piece of metal, forming the portion of the interior of a large piece, due to tension of P, Q, R tons/in² acting in directions parallel to the edges and across the faces.

The piece of metal will be strained into a slightly enlarged brick shape, so that the lengths of the edges, denoted by x, y, z suppose, will become stretched to

$$x(1+e),\ y(1+f),\ z(1+g), \text{ suppose}; \tag{26}$$

so that the extensions of the edges are represented by the numbers e, f, g.

As a consequence of Hooke's law and the homogeneity of the metal, we shall have

$$\begin{aligned} P &= Ae + Bf + Bg, \\ Q &= Be + Af + Bg, \\ R &= Be + Bf + Ag; \end{aligned} \tag{27}$$

where A and B are two constants depending on the elasticity of the metal.

By solution of these three equations

$$P - \frac{B}{A+B}(Q+R) = \left(A - \frac{2B^2}{A+B}\right)e, \tag{28}$$

or

$$\begin{aligned} P - \sigma(Q+R) &= Me, \\ Q - \sigma(R+P) &= Mf, \\ R - \sigma(P+Q) &= Mg, \end{aligned} \tag{29}$$

on putting

$$\frac{B}{A+B} = \sigma,\ A - \frac{2B^2}{A+B} = M. \tag{30}$$

29. For a simple tension, as in a test piece or a tie rod, $Q = 0$, $R = 0$, and then

$$P = Me, \tag{31}$$

so that M is, as before, Young's modulus of elasticity, as determined in the testing machine; and then

$$f = g = -\sigma e, \tag{32}$$

so that σ, called *Poisson's ratio*, is the ratio of the lateral contraction to the linear extension of the test piece, under simple tension.

But if lateral contraction is prevented by appropriate lateral tension, so that $f=0$, $g=0$, and the strain is a pure extension e, then

$$P = Ae, \quad Q = R = Be; \tag{33}$$

and the modulus of elasticity $\frac{P}{e}$ now appears as equal to A:

and

$$\frac{M}{A} = 1 - \frac{2B^2}{A^2+AB} = \frac{(A-B)(A+2B)}{A(A+B)} \tag{34}$$

30. For steel it is found that $\sigma = \frac{1}{4}$, so that $A = 3B$, and

$$\frac{M}{A} = \tfrac{5}{6}; \tag{35}$$

and now

$$\begin{aligned} P &= A(e+\tfrac{1}{3}f+\tfrac{1}{3}g), \\ Q &= A(\tfrac{1}{3}e+f+\tfrac{1}{3}g), \\ R &= A(\tfrac{1}{3}e+\tfrac{1}{3}f+g), \end{aligned} \tag{36}$$

$$\begin{aligned} Me &= P-\tfrac{1}{4}(Q+R), \\ Mf &= Q+\tfrac{1}{4}(R+P), \\ Mg &= R-\tfrac{1}{4}(P+Q), \end{aligned} \tag{37}$$

the formulas employed by Virgile, Clavarino, and other writers on this subject; but we have thought it useful to make this digression to show in an elementary manner the principles upon which these formulas depend.

31. Consider now the application of these formulas to the problem required by the gunmaker, the determination of the strains due to the stresses in the interior of a thick steel tube; we take a small brick shaped element cut out of the material

(i) by two adjacent co-axial cylinders of radii r and $r+dr$;

(ii) by two consecutive radial planes;

(iii) by two consecutive transverse plane cross sections.

Then taking x, y, z in the circumferential, radial, and longitudinal directions, we put in accordance with the preceding principles, and with equations (13), (14),

$$P = t = ar^{-2} + b,$$
$$Q = -p = -er^{-2} + b, \tag{38}$$

leaving R undetermined for the present.

32. Denote by u the increase of the radius r of the circumferential fiber due to the applied stresses; then the fiber is stretched from a length $2\pi r$ to a length $2\pi(r+u)$, so that the circumferential extension

$$e = \frac{2\pi u}{2\pi r} = \frac{u}{r} \tag{39}$$

The radial extension

$$f = \frac{du}{dr} \tag{40}$$

while the longitudinal extension g is left undetermined for the present.

We can, however, show that R and g may be taken as constant; for since

$$Me = M\frac{u}{r} = P - \sigma(Q+R)$$
$$Mu = (P - \sigma Q)r - \sigma Rr,$$
$$= (1+\sigma)ar^{-1} + (1-\sigma)br - \sigma Rr, \tag{41}$$

differentiating with respect to r,

$$M\frac{du}{dr} = -(1+\sigma)ar^{-2} + (1-\sigma)b - \sigma\frac{d}{dr}(Rr)$$
$$= Mf = Q - \sigma(R+P)$$
$$= -(1+\sigma)ar^{-2} + (1-\sigma)b - \sigma R, \tag{42}$$

which is satisfied if $\frac{dR}{dr} = 0$, or R is constant; and then

$$Mg = R - \sigma(P+Q) = R - 2\sigma b, \tag{43}$$

is also constant, so that g is constant.

33. The constant value of R may be taken as equal to the total longitudinal thrust on the end of the bore $\pi r_0^2 p_0$ tons of the internal pressure p_0 tons/in², divided over the area in square inches of the cross section of the material of the gun; or in considering the initial stresses in a state of repose, we may put $R = 0$.

34. Now considering the adjacent circumferential fibers at the

surface of the n.th and $n+1$.th hoops, each practically of radius r_n, then the inner fiber of the $n+1$.th hoop has had its radius stretched from $r_n - u_n$ to r_n; so that, as it is immaterial whether we take r to refer to the unstrained or the strained radius of the fiber, we may put

$$r = r_n, \quad u = u_n,$$

in equation (41); and at the same time put

$$P = t_n, \quad Q = -p_n,$$

so that

$$Mu_n = (t_n + \sigma p_n) r_n - \sigma R r_n \tag{44}$$

In the adjacent outer fiber of the n.th hoop, the radius has been diminished from $r_n + u'_n$ to r_n, so that we must put

$$r = r_n, \quad u = -u'_n,$$

and at the same time

$$P = t'_n, \quad Q = -p_n,$$

in equation (41); and then

$$-Mu'_n = (t'_n + \sigma p_n) r_n - \sigma R r_n \tag{45}$$

and, subtracting

$$M(u_n + u'_n) = (t_n - t'_n) r_n, \tag{46}$$

$$\text{or} \quad {}_nS_{n+1} = 2r_n \frac{t_n - t'_n}{M}, \tag{47}$$

as employed above, in equation (23).

For different moduli of elasticity M and M', equation (46) would become changed to

$$Mu_n + M'u'_n = (t_n - t'_n) r_n, \tag{48}$$

The shrinkage ${}_nS_{n+1}$ is thus the elongation which would be produced in a bar of metal $2r_n$ inches long by a tension of $t_n - t'_n$ tons/in²; also from equations (13), (14),

$$t_n - t'_n = (t_n - t_{n-1}) - (p_n - p_{n-1})$$

$$= t_n - t_{n-1} = \frac{r^2_n - r^2_{n-1}}{r^2_n + r^2_{n-1}} (t_{n-1} + p_n). \tag{49}$$

35. Considering that the curve of circumferential tension is continuous for the powder stresses, the addition or subtraction of these stresses does not alter the difference $t_n - t'_n$, so that the shrinkage ${}_nS_{n+1}$ can be calculated from the diagram and values either of the firing stresses in action or of the initial stresses in

repose; and it is independent of the shrinkage imparted at other surfaces of contact of the tubes, provided that it is calculated as the shrinkage of the parts before assemblage.

If, however, the shrinkage is estimated for the difference between the internal diameter of a finished hoop and the external diameter of the partially built up gun over which the hoop is to be shrunk, then the initial stresses already set up in the gun must be taken into account and deducted.

This is illustrated in the diagram of *Notes on the Construction of Ordnance*, No. 31, by Lieutenant Rogers Birnie, showing the shrinkage (enlarged 50 times) of the different finished parts, before assemblage, in the intermediate states during assemblage, and in the final state, when a jacket and two hoops are shrunk over the *A* tube of an 8-inch gun.

36. With the numerical data of §§ 22, 26,

$$r_1 = 7 \text{ inches}, \; t_1 - t'_1 = 12.7 \text{ tons},$$
$$r_2 = 11 \text{ inches}, \; t_2 - t'_2 = 10.7 \text{ tons},$$
$$r_3 = 13 \text{ inches}, \; t_3 - t'_3 = 3.6 \text{ tons};$$

so that, with $M = 12{,}500$ tons/in^2,

$$_1S_2 = 12.7 \times 14 \div 12500 = 0.014 \text{ inches},$$
$$_2S_3 = 10.7 \times 22 \div 12500 = 0.019 \text{ inches},$$
$$_3S_4 = 3.6 \times 26 \div 12500 = 0.007 \text{ inches},$$

or 14, 19, and 7 thousandths of an inch.

In a state of repose the tension of the outer fibers of the outside hoop

$$t'_4 = 8.1,$$

and the circumferential pressure in the interior of the bore

$$-t_0 = 19.9;$$

so that, with $r_0 = 5$, $r_5 = 16$,

$$_0S_1 = 19.9 \times 10 \div 12500 = 0.016,$$

or the contraction of the caliber, in consequence of the shrinkage, is 16 thousandths of an inch, which is rather excessive; while

$$_4S_5 = 8.1 \times 32 \div 12500 = 0.021,$$

or the elongation of the external diameter due to the shrinkage in 21 thousandths of an inch.

37. The coefficient of expansion of steel per 1 °F. is almost $1 \div 150{,}000$; so that if ${}_nS_{n+1}$ denotes the shrinkage during manufacture, the temperature must be raised

$$150{,}000 \frac{{}_nS_{n+1}}{2r_n} \tag{50}$$

degrees Fahrenheit for the $n+1$.th hoop to be expanded sufficiently, so as to slip over the n.th tube of the partially completed gun.

The Theory of Wire Gun Construction.

38. An inspection of the stresses in fig. 4 shows that if the interior surface of the tube is strained to its full allowable working tension t_0, the remainder of the metal is not bearing a fair share of the work; and the loss of strength may be represented graphically by the area $t_0t_4s_4$, the difference between the rectangle r_0s_4, which would represent the resistance of the section r_0r_1 of the metal if all the fibers took up the full amount of tension t_0, and the area $t_0t_4r_4r_0$, representing the actual resistance of the section.

In the built up gun this loss of resistance is reduced by the system of shrinkage, as shown by an inspection of the serrated edge of the curve of circumferential tension in fig. 7.

The maximum economy of material would be secured if we could make all the circumferential fibers take up the full working tension (say of 15 tons/in^2) when the gun is fired; but to secure this condition only approximately with the built up system would require the number of tubes and hoops to be very much increased, and this is impossible by reason of the great increase in cost and time of manufacture.

The difficulty is solved by adopting the system proposed by Dr. Woodbridge and Mr. J. A. Longridge, of strengthening an inner tube A by winding on it steel wire; and now the tension of the wire may be so adjusted during the process of winding, that when the gun is fired with a given pressure p_0, the circumferential tension t in the wire shall be uniform.

For a complete history and treatment of this system the reader should consult "*Les canons à fil d'acier*" by Lieutenant G. Moch, or its translation in *Notes on the Construction of Ordnance*, No. 48, 1888; it is proposed here only to exhibit the application of the geometrical methods of construction.

39. Let fig. 9 represent the firing stresses in a wire gun, composed of an inner tube (A), the wire coil (B), and an outer jacket (C).

The jacket (C) is required merely for the protection of the wire, and it may be supposed fitted over the coil (B) without appreciable shrinkage; when the gun is in action the stresses in

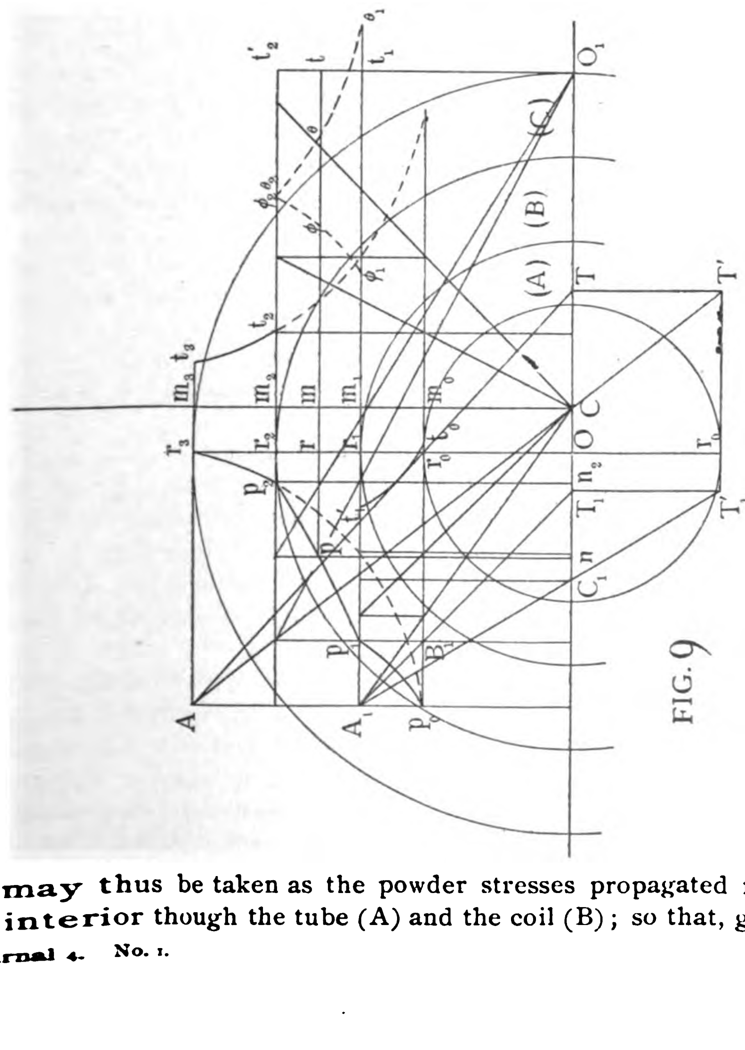


FIG. 9

(C) may thus be taken as the powder stresses propagated from the interior though the tube (A) and the coil (B); so that, given the internal pressure p_0, the curves $p_0 p_2 r_3$ of radial pressure and $t_3 t_2$ of circumferential tension in the hoop (C) are the curves of powder stresses, drawn on the assumption that the material is homogeneous.

The center C of these Barlow curves is therefore obtained by producing the second diagonal Ar_0 of the rectangle $p_0 r_3$ to meet Oy in T, drawing TT' downward at right angles to Oy and of length r_0, and then joining AT', which will cut Oy in C.

The point p_2 in which the curve of radial pressure $p_0 r_3$ meets the ordinate $r_2 p_2$ is then obtained geometrically in the manner explained in § 15.

40. In the wire coil (B) the firing stresses are represented by a given uniform circumferential tension t, represented by the straight line $t'_2 t t_1$ parallel to Or, and by the curve of radial pressure $p_2 p p_1$ which is therefore a hyperbola with $t'_2 t_1$ and Oy for asymptotes.

This follows either from equation (5), because the subtangent nv is equal to the ordinate pt in a hyperbola; or otherwise, from equations (1) and (2), because the equilibrium of the wire coil bounded by the radii r_2 and r requires that

the rectangle Op—rectangle Op_2=rectangle $r_2 t$

or, adding the rectangle Ot,

the rectangle nt=rectangle $n_2 t'_2$

a characteristic property of the hyperbola $p_2 p$, having $O_1 n$ and $O_1 t$ as asymptotes, O_1 being the point of intersection of Oy and $t'_2 t_1$.

The point p_1 in which this hyperbola of radial pressure $p_2 p p_1$ cuts the ordinate $r_1 p_1$ is obtained geometrically in the manner explained in § 16.

41. Lastly in the tube (A), subject to the applied external and internal pressures p_1 and p_0, the method of § 20 gives the determination of the corresponding Barlow curves, and thus of t'_1 and t_0.

42. The powder stresses have already been determined incidentally: so that deducting these powder stresses from the firing stresses of fig, 9, we are left with the initial stresses, which stresses are to be imparted during the process of winding the wire.

It will be noticed that the tube is initially in a state of great circumferential compression, and will approach dangerously near the crushing pressure of the steel of the (A) tube; on the other hand a great initial compression is supposed to possess the advantage of improving the resisting power of the material against erosion.

The Severn tunnel may be instanced as an exemplification of the excessive crushing pressure set up in a tube of brickwork due to the pressure of the surrounding water outside; and if this water, due to the adjacent land springs, is not kept down by incessant pumping, the pressure is sufficient to crush the bricks on the interior of the tunnel.

43. It still remains to determine the varying tension at which the wire must be wound on, so that in the finished coil (B) the curve of initial circumferential tension may assume the requisite form $\varphi_2\varphi_1$ of fig. 9. Calling this varying tension the *winding tension* of the wire and denoting it by θ, it is assumed that this winding tension θ is equal to the finished initial tension φ increased by the circumferential stress due to the initial radial pressure ϖ at the radius r, acting on the partially finished tube and coil between the radii r_0 and r; and thus, from equation (15),

$$\theta=\varphi+\varpi\frac{r^2+r_0^2}{r_2-r_0^2} \qquad (51)$$

In other words, it is assumed that the tension of repose φ is less than the winding tension θ by the amount due to the radial pressure ϖ at the radius r and zero pressure at the radius r_0 in a homogeneous tube.

Now, since the powder stresses are the difference of the stresses of the (t, p) system and of the (φ, ϖ) system,

$$t-\varphi=p_0\frac{r^{-2}+r_3^{-2}}{r_0^{-2}-r_3^{-2}}, \qquad (52)$$

$$p-\varpi=p_0\frac{r^{-2}-r_3^{-2}}{r_0^{-2}-r_3^{-2}}, \qquad (53)$$

and (§ 40)

$$t+p=(t+p_2)\frac{r_2}{r}, \qquad (54)$$

so that

$$\theta = t - p_0 \frac{r_0^2}{r^2} \frac{r_3^2 + r^2}{r_3^2 - r_0^2}$$

$$+ \left(t \frac{r_2 - r}{r} + p_2 \frac{r_2}{r} - p_0 \frac{r_0^2}{r^2} \frac{r_3^2 - r^2}{r_3^2 - r_0^2} \right) \frac{r^2 + r_0^2}{r^2 - r_0^2} \qquad (55)$$

and, after algebraical reduction, this can be expressed in the form

$$\theta = \frac{L}{r} + \frac{M}{r - r_0} + \frac{N}{r + r_0}; \qquad (56)$$

when

$$L = -(t + p_2) r_2 \qquad (57)$$

$$M = t(r_2 - r_0) - p_0 r_0 + p_2 r_2 = (t + p_2) r_2 - (t + p_0) r_0, \qquad (58)$$

$$N = t(r_2 + r_0) + y_0 r_0 + p_2 r_2 = (t + p_2) r_2 + (t + p_0) r_0 \qquad (59)$$

The curve representing θ can thus be plotted out by ordinates equal to the sum of the three ordinates

$$\frac{L}{r}, \quad \frac{M}{r - r_0}, \quad \frac{N}{r + r_0},$$

of corresponding hyperbolas; the first of these three being the hyperbola of firing radial pressure in the wire coil B.

Putting $r = r_2$ makes $\theta_2 = \varphi_2$; as is obviously the case, since the winding tension of the last layer of wire must be the same as the tension in repose.

An experimental investigation of the wire gun theory is given in *Notes on the Construction of Ordnance*, No. 38, *On Winding and Dismantling an Experimental Wire-wound Gun Cylinder*, by Lieutenant W. Crozier, 1886.

Errata.—First line, page four, for $\frac{1}{2}(r_0 + r_0)$ read $\frac{1}{2}(r_0 + r_1)$.

DEVELOPMENT AND CONSTRUCTION OF MODERN GUN CARRIAGES FOR HEAVY ARTILLERY.

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On looking over the immense amount of material on this subject it is apparent that either an outline only can be given or a great deal more written than would be suitable in this paper. The former is chosen, and, in addition thereto, is presented a theoretical view of what it is believed our future development should be.

The first carriages of any account were made of wood and with wooden wheels whose axes were perpendicular to the axis of the piece, giving few facilities for maneuvering and none for checking recoil. Recoil checks were added, consisting of a cable passing through an eye in the knob of the cascable and fastened to the parapet or bulwark, and elevation was given and maintained by preponderance and a wooden chock or quoin. An improvement added to these carriages was to set the wheels nearly at right angles to the piece and coning them to run on a circular path to give facility for training: then came the mounts of two parts, chassis and top carriage, and then the material changed to wrought iron. With this change, or soon after, came different methods of checking recoil, such as gravity, friction, spring, pneumatic, hydraulic, counterpoise, or combinations of these.

New methods of elevating, such as the ratchet post and elevating bar, gear wheels, and toothed arc in its several forms, and hydraulic and pneumatic; and a system of hauling the gun from battery by means of windlass and cable, in place of handspikes working in wheels of top carriage. Now we have changed to steel and have electricity as a motive power, and have changed or rather added to our forms of shelter, and thus greatly modified and complicated our mounts without having changed their principles to any great extent. For barbettes we have the old form with a seven-foot parapet and the gun trunnions nine or ten feet above the pintle, trained and elevated by hand or machinery, preferably by hand, requiring a ladder to get up to the gun and the carriage occupying an immense amount of space. Then the center-pintle live-roller-ring barbette mount, economical of space but still keeping the gun at some distance from the pintle. The casemate carriages are better in principle, as they bring the gun down nearer to the pintle. They are pivoted as near the port as possible, to give the largest field of fire for a given area of porthole. Then come the innumerable varieties of disappearing mounts, the counterpoise, the hydro-pneumatic, pneumatic, and the monstrous combination of counterpoise and pneumatic of Captain Gordon. The spring return mortar carriage is one of the latest and best for high angle fire and is a combination of hydraulic and spring check. All these carriages have loading machinery, elevating and traversing gear, and on most of the larger ones is so arranged as to be worked either by hand or machinery; the elevating apparatus, in some cases, is so arranged by means of friction wheels as to be relieved of the shock of firing. Trunnions are abandoned for saddles and slides in the heavier ones.

As to construction, the material is of the best and plans in general are of good design, but it is not thought that the workmanship has reached its proper limit. There is no reason why not, and every reason why, the best of work should be put on carriages for heavy guns. *First*, they are accurate weapons and their usefulness is discounted if used on inaccurate mounts. *Second*, no allowance can be correctly made for such inaccuracies as they vary without sequence, that is, the error is not constant under constant conditions. Every joint in a carriage should be as perfect as possible, no play should be allowed at any point, and, if possible, the design should be such as to afford no comparatively long span which might yield by flexion.

In regard to the requirements which a carriage for heavy guns must fulfill and the lines to be followed to comply with these, the following remarks are offered, although they may not be strictly within the limits of the subject.

The requirements mentioned above may be stated as follows :

1. Furnish a satisfactory and reliable support from which to fire the gun. This is the most essential.
2. Allow the gun to be easily and quickly loaded, trained and fired.
3. As light as possible, consistent with necessary strength.
4. As simple and with as few points as possible, about which motion can take place.
5. Be suitable to all positions.
6. Allow of such protection to gun and detachment as is consistent with its effective use.

As to the first condition, any carriage which does not fulfill this should not be used, obviously, as with modern guns any shot which is not accurately started on its way is wasted. Of course errors in laying the gun may be counteracted by the error of the carriage, but we are not expected to make errors in laying the gun. The points about a carriage which give rise to inaccuracies, are play at different places, as between rails and guides, between pintle and carriage, at points about which rotation takes place and flexure of supports between points widely separated. Also the moment about the pintle in all except the disappearing carriages causes irregular motions of the axis of the piece.

To fulfill the second, friction is to be avoided as far as possible and a loading apparatus provided such that the gun can be loaded in any position.

The third requires the best of material and care in manufacture.

The fourth should be fulfilled to make repairs as easy and rapid as possible and to assist the fifth.

The fifth allows all positions to have the same carriage, tending to rapidity and accuracy in construction.

The sixth is the last consideration, as the effective use of the gun must be the prime object and cover secondary.

In considering the advantages and disadvantages of the present methods of mounting guns and their use,—especially sea-coast guns,—and then considering the forces opposed to them and deciding on the type of carriage which would seem most suitable and more nearly up to the standard than any other, I know that I may be opposed by the great majority, but I think I am right and time alone can decide absolutely.

Land carriages or mounts may be divided into three general classes, barbette, disappearing, and casemate or turret.

Barbette mounts are gradually falling into disfavor with most nations because of the continual exposure of carriage, piece and detachment, and for lack of a suitable carriage. As regards the fire from such a mount, it is greater in accuracy and volume than from any other if properly constructed. This results from its simplicity and compactness and lack of long unbraced pieces carrying the strain of recoil and from the fact of its always being ready to be fired the instant it is loaded.

The disappearing type is a very costly and complicated mount, requiring great height of parapet which, as at present constructed, is magnificent material for splinters and also for disabling the piece and carriage. There is a loss of rapidity of fire and also of accuracy on account of play at joints, which can never be wholly eliminated, and springing of the long supporting pieces of the gun making the jump unequal. They require the greatest of care and skill in maintenance and handling and are very difficult to repair. Turret and casemate mounts are fully as costly and in the turret still more complicated than the disappearing, as they have the same fault of lessening the rapidity of fire. Besides, casemates limit to a dangerous extent the field of fire, offer an ideal target and are not invulnerable to repeated blows on same front. Turrets are not so conspicuous, but in muzzle pivoted carriages a shot while not injuring the gun may jam it. In the Grüson type, one segment disabled destroys the whole turret.

All except the barbette afford good protection while they last, but cover is not all that is needed. The guns are mounted to fire at vessels, not to remain under cover; with cover comes the temptation to make too much use of it.

Forms of parapet for the different mounts. For barbette mounts the simpler the better, and one reason and the great one why barbette mounts are falling into disfavor is that the form and command of the parapet above the pintle is maintained at its old value, while necessary changes due to the greater energy of recoil are neglected. The parapet should not have a particle of masonry exposed to fire or near enough to the surface of the earth so that splinters could be thrown through the earth covering. It should not be revetted with masonry as in that case any shot coming through near the crest carries splinters with it and any shot coming into a gun pit would be held and exploded by such a revetment, whereas, without it, it would sink in sand or earth and its explosion do little or no damage. The forms of the parapets for disappearing mounts are the greatest weakness of this system. Since their great height offers chances for splinters from near the crest being carried farther and doing more damage than in the case of a lower parapet, and also that any material knocked down behind it is harder to dispose of and more liable to damage the mount than if its construction were simpler; if a shot does enter the pit its effects are confined within the retaining walls. Turrets and casemates (armor-clad) are sometimes useful in confined situations where all the fighting is done at short ranges, but it seems a needless waste of money to obtain the cover they afford at the loss of the volume of fire which the same amount of money in the form of guns and simpler mounts would give.

The importance of cover has, I think, in the case of sea-coast fortifications been overestimated. The tendency in fortifications, at present, is to simplicity together with invisibility, or if this latter is not attainable, to make the target as inconspicuous as possible, if necessary make false emplacements to draw the hostile fire, these latter to be just conspicuous enough to attract attention. Simplicity carried to extreme is a depression in the ground of sufficient size in which to work the gun, and not too deep to fire over the edge, or the simple bank of earth, and this sort of cover will best stand the test of use and be easiest repaired, gives no splinters and smothers all explosions of shells. Some of the faults of the cover used with disappearing or turret mounts are the amount of masonry work required, the difficulty of repair, and in a disappearing mount confining the effects of a shot which enters the gun pit to the pit itself; also earth or material knocked from its crest is apt to clog the machinery and is very difficult to remove under fire. In turrets or casemates the shock of a hit must have great effect on the men.

With all cover is a loss of rapidity of fire, as it is impossible, when the gun is loaded in one position and then moved to another to be fired, to have as great a rapidity of fire as when the gun is loaded and fired from one position or only moved after loading to train it.

As to the necessity of cover, let the probable results of naval firing given below speak. It is said that cover is necessary or the detachments will be driven from their guns by the quick and rapid fire guns of the ships. Are the shore batteries to have none of these? If they do, surely their accuracy will be greater than that of those on the ships; and if at a given range these guns on board ship can keep men under cover, cannot these same guns on shore with their more solid platforms silence those on the ships? And the ships cannot afford to throw away the ammunition of their heavier calibers in the useless endeavor to search out and destroy these hornets, since as the ships began to get close in, they would leave them to take up others prepared in advance. Protection from the lighter projectiles could be given to barbette carriages by shields not strong enough to retain or burst the heavier shells.

Means of increasing the accuracy of fire. We have our guns, carriages, projectiles and powders, and our limit in accuracy is their limit. As soon as any new thing is suggested in connection with powder, projectile or gun, someone or some nation experiments with it to determine its value, and if it will increase the accuracy or power of the gun it is adopted. But it looks if all our attention was being concentrated on these to the neglect of the mount; yet, to-day, accuracy of fire depends more on the mount than on the gun; *i.e.*, the error of the gun is less than the error of the carriage, due to faults in design or workmanship. Why, when mounts for heavy guns are made, do they always throw them together hap-hazard, loose in every joint and uncertain in their action? The breechblock of a gun is made a perfect fit and what part of a gun carriage has a greater strain? Can we not have a carriage with joints and connections so made that they would not look as if made either with insufficient tools or skill or both? When we have such a carriage our accuracy of fire will depend principally on gun, powder and projectile, and not as at present on the carriage.

Direct fire from shore will probably never have great effect beyond 8000 yards, from there down to 2500 yards protection is unnecessary, and it is only within 2500 yards that we need it and then comes in the other more pressing need, rapidity of fire. How determine which is the more important? It looks as if it resolved itself to this: at the longer ranges it is not necessary and at the shorter you can't have it and do your work well. If the work guards a channel or the entrance to a harbor (as it probably will) when the ship reaches the 2500-yard limit, if it is in fit condition, it will run by if possible and this must be prevented at all risks. To do this you must keep its men under shelter away from its light unprotected guns by a heavy fire of similar guns, and disable the vessel, if possible, with your heavier guns. Little damage can its heavy guns do while speeding by. In this portion of the struggle every shot added to total number is of immense value.

The parapet should be as simple and inconspicuous as possible and made of material easily obtained, to secure readiness and ease of repair; should disturb the natural appearance of the ground as little as possible to secure invisibility; should contain no masonry to avoid splinters, and with a barbette carriage only sufficient height to cover the platform, the gun and carriage being brought down from its present height close to the pintle; and should have no revetment either of masonry or timber. The typical mount should be capable of delivering an immense volume of accurate fire. This demands a carriage with few joints to secure accuracy, and one which can be loaded and fired from the same position, or rather one that can be kept all the time on the object to be fired at, and loaded in any and all of its positions.

In considering the forces opposed to sea-coast works, I have proceeded in an unusual manner, but, I think, correctly. From the published reports of heavy gun practice made by ships under varying conditions the following probable results have been deduced, and I think that from past achievements they will be considered reasonable.

The chances of striking a barbette gun from the front at a range of 1000 yards or less is one in fifty when the vessel is at anchor in comparatively smooth water, and one in twelve hundred when the vessel is moving. This applies to modern breech-loading guns of 3-inch caliber and upwards, practice being held under peace conditions. Now assuming a fair decrease in accuracy for the different conditions of war and peace, I believe that on an average it would take the heaviest armed man-of-war at a range of 1000 yards or less one hour per gun to disable even a barbette battery "*à fleur de l'eau*" and proportionately longer at greater ranges. This is on the assumption, which I think reasonable, that the defense is strong enough to keep the vessels in motion and that the accuracy of fire from the ships is diminished by from one-third to one-half. The fire of the smaller caliber quick and rapid fire guns is greatly dreaded by the occupants of a barbette battery, but it is not so very dangerous. Experiments made by the English at Inchkeith show that, at ranges varying from 850 to 1250 yards, out of 15,000 rounds fired from this class of guns at dummies representing the detachment of a muzzle-loading barbette gun in the most exposed positions they would have in loading, only 15 hits were made, and with a breech-loading gun similarly mounted the proportion must be still smaller. "The fight at Alexandria", as Colonel Clark says, "is no marvel when we come to consider the results obtained at target practice under similar circumstances". Another fact is worthy of notice; we seldom see in this connection the effect on ships of similar small caliber guns mounted on shore even outlined, and this must be much more severe than the effect on the land defenses. When we come to consider the relative accuracy of the same gun on a land mount as compared to a floating one, it is contrary to every principle of reasoning to suppose that a naval attack can silence land defenses, or rather coast defenses, if any care at all has been displayed in their design and construction. As regards relative accuracy, the land overmatches the sea by between two and three to one, and must continue so to do as long as accurate shooting guns are employed. Of course war practice from land mounts cannot equal peace practice, but the loss of accuracy here will not be as great as that of the ships, because the ships cannot know the range as accurately as the land batteries and cannot on account of channels, &c., take up as advantageous positions, nor observe the effects of their fire so well, nor have as good a target, if any, to fire at; and the peace practice of land batteries more nearly resembles war practice in firing at a floating target, while ships seldom fire at a land target. And a word here for the purpose of avoiding criticism although it may only open a new field. Many things are referred to experience, and among them the probable results of a naval attack on coast defenses; but this, it is thought, is a great mistake, since past attacks with one exception were made in the days of the smooth-bore muzzle-loading gun and probably are valueless as a guide. At the exception, Alexandria, on one side their weapons were in order and they knew how to handle them; on the other these things were wanting. Therefore until an attack is made by a modern fleet on modern works equally well equipped and served, we remain without the guide of experience and must trust to theory. With regard to the value of S.B.M.L. attacks as a field from which to obtain valuable lessons there is this to say, and it is said very well by Colonel Clark in "Fortifications". "The vessels of a fleet greatly outmatched the coast defense in number of guns, in many cases a hundred to one, and consequently to the same extent in the number of projectiles, weight of metal per gun being practically equal. The ranges were absurdly short compared to those at which fighting must be done in the future, varying from 50 to seldom over 600 or 700 yards. The guns shot so wildly that, with the immense number of projectiles thrown and the short ranges, many hits must be made, no matter how wrong or careless the laying of the piece, if only the general direction was preserved." "Also the defenses themselves were usually an ideal target, always a distinctly visible one. At the bombardment of Fort Fisher 115 shots per minute were fired by the fleet, little wonder if enough of them reached the fort to keep the men away from M.L. barbette guns." But with modern conditions no comparison with old methods is of use. Compare the following remarks with the preceding and see if any valuable lesson from experience can be deduced. To-day the ships mount a much smaller number of heavy guns, these guns shoot where they are pointed, their velocity is so great and trajectory so flat that if one overshoots by no possibility will any damage result, the same for a miss laterally. The guns for harbor defense are not placed in an elaborate target but distributed so as to secure the most comparative invisibility consistent with effective use, and the natural appearance of the ground is retained as much as possible, and the ships will fight at greater ranges. Probably the shortest will be 1500 yards as it would be suicidal to bring a ship up to the old ranges. The comparison between the old and the new is almost that between a shot gun and a rifle, if you have enough shot guns and shoot often enough you are bound to hit often; with rifles, however, you must aim at the object or you wont hit it.

The authority mentioned above says almost in so many words and makes evident by his reasoning, that a high power 6" B.L.R. is sufficient to render powerless any man-of-war. Of course he does not mean that it can attack their armored parts, but that it can make them untenable, since they have not sufficient armored cover for the crew. The ordinary cruiser is of course completely at the mercy of such a gun. The smaller quick and rapid fire guns can make the interior of the majority of ships an exceedingly uncomfortable place and prevent the use of machine and rapid fire guns as at present protected on board of any man-of-war, and this at ranges at which the ship can make little if any effective return. Ships as built at present are designed to meet ships, not to attack land fortifications. The majority, to secure the maximum protection from their armor, must fight bow on, and thus lose the use of the greater portion of their quick and rapid fire guns.

We now come to the consideration of the typical modern gun carriage, and it is assumed that all who have got this far know which will be advocated. But first let us go through the six conditions imposed above and try to show that this selection is the correct one.

First and chief, to furnish a satisfactory and reliable support from which to fire the gun. To fulfill this the simpler and stronger the better; this is shown on proving grounds where no great amount of training is necessary; see how they simplify the mount. Of the three types of mounts mentioned the barbette is easily superior to the others in this respect. It is or can be made more rigid than the others except where they follow the same lines; when built on different lines unevenness in action results.

Second, allow the gun to be easily and quickly loaded, trained and fired. The barbette is easily first here.

Third, lightness for given strength is only obtainable in a barbette mount.

Fourth, the barbette mount is simplicity itself compared to the others. It can be made with fewer points at which looseness is possible.

Fifth, be suitable to all positions. Here is where we find the greatest difficulty, but it can be obviated. Considering the accuracy of naval guns as shown above, think of a place where a gun on a barbette mount would suffer very severely, and in the very exceptional case of a rock in a channel where there is no room for secondary batteries, and deep water right alongside, a position where they say a turret is the only thing. What is a turret but a barbette mount with complications in the way of cover?

Sixth, as much protection to gun, carriage and detachment as is compatible with the efficient handling of the gun. In all these considerations the mount and emplacement are to be taken together since they are practically one. Even here the barbette mount properly constructed is best, as it affords all the protection possible with the most effective use of the gun. Do not understand this to advocate the barbette mount as at present constructed; it simply means that this system offers possibilities in the direction of efficient service that the others do not, and I am going to try to show the points where it can be improved. The recoil cylinder to be concentric with the gun on which a flange acts as the piston, automatic return to battery after firing, the recoil cylinder to be connected on lowest element to a live roller ring which connects directly to the pintle. The recoil cylinder to revolve in a vertical plane about its connection to the live roller ring and to carry the loading and elevating apparatus. The axis of the gun to be just far enough above the live roller ring to allow giving the greatest elevation desired. The parapet to be a simple bank of earth, a sunken path around the gun affording the detachment all the protection necessary from heavy guns, and a shield on the gun keeping out the smaller projectiles. The elevating apparatus to be quick-acting hydraulic rams, one at the front and one at the rear of the recoil cylinder holding it steady in all positions. All work to be done by electric motors with a supplemental hand gear to avoid delay if motor fails. With such a carriage and good workmanship there can be little if any jump, there is little weight and all parts are easily replaced, the gun having to be raised only six inches to renew the whole outfit, the gun is close to the point of resistance, there is as little exposure as possible, no splinters from the parapet and nothing to confine the effects of a shell. Such a parapet will stand an unlimited amount of bombardment, as it has been shown that earth slopes of this shape cannot be damaged to any extent by the fire of the modern high-power gun; and as for the chances of striking the guns there is little danger, if they are dispersed and so arranged that of all the shots fired at one gun none can do any damage to another. The time required to silence them singly would surely afford sufficient time to injure the vessels so badly that they would be unable to continue the struggle. And it is maintained that given a certain sum of money with which to defend a place, a great deal stronger defense can be made if this money be used in procuring guns of from 6″ to 10″ caliber and mounting them as above, than by expending it for heavier guns and the more costly heavily protected mounts, because the guns and ammunition can be handled more quickly, and the latter is much cheaper with these of medium size than with the heavier guns. The effect on the vessels is practically the same as that of the heavier guns, and the much larger volume of fire secured is a great advantage. Of course it is not to be assumed that all the guns of the defense would pass through the fight unharmed, but the same may be said no matter how they are mounted, and allowing that the loss of the barbette mounts is 25% or even 50% in excess of the other styles of mounting guns, unless you allow more than double the loss, you would still have more guns available at the end of the struggle with the above system than with the Engineers' present system. Another seeming fault with their system is that of grouping the guns, at least that is what they have done here.* It will certainly be difficult to hit near the crest of the parapet of the emplacements that they have built here, but I do think that it would be more difficult to hit a single gun behind a low bank. At least they would not have such a beautiful target to shoot at.

In conclusion, as we only need protection to an extent proportionate to the danger, if any one will take the trouble to determine the amount of this danger, he will see how little protection is really necessary.

* Fort Monroe, Virginia.

THE BUFFINGTON-CROZIER EXPERIMENTAL DISAPPEARING CARRIAGE FOR 8-IN. BREECH LOADING STEEL RIFLE.*

By First Lieutenant M. F. HARMON, First Artillery, U. S. A.

Plates for illustration of this article furnished through courtesy of the Editor of the *American Engineer and Railroad Journal.*

Incidental.

As mounted at Sandy Hook the forward end of the carriage rests on a cast iron annular platform plate which is fastened securely by means of long anchor bolts set head down in the concrete and accurately placed during the construction of the platform. This device is a feature of the Proving Ground adopted in the interest of economy both in money and space. Undercut radial slots cast in the platform plate provide bearings, at varying distances from the center of the plate, for bolt heads, the corresponding bolts passing up through holes in the base-ring. In the service emplacement these latter bolts will be set in the concrete and the base-ring will rest directly on its surface. The platform plate used in the proof of this carriage will also be used in testing the 10″ carriage of the same design, thus avoiding the necessity and saving the expense of constructing a new concrete platform.

The Carriage.

This is a front pintle disappearing carriage.

All the large pieces which are used in its construction are steel castings. The counterweight is cast iron; it may be made of lead in future. Working parts are forged steel. All bolts are wrought iron. Bearing surfaces are finished. The platform is concrete. The base-ring is cast in one piece. Its exterior diameter is about eight feet and the width of the ring is about

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two feet. Two rings, separated by a groove, project upward from its general surface. The inner ring is narrow, projects more than the outer one and constitutes the pintle. The outer ring, about eight inches wide, is the roller path. Its finished surface inclines slightly downward as it recedes from the center, and on it rest the rollers, eighteen in all. They are frustums of cones, forged steel, turned to gauge and finished; their taper corresponds to the inclination of the path, which places their axes in a horizontal plane; their common vertex is in the axis of the pintle. The inner end of each roller is provided with a flange which rests against the inner edges of the base-ring and the racer. These flanges prevent radial displacement of the rollers. Short journals projecting from the ends of the rollers support two distance rings, slots in the lower edges of which fit over the journals and preserve the relative circumferential positions of the rollers on the path.

The racer is slightly smaller than and very similar to the base-ring. The rings project downward from its general surface and the inner one fits over the corresponding projection on the base-ring (the pintle) with just enough clearance to permit free motion around it. The path part of it is just like the corresponding part of the base-ring; it rests on top of the rollers. The rollers and paths are provided with a dust guard.

At the muzzle end of that interior diameter which lies in the plane of fire two cast steel holding-down clips are rigidly attached to the racer and revolve with it, engaging with slight clearance under a flange which projects inward from the upper end of the pintle; these prevent the front end of the carriage from rising without interfering with free motion on the rollers.

The front end of the chassis rests on top of the racer and is fastened to it by tap bolts. The rear end is supported as follows: The traverse wheel transom is bolted to the bottoms of the chassis rails at their rear ends. Two brackets, one near each end, are cast on its under face. Each bracket contains the bearings for the axles of two traverse wheels. The four wheels all travel on the same arc.

The chassis rails are about fifteen feet long by six feet high and are each cast in one piece. They are, approximately, I beams in section and rectangles in elevation, though the depth of the rear ends is considerably increased to provide seats for the elevating arcs. It results in consequence that the reference of the rear traverse circle is somewhat less than that of the base-ring. Each rail is cored in two places to regulate the cooling strains, and a curved rib projects from the outer surface of each to prevent lateral bending.

The rails are assembled by means of the racer, which is also a horizontal transom, a middle transom and the horizontal traverse wheel transom already described. The middle transom is a flat arch whose spring lines near the bottoms of the rails and crown near their tops are perpendicular to the planes of the rails. In the experimental carriage the tops of the rails are horizontal. In future carriages for the same caliber they will probably incline upward to the rear about two degrees.

Set in pockets and journaled into each chassis rail near its top, so as to project but slightly above its surface, are ten cylindrical rollers placed equi-distant from each other, their axes horizontal and perpendicular to the length of the rail. The top carriage travels on these rollers in moving in and from battery. Clips cast on the bottom rails of the top carriage grasp flanges cast on the outside of the top rails of the chassis throughout the length of the former, and the carriage is placed on the chassis by sliding it on from the rear.

The hydraulic cylinders form part of the top carriage. The latter is cast in two pieces. The two castings are assembled by means of bolts and nuts, the median line of the horizontal transom being the junction line. The horizontal transom is strengthened both longitudinally and transversely by ribs which project both above and below its general surface: the longitudinal ribs on the inner edges of the two parts join and form one central rib. The assembling bolts are body bound bolts driven home.

Bolted under the front end of each clip of the top carriage is a short ratchet containing seven teeth a few inches apart. Far enough below each ratchet to make the short arm of the lever four inches long, and properly located on each chassis rail, are three strong pins for fulcrums. If for any reason the piece fails to run fully into battery under the action of the counterweight it may readily be forced the remaining distance by applying a lever on each side in these ratchets, each lever being manned by two cannoneers.

The top carriage is low as a whole, the cheeks projecting but slightly above the cylinders, while the latter rest directly on the chassis rollers. It may be of assistance to those who have seen the 8″ barbette top carriage to know that the one that I have attempted to describe is very similar to it in appearance.

In the trunnion beds of the top carriage the trunnions of the gun levers rest. These gun levers look like the walking beams of a small side wheel steamer. Each is cast in one piece. The two arms into which the trunnions divide each lever are of nearly equal lengths, each about six feet, the lower arm being slightly the longer. In the lower end of each lever is a hole six inches in diameter; these holes constitute bearings for a cross head shaft which, passing through them, extends to the chassis rail on each side; each end of the shaft is attached to a guide block which moves on a vertical guide way formed on the inside of the forward end of each chassis rail. A ratchet about three feet long and containing 17 teeth is formed in the front face of each of these guide blocks. Spring pawls near the top of each chassis rail engage in the top pair of ratchet teeth when the carriage has recoiled through about two-thirds of its path.

A trunnion bed is formed in the upper end of each gun lever and in these rest the trunnions of the gun.

Both pairs of cap squares (one pair over the trunnions of the gun levers, the other over the trunnions of the gun) slide in from the ends of the trunnions and form joints which are securely locked against vertical motion.

Returning to the forward ends of the gun levers, the cross-head shaft which passes through them supports two forged steel suspension rods, each three and one-half inches in diameter; they are symmetrically placed on the shaft, about 28 inches from axis to axis. These rods support the counterweight. The last named was designed to be wholly of cast iron, but as finally used in the test of the carriage a portion of the cast iron was replaced by lead pigs weighing about 88 lbs. each, they being more convenient to handle when it is necessary to vary the counterweight. The weight of the counterweight is 38,600 lbs. It is made up as follows, beginning at the bottom: Four disks of cast iron weighing 7000 lbs. each; sixteen semi-disks of cast iron weighing 500 lbs. each; 26 lead pigs. The suspension rods pass down through holes in the large disks and heavy nuts on the rods beneath the bottom one retain the disks on the rods. The semi-disks are placed between the suspension rods; slots cut in from their semi-circumferences permit the disks to drop into position; the suspension rods enter the slots. The lead pigs are piled on top of the cast iron. Summarizing the foregoing remarks concerning the counterweight, we have a right cylinder with a circular base, built up of cast iron and lead and permitting variation in weight according to necessity; its altitude is about 7 feet and the diameter of its base is 3.5 feet. It is constrained to move in a vertical path by the guide blocks and guide ways already described. In descending it passes within the base-ring, the racer and the platform plate into a well in the concrete platform. The semi-disks and lead pigs are removable to provide for decreasing the counterweight in order to permit the gun to recoil to the loading position when reduced charges are used.

While this provision for varying the counterweight was necessary in an experimental carriage, and is desirable in general, to provide for contingencies, the occasions when recourse to it will be necessary should be rare indeed, after the gun and carriage have been subjected to the proof rounds, because no useful result can be attained in target practice by the use of reduced charges in guns of position.

While the gun levers resemble walking beams for a small "side-wheeler" they constitute a grand artillery see-saw. The loaded gun represents one boy and the counterweight the other. When the gun is in battery the upper ends of the gun levers incline to the rear of the vertical about 13 degrees, the gun is up and the counterweight down. Upon firing, the gun recedes and descends at the same time: the counterweight rises and the gun levers rotate to a horizontal position. Upon tripping the pawls, down goes the counterweight and up comes the gun, the gun levers resuming the nearly vertical position.

The axis of either gun lever intersects the axis of the cross-head shaft, the axis of rotation of the gun lever itself and the axis of the trunnions of the gun, all at right angles; when the gun recoils the first named of these points of intersection moves in a vertical path (the guide way) and the second in a horizontal path (parallel to the top of the chassis rail). We then have one straight line two of whose points are moving along two other straight lines which intersect at right angles; the third of the foregoing points of intersection must therefore describe the arc of an ellipse. Since the intersecting lines are at right angles to each other they are the axes of the ellipse, and the generating point will be at a vertex when the axis of the gun lever is horizontal, which it is at the end of the theoretic recoil.

The recoil is controlled by means of two hydraulic cylinders in conjunction with the counterweight. The cylinders are connected at their front ends by an equalizing pipe. The piston rods are stationary and hollow. Their forward ends are rigidly attached to lugs cast on the front ends of the chassis rails and projecting upward from their technical top. They are not through rods; consequently when by recoil the top carriage is forced to the rear the effect is a withdrawal of the rods from the cylinders which, if unprovided for, would produce a vacuum in each cylinder corresponding to the cubic contents of that portion of the piston rod which is withdrawn. To avoid the vacuum a reservoir cylinder is placed across the front of the chassis, above the tops of the rails, its ends being supported by the lugs to which the piston rods are attached. A small pipe is led from it to the forward end of the hole in each piston rod. As the gun recoils oil flows from this reservoir through the piston rods to fill the space in the cylinders vacated by the rods. The reservoir cylinder is provided with a vertical air vent on top at each end; an inch pipe with a return bend to keep out dirt. The two pipes which lead to the piston rods are merged into a single pipe before reaching the cylinder, and between their junction and it are placed a check valve and a by-pass valve, the latter controlled by a lever. Remembering that the spring pawls do not engage in the first pair of teeth in the ratchets on the counterweight guide blocks until the top carriage has recoiled through about two-thirds of its total path, it will be readily understood that with a recoil less than this fractional part of the whole, the carriage would, upon cessation of the recoil, immediately run in battery under the action of the counterweight, so far as restraint imposed by the pawls and ratchets is concerned. The check valve holds it at the end of the recoil and saves that much labor in running it from battery. This device is ultra-precautionary, and the condition demanding resort to it should rarely arise; if it should arise it may be met by temporarily decreasing the counter weight.

In future carriages of this type it is probable that through piston rods will be used and that the counterweight ratchets will be lengthened enough to allow the pawls to engage in consequence of the recoil produced by the smallest charge likely to be used under any circumstances, thus eliminating the reservoir cylinder and its attachments. The proposed change is a commendable one because it constitutes a simplification. If executed it will remove the only valve in the system.

The limits of the loading position are amply separated. There are 17 teeth in each ratchet. The piece can be loaded when the pawls engage in any of them, the facility increasing with the recoil until the theoretic loading position (with the gun at about 9° 30′ elevation) is reached. This increase of facility in loading with the increase of recoil results from the relation between the paths described by the breech and muzzle during recoil; the relation is such that the less the recoil, within the limits of the loading position, the greater is the elevation of the piece when it comes to rest (an effort will be made later to indicate the reason more clearly) and as a consequence the greater the force required to ram the projectile to its seat. . With carriages of this type for guns of larger caliber and the same loading angle this consideration would restrict the loading position within narrower limits than those which are permissible with the 8″ gun, due to the greatly increased weight of the projectile. This fact, however, is of no special importance, since the recoil due to the service charge leaves the gun very accurately and uniformly in the theoretic loading position: and in addition the loading angle will be decreased in carriages for guns of larger caliber. For working the piece from battery by hand-forged steel levers about 4.5 feet long are permanently attached, one to each chassis rail near its top, just in front of the spring pawl. The forward end of each lever is keyed to its own crank shaft which passes through the chassis rail, the crank being inside the rail. The levers incline downward to the rear at an angle of about 45° and the handle part is bent away from the chassis rail for convenience of access. On the crank pin (in *rear* of the fulcrum) the corresponding pawl is pivoted. The length of the crank is two and five-eighths inches; a stop on the chassis rail prevents the pawl end of it from rotating downward.

The pawls being between the fulcrums and the points of application of the force, raising on the handle ends of the levers raises the pawls; consequently raises the counterweight and the lower ends of the gun levers, thus forcing the piece from battery. Of course this arrangement is not available unless the recoil is sufficient to cause the pawls to engage in the first pair of ratchet teeth. From any point between the position just indicated and in battery the piece must be worked back by means of tackle. Provision is made for its attachment to the carriage. It will rarely be necessary to have recourse to either device in service.

An elevating band is clamped around the gun near the breech, and at the ends of its horizontal diameter the upper ends of the forged steel elevating arms are pivoted on trunnions which project from the surface of the band. The lower ends of these arms are pivoted to circular elevating racks. A cast steel truss brace is placed between the arms and bolted to them to prevent lateral bending. The arms are about 11 feet long.

Elevation is given by means of the racks mentioned and geared wheels. The racks are of forged steel; they move in circular guide ways which are bolted to the inner faces of the chassis rails. The centers of these circles are in the upper axis of rotation of the elevating arms when the gun is in the theoretic loading position, and their common radius is the distance between the axes of rotation of those arms. Motion is communicated to the elevating racks through two hand wheels, one outside each chassis rail and both fastened on the same through shaft; the radius of each wheel is 2 feet and the spokes project 6 inches beyond its rim. Two pinions on the through shaft, one outside each chassis rail, engage in spur wheel; inside each rail, on the same shaft with the corresponding spur wheels, is a pinion which engages in the circular elevating rack on that side.

The gun may be elevated after running into battery, or the gear may be set for the proper elevation while the gun is still from battery; the latter involves less manual labor, since only the circular racks and a part of the elevating arms have to be raised (one cannoneer can do it easily); the gun assumes the proper elevation as it moves into battery, the counterweight doing the work instead of the cannoneer. A spring friction clamp near one hand wheel, relieved by means of a lever, grasps a friction drum on the shaft and prevents change of elevation.

The quantity of elevation will be indicated by a pointer attached to one of the chassis rails just over the spur wheel, the degrees and subdivisions being engraved on a ring of suitable metal let into the face of the latter. The unit of the scale will be 1′.

Due to the preponderance caused by the elevating racks, arms and band, the back lash of the gear is always downward and there is no lost motion upon changing the direction in which the hand wheels are turned, the gun instantly responding to the change.

The elevation, remember, is varied by moving the circular racks along their guide ways. Any point on the upper axis of rotation of the elevating arms will describe the arc of a circle during recoil. These arcs will be different for different elevations, but since their radius is also the radius of the path of the circular rack, and their centers are on that arc, they must all intersect at its center.

The path of a given point on the axis of the trunnions of the gun during recoil varies in length only; it is always the same arc of the same ellipse, or a portion thereof, no matter at what elevation the gun may be fired.

This path being constant and the others all intersecting in a common point the result is that at whatever elevation and with whatever charge the gun may be fired it is always constrained to recoil toward the theoretic loading position, reaching that position very accurately with the service charge.

For traversing, a short link chain is anchored, one end at each end of the traverse circle. Starting at the anchor on the right the chain passes beneath the right chassis rail, under a small guide wheel suspended in a bracket projecting down from the traverse wheel transom, up over a sprocket wheel, down under a similar guide wheel on the left and out beneath the left chassis rail to the left anchor. A through shaft with a crank handle at each end and a worm in the middle, the worm working in a worm wheel on the same shaft with the sprocket wheel, constitute the gear for giving motion to the last named wheel. The gear is inclosed by a dust guard. The worm is provided with ball bearings and the traverse wheels have roller bearings. One cannoneer can traverse the piece quite rapidly when all the contact surfaces are clean.

The projectile is raised for loading by means of a crane and geared wheels, using rope tackle, and one cannoneer turning the crank readily raises it while the piece is being sponged.

The front buffers are rubber cylinders about 2″.5 in altitude: they encircle the piston rods at their forward ends, abutting against the lugs which support the rods. The rear buffers are bolted on top of horizontal brackets which project inward from the chassis rails near their top and rear. They are made up of alternate horizontal layers of plate iron and sheet rubber and are not intended to receive much of a blow, the accuracy with which the recoil is controlled making it unnecessary that they should. The areas of the apertures in the piston heads are varied by means of throttling bars: they were computed to produce a uniform strain during recoil.

To permit the piece to run in battery the by-pass valve must be open; one handspike is then applied to the lower arm of each pawl through square eye-bolts screwed into the front end of each chassis rail for that purpose. One cannoneer mans each handspike; standing in front of the handspikes they release the pawls by a pull on the handspikes at the command *heave*, holding them clear of the ratchets while the piece runs in battery under the action of the counterweight, which it does in about 3 seconds.

When the gun is in battery the axis of its trunnions is about 15 feet above the plane of the rear traverse circle and about 10.5 feet above the terre-plein or loading platform.

It is the intention to graduate the rear traverse circle. The limits of elevation are +15° and —5°. The horizontal field of fire covers 180°. Cannoneers working at the breech of the gun are protected from a projectile grazing the interior crest so long as the angle of fall does not exceed 7°.

The position of secure piece is from battery; that is where the last shot of a series will leave it and where the first shot of the next series will require it; it is also a position of concealment, viewed from the front.

When the piece is in battery the muzzle projects beyond the interior crest from 7.75 feet at the extreme elevation to 8.3 feet when the axis is horizontal. The jump for an elevation of 2° 42′, which corresponds to 3000 yds. range, is minus 2′ 35″. It varies with the elevation.

In order to have access to the breech for loading it will be necessary either to lower the platform about 4.5 feet from the level of the terre-plein, or build a loading platform about 4.5 feet high encircling the rear of the carriage. The former will be the better as well as the less expensive arrangement where it can be used, since it will avoid the necessity of raising the projectiles from the terre-plein to the loading platform in action and will require less height of parapet.

The weight of the carriage without the counterweight is 85,000 lbs. Captain Crozier expects to reduce this about 30% in the next carriage for the same caliber gun.

The hydraulic cylinders should be completely filled with the piston rods in. Neutral oil is used at the Proving Ground.

The carriage was manufactured by the Southwark Foundry and Machine Co., of Philadelphia. The steel castings were made by the Midvale Steel Co., of the same city.

The strength of the detachment for serving B.L.R. guns, in those cases in which the projectile is rammed by man power, seems to be fixed by the number of cannoneers required to seat the projectile properly, this number being as a rule sufficient for all the other operations involved in the service of the piece.

This carriage possesses no advantage in that particular; slightly the reverse in fact since the projectile has to be rammed up a slope whose minimum inclination is about 9° 30′. One gunner and four cannoneers therefore constitute the detachment for serving the piece, one additional man being necessary when pressures are taken.

The System in Action.

When the gun is fired it and the top carriage move to the rear, the counterweight rising and the gun descending as it recedes: any point on the upper axis of rotation of the elevating arms describes the arc of a circle, while any point on the axis of the trunnions of the gun itself describes the arc of an ellipse one of whose vertices is where the generating point comes to rest at the end of the theoretic recoil, as has already been stated. The resulting motion of the muzzle, which is the object in view just now, is a sinuous curve; during the first instants of recoil the muzzle drops slightly as it moves back, then follows a nearly straight line path for about 6 feet, gradually rising however until the highest point of its path is slightly higher than its beginning; during the last few inches of the motion of translation in recoil the muzzle drops abruptly close behind the parapet and well down, its path again becoming almost a straight line. During these last few inches of recoil the trunnions are approaching the vertices of their elliptical paths and consequently are moving nearly vertically downward, the relative motion of the breech in the same direction being much less during the same period. The effect is to rapidly decrease the elevation of the piece during these few inches of recoil and this explains why the facility of loading increases with the increase of recoil.

The time of recoil is one second.

When the gun is fired at the maximum depression the muzzle clears the interior crest by inches the number of which is fixed at pleasure when computing the lengths of the gun levers. The motion of the muzzle is almost an ideal one for the purpose in view, yielding economy of space and superior cover.

The elliptical paths of the trunnions, together with the manner of their generation, lead to this additional very important advantage that the relative acceleration of the motion of the counterweight is least when that of the gun and top carriage is greatest, and the strains due to setting in motion the large mass of the counterweight are consequently minimized. An examination of the paths involved will satisfactorily establish the theory; the system in action shows the practice to agree. When the gun is fired there is no visible indication of shock in any part of the combination, and no perceptible movement of the chassis.

The action of the whole appears as gentle and graceful as that of a señorita's fan on a summer day, and "it is difficult to realize that such tremendous energies are at work".*

The alterations found necessary during the progress of the test of this carriage were few and slight. Ninety-six rounds have been fired from it, 77 of which were with the service charge. But one break occurred and that was through no fault of the carriage. Upon changing guns on one occasion the elevating band was not sufficiently clamped; during recoil it slid forward on the gun throwing the muzzle down against the reservoir cylinder: a small piece was thus broken from one of the lugs which support the cylinder.

In the rapidity test 10 rounds were fired in 12 minutes and 21 seconds. This result fulfills Max O'Rell's conditions for awakening Jonathan's enthusiasm, for it "broke the record"; and concerning it we may say "in the world".

The mean deviation from the center of impact in a group of 10 shots fired at a vertical target, range 3000 yards, using a Scott sight on the gun, is 1.61 feet. Eight of the 10 shots struck in a square yard a yard square and the 10 are in a rectangle $3' \times 5.5'$. This is the best target I have been able to find recorded at the Proving Ground at a range of 3000 yds. with an 8″ gun, the next less mean deviation being 2 feet.

Neither the spur wheel nor the traverse circle are graduated for this carriage, details of this nature having been held in abeyance pending the result of the test; while the target just mentioned was being made the elevation and direction used were scratched on one spur wheel and the traverse circle, respectively, opposite

* *American Engineer and Railroad Journal*, Vol. LXVIII, No. 2, February, 1894.

temporary brass pointers attached to the chassis. A target of 5 shots was then made at the same range, using only the marks on the carriage for aiming. The 5 shots were placed in a rectangle $4.5' \times 5'$. The mean deviation from the center of impact is 2.43 feet. The lateral dispersion is the short side of the rectangle in each case.

The term "Disappearing", as applied to the carriage, is scarcely appropriate since it is the gun and not the carriage which plays hide and seek with the enemy; the latter is hidden from his view at all times and the word "Concealing" is more accurately descriptive of its functions.

Turning to horses for a comparison, if we let a scrub broncho (disposition included), equipped with a cow boy outfit, represent the old style barbette chassis and top carriage in appearance and behavior, this one may quite properly be represented in the same respects by a clean limbed, full eyed, well trained hunter with a Kentucky racing tree on his back. The difference in care required in the two cases is equally well indicated by the same comparison. Illustrating the latter point; when the bearing surfaces involved were *clean* and properly lubricated I have seen one man traverse the carriage quite rapidly without assistance and with no great exertion, while in making the target of five shots previously mentioned, four cannoneers had about all they could do to move it. The difference was caused principally by a little sand in the roller bearings of the traverse wheels.

When the carriage is not in use exposed bright surfaces should be covered with commercial cosmic. This, while protecting the surfaces, collects dirt and must be removed when the carriage is to be used again.

Since writing the foregoing about eight months ago, the carriage of the same design for a 10″ B.L. steel service rifle has been received at the proving ground at Sandy Hook and tested.

The carriage was assembled and tested on the emplacement used in testing the 8″ carriage, the only alteration being a new traverse circle to correspond to the longer radius.

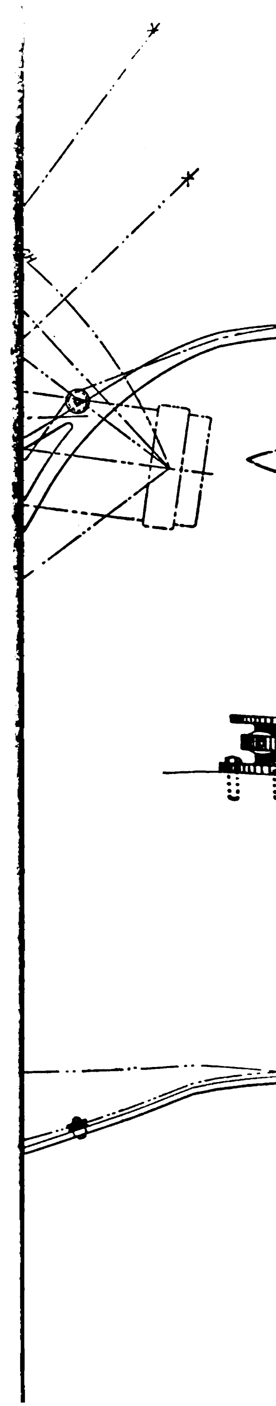
The 10″ B.L. Wire Wound Crozier Steel Rifle arriving at the proving ground at about the same time, was mounted on the carriage.

[This gun is intended to be worked to 42,000 lbs. pressure while the working pressure for the service rifle of the same calibre is 37,000 lbs. In 29 of the 77 rounds which have been fired from the gun at this writing, the pressure averaged 43,000 lbs. per square inch. The maximum pressure obtained was 46,240 lbs. A charge of 254 lbs. corresponds to a density of loading of 0.95. With a suitable powder this charge is expected to give the 10″ service projectile (weighing 575 lbs) a muzzle velocity of 2,140 ft. per second, the pressure being 42,000 lbs. No powder designed for the chamber of this gun has been delivered at the proving ground yet, in consequence of which the theoretic muzzle velocity has not been verified practically. The cartridge is 66 inches long and is made in two sections for convenience in handling.]

Bearing in mind the necessary increase in the size of the different parts of this carriage over that of the corresponding parts of the 8″ carriage, the description of the latter applies equally to the former, except in a few particulars to be mentioned now.

The chassis rails instead of being horizontal as in the 8″ carriage, incline upward to the rear at an angle of 3°. This is a departure from the original design, and the alteration was made after the carriage was practically completed according to the original design, the object being to cause the gun to run in battery with less preponderance of counterweight than was required with the horizontal rail. This change has the effect of causing the loading angle to vary slightly in this carriage as the angle of elevation is varied, instead of being constant as would have been the case had the rails remained horizontal or been designed with the 3° slope in the beginning.

A geared windlass having a drum inside each chassis rail, and a crank handle on each side large enough for four men to work on, constitutes another feature not found in the 8″ carriage. This is for use in drawing the gun from battery by hand, and with ten men, four on each handle and one on each fall, the operation was performed in eleven minutes, 33.25 seconds. The



ratchets on the counterweight guide blocks are slightly longer than those on the 8″ carriage, and contain twenty teeth each.

These are the only particulars in which the 10″ carriage differs from the one described for the 8″ gun.

Incidentally it might be mentioned that the gun used in testing the carriage has about 900 lbs. counter preponderance, and the thrust of the elevating arms in this particular combination is not so aggressively downward as it would be with a service rifle. For this reason if the combination should be made permanent, the last movement in elevation should always be in the same direction, preferably a depression in order to take the weight on the gear.

The carriage without the counterweight weighs 66 tons. The counterweight and the gun weigh 30 tons each, making the total weight of the carriage 96 tons and the weight to be traversed 126 tons.

Sixty-nine gallons of oil are required to fill the recoil cylinders.

Balata, a substance somewhat similar to rubber, was used for the front buffers. It resisted the action of oil much better than does rubber, and answered well in other respects.

The axes of the gun levers are inclined 12° to the rear of the vertical when the gun is in battery.

The maximum recoil is obtained with about 2° elevation. The variation in this respect however is very slight. With all the elements of fire constant save the elevation, varying it by small increments from the minimum to the maximum, will not cause a variation in the recoil of more than two teeth on the ratchet, corresponding to but a fraction of one inch on the chassis rail. In the test I believe that the maximum variation obtained in this manner was one tooth on the ratchet.

Traversing is done by the hand quite readily when the gun is in battery and without much difficulty when it is from battery. The latter of course, is the position that the gun will have to occupy when the operation is performed in service, in order to conceal it from the enemy until the last moment.

In manipulating the carriage by hand during the test the following results were obtained :

Time required to traverse through 48° 56′, the maximum angle permitted at the proving ground platform.

Gun in Battery.

Four men did it in one minute, 59.5 seconds.

Gun from Battery.

Eight men did it in two minutes, 5.75 seconds.

The traverse circle was not machined on the under side. It was laid on old concrete and could not be placed accurately horizontal. In two portions of the path the traverse wheels did not all bear.

Time required to elevate and to depress.

Gun in battery and depressed 4° 20′ to elevate to +16°. Done by four men in 31 seconds.

Gun in battery and elevated 16° to depress to —4° 20′. Done by four men in 34.75 seconds.

Gun from battery and depressed 4° 20′, to elevate to + 16°. Done by two men in 30 seconds; by four men in 20 seconds.

Gun from battery and elevated 16°, to depress to —4° 20′. Done by two men in 54.25 seconds; by four men in 29 seconds.

With the horizontal chassis rails the maximum depression permitted by the carriages was 4° 20′, and stops were placed across the circular guide ways limiting the motion of the racks accordingly. Changing the rails increased the attainable depression to about 5° 30′ and the elevation to something over 16°.

In firing at a depression the stops were removed and the gun fired at —5°.

The accompanying vertical target was made in the following manner.

Before the firing was commenced the gun was aimed at the left edge of the 3000 yards target by means of wooden bore sights. The direction thus determined was recorded by making a mark with a scribe on a short strip of brass temporarily attached to the traverse circle by means of two screws, the index or pointer being similarly attached to the chassis.

From this mark as an origin, corrections were made for lateral deviation.

For elevation a pointer was attached to the left chassis rail just over the left spur wheel of the elevating gear, the gun was permitted to run in battery, and a non-commissioned officer was sent up on top of it with a quadrant. The spur wheel was thus graduated in degrees from 0° to 15° for general use during the test, and the additional graduations 2° 27′, 2° 33′, 2° 38′ and 2° 43′ were added for use in making the target. The circular guide way on the inside of the chassis rail may be graduated also.

The quadrant was not used on the gun again until after the target was completed, and no sights were used save the bore sights mentioned, and they were used only to establish an origin for direction. In other words only the graduations described were used in aiming the gun.

The object of proceeding in this manner was to test the efficiency of the carriage as the object of reference, not only for elevation but also for direction.

The result is not phenomenal in the abstract, but considering the conditions set forth and the additional fact that the wind was variable, it is quite satisfactory. It is sufficient to prove that with properly constructed scales, the gun may be aimed in this manner with precision.

A similar target of five shots, it will be remembered, was made from the 8″ carriage, but the test in that case was not quite so severe. That target was made after considerable practice for accuracy at the same range using the Scott sight, and the marks afterward used in marking the target of five shots were established and amply verified during the practice. In this case this target, including the preliminary rounds fired to find the target satisfactorily, constitutes the only firing for accuracy done with either the gun or the carriage.

In making a target at the proving ground the rule is, once satisfactorily established on the target, neither elevation nor direction must be altered till the target is completed. The theory is good and the practice would be equally so if the wind would only make a similar rule and stick to it, but at Sandy Hook it doesn't. In this case it is believed that in one or two instances the result might have been improved by making slight corrections to counteract the effect of changes noted in the wind before the shot was fired.

The projectiles used were solid shot: they varied slightly in weight, and I believe responded to the variation in each instance.

The gun has been fired at varying angles of elevation from —5° to + 15°, and the only part of the carriage in which a break occured was removed bodily, thrown away and not replaced. The part referred to was a steel transom which was bolted to the rear of the upper ends of the gun levers. The shock of discharge broke some of the bolts, and the transom was removed, being considered not essential.

I recall no other break of any kind throughout the test.

In the test for rapidity, ten rounds were fired in 14 minutes, 41.9 seconds. The detachment consisted of one non-commissioned officer and eleven privates. In this test the elevating gear was set at 10°; when the firing was completed it was found to have changed scarcely 1′. The detachment took shelte. before each discharge.

The castings were furnished and the carriage was manufactured by the same firms, respectively, that were similarly interested in the 8″ carriage.

Bids have been opened recently which will probably lead to the immediate manufacture of twenty-one service carriages, similar to this one but slightly modified.

The reservoir cylinder and its connections and attachments will be eliminated, and the ratchets on the counterweight guide blocks lengthened as in case of the 8″ carriage.

Five 8″ carriages, modified as predicted in the description, are being manufactured in Watertown Arsenal.

In new carriages of both sizes the slope of the chassis rails will be 2°. The counterweights will be of lead; 32,000 lbs. for the 8″ carriage and 80,000 lbs. for the 10″.

The carriages without the counterweights will weigh 31.6 tons and 52 tons, respectively. The size of each will be correspondingly diminished. The elevating racks and guide ways will be straight instead of circular.

Gun iron will be used in place of steel castings for top carriage, base rings and traverse circles.

There are other minor changes.

SHALL THE UNITED STATES HAVE LIGHT ARTILLERY?

By Second Lieutenant GEORGE M. WRIGHT, First Light Artillery, Ohio National Guard.

This is pre-eminently the age of the specialist. Only persistent, intelligent effort, long applied in some special work, gives the experience, skill and efficiency now demanded. The idea that "division of labor" is essential to success has steadily grown into a principle and become axiomatic. The conditions of modern civilization have rendered such result inevitable. Mere brawn and sinew can no longer hold their own against specialized training and skill. Numbers alone are often an element of great weakness. Especially is this true in modern warfare: and yet we as a nation almost absolutely refuse to admit the application of this truth to war. As a nation we act as if we believed ourselves to be *born* soldiers. We talk of the art of war as if it all came to an *American* by intuition. We are by no means an ignorant people, nor are we at all slow in arriving at logical conclusions in the ordinary affairs of our daily life. Yet in all questions relating to military affairs we blindly ignore the plainest teachings of history. This is almost incomprehensible, especially when so many lessons from our own short history, many of them within the memory of the present generation, speak to us so loudly. But Draper's conception of the cycle of a nation's life,—having its birth, infancy, youth, manhood, old age and death,—is the true one, taught by all history. We as a nation are now in our youth :—hopeful and buoyant to-day with the consciousness of almost unlimited strength and resources; altogether thoughtless and careless of the morrow; utterly blind to and forgetful of the past, and scorning the lessons to be drawn from the experiences of older nations :—the exuberance of youthful health and vigor leading to an overweening confidence in our ability *to do anything, at any time, without preparation, training or experience.* By no means lacking in good common sense, nor ignorant of human nature, yet we cherish the insane idea that we are a peculiar and chosen people, set apart from the other nations of the earth, and exempt especially from the scourge of war. It is useless to call attention to the fact that no generation has yet lived in any land without war. We blindly close our eyes, and our little army is reduced, "skeletonized", or kept at a stand-still, while the population and wealth of the nation very rapidly increase, and our interests abroad continue to extend, and grow in magnitude and importance. All history teaches, and our knowledge of human nature confirms it, that such continued increase in wealth, prosperity and power, will at home give rise to many causes for internal disorders, and abroad will be considered by other nations as a menace to them. It is utterly impossible for us to keep out of foreign complications; and clouds, threatening the most serious internal disorders, seem to be growing thicker upon our horizon. This is no pessimistic view, but only a plain statement of facts, and logical deductions from history and human experience. The conditions of our infancy and very early youth as a nation were such as might well seem almost to preclude the idea of a war with any foreign power; and it has ever been our policy to assume and insist upon a kind of national isolation. Notwithstanding all, complications and wars even with foreign powers have come to us. Now, despite all our fine theories and assumptions, we are no longer isolated;—steam and electricity, and the wonderful ingenuity and skill of man, have so annihilated space. And *no man nor nation can do his or its duty by remaining, or attempting to remain, in isolation.* Men are but atoms, families but molecules, and nations but segregations of these in the great mass of humanity; and it is the law of nature that we must be continually bumping up against one another.

No matter how much we may try to deceive ourselves with fancied immunity from disorders and dangers at home and perils from without, common to the rest of humanity, the facts remain. In the future they will surely confront us in their stern reality, as they have done in the past, enforcing recognition when we least expect it. None of these facts can be successfully controverted. There is no doubt whatever that we do and shall need an efficient army; and there is no doubt that proper organization and careful, technical training are essential for success in modern warfare. Yet we maintain our little theoretical nucleus of an army with no proper organization for field service as a whole, and without any organization whatever, except that of the battery, in a branch of the service so extremely important as the light artillery. Indeed it is questionable whether we have any light artillery. In this day a few isolated and independent light batteries can, for tactical purposes, hardly be called "light artillery". A population of more than sixty-five millions, with untold wealth and natural resources, and *only ten batteries* of light artillery in our regular army,—only half enough for a single army corps, even on a war footing of six guns to each battery and with the force properly organized! Without even the semblance of a light-artillery organization beyond that of the battery, except the one provisional battalion of three batteries for instruction at Fort Riley, *there is no tactical bond whatever binding the light batteries into any organization that would render them of use in war.* Not more than three of them are ever together, and then only temporarily. They are in fact isolated and independent, under separate and independent heads, and these without any chief of the same arm over them. And this is in a day when all the best authorities agree in affirming that in war *the combatant who brings the greatest mass of effective artillery first into position, and who first gets the range, and whose artillery is trained to hit, will win the battle.* Not only is it of the greatest importance that a force of light artillery be maintained, but, for the development of the required efficiency, proper organization and long continued and careful training are absolutely necessary. An *efficient* force of light artillery cannot be created in a month, nor in a year; and it should at all times be remembered that *light artillery without efficiency is only expensive and cumbersome baggage, conducive often to defeat, but never to victory.*

In considering the numerical strength of the infantry, cavalry and artillery of our regular establishment, it is customary to include all of the artillery, heavy as well as light. Thus it is made to appear that we have five regiments giving us about four thousand artillery in an army aggregating about twenty-eight thousand. Such comparisons very often convey the impression that this is the actual force of artillery for service with an army in the field. But it must not be forgotten that for service as light artillery we have no such force; that instead of five regiments we have not even one organized regiment; that our entire force of light artillery, if it may be called such, consists of *only ten isolated batteries*. Even on a war footing of six guns to each battery, and with the force properly organized, we would have only half enough light artillery for an army corps of the aggregate strength of our present army. No actual assembling or massing of our entire regular army into a single corps is ever to be expected, even in war. But when we consider the time required for the long continued and technical training necessary to render a force of light artillery efficient, it certainly is astonishing that so little attention is given to this branch of the service. The truth is that army legislation has in view little or no preparation for the future compared with our supposed immediate necessities. This is considered as being eminently practical and wisely economical. Unbounded confidence in our all-sufficiency as a nation successfully to meet any and every emergency whenever it may arise causes preparation for the future to be ignored. Surely our patriotism and bravery are unlimited. And is not patriotism better than powder, and bravery better than bullets? This being the popular opinion, any question of the kind now under consideration should be so treated as to bring it within practical limits. Practically there is little use in urging any very considerable increase of the army in the very near future. The proper organization, equipment and training of the present force, however, should be urged over and over again until the desired end is accomplished. And an increase of the light artillery to at least double the present number of batteries, and its proper organization, equipment and training, should also be persistently urged. Within these limits the present discussion will be confined, although a truly wise and adequate preparation for national defense would cover a much broader field. The subjects of this discussion are by no means new, and no doubt we are thrashing over much old straw. But experience shows the potency of continued agitation of meritorious questions. No two persons see the same thing from the same point of view; and it is by the continued discussion of old ideas that advancement is made to their final adoption.

The object of any organization is the accomplishment of some desired end. The sole purpose and object of every military organization is, or should be, *efficiency in war*. In no case should any so-called "peace establishment", or any organization for military administrative purposes even in peace, be other than that which has this end in view:—*the development of efficiency for war*. Can it truthfully be claimed by any one that the present "organization" of the light artillery of our army is in the least conducive to any such efficiency? Truly this so-called "organization" is based upon no *tactical* principle whatever. Nor is it in any way conducive to long continued systematic training, and the acquirement of any real efficiency. With it any proper *esprit de corps*, so necessary for any high degree of efficiency, is wholly out of the question. It is assumed without further argument that we shall need and should maintain light artillery for service in the field, and also artillery for coast defense. That we now have an efficient force in either of these branches of the service will not be claimed by any one at all conversant with the facts. How can any real efficiency in either branch be developed under a system, or rather lack of system, in which there is no due recognition of the fundamental differences so widely separating the two branches in their respective functions and spheres of action? What valid argument can there be for uniting in the same organization light artillery designed for maneuvering with troops in the field, and heavy artillery intended for service in fixed coast defenses? Is not every valid argument in favor of a separate organization for each, under its own chief? Our light and heavy artillery have not always been united. As early as 1809 we find them in separate organizations,—a regiment of light artillery, and a regiment of "artillerists",—even in the small army of that day. After the increase of the army in 1813, the former regiment of "artillerists" and the two new regiments of artillery, together known as the First, Second and Third regiments of artillery, were, by General Orders, May 12, 1814, Adjutant and Inspector General's Office, under authority of the Act of March 30 of that year, consolidated into an artillery corps of twelve battalions, each battalion to consist of four companies; and in addition to this corps of artillery the regiment of light artillery still retained its separate organization. Why was this changed? Why were these two distinct branches of the service ever united? Why was all the artillery in the service, coast and field, heavy and light, including also the *personnel* of the Ordnance Department, dumped into one organization,—*if, indeed, that can properly be called a military "organization" which has no head, and between whose parts there can be no tactical union whatever?*

The first four regiments of artillery, as now numbered, and, so far as concerns the union of heavy and light batteries, as now organized (with the exception of having at first one light battery, or "company", instead of two in each regiment), were born at Washington, D. C., on the second day of March, A. D. 1821,* under a very unlucky star. The alleged statesmen who officiated at their birth were so impressed with the special necessity for economy (?), and the general worthlessness of soldiers, that they reduced the army at the same time to 5600 men. The Act of Congress of April 12, 1808, had authorized the regiment, already mentioned, of ten "companies" of light artillery. In the reorganization of 1821 this light artillery, solely for alleged economic reasons, was merged into and partitioned among the four regiments of artillery then brought into being, but without retaining the character of light artillery. For like alleged economic reasons, but to leave the army with the name at least of having *some* light artillery, it was provided that one "company" in each of the regiments, four in all, should be armed, equipped and designated as light artillery. It has just been said that four regiments of artillery were born in 1821. This statement should

* The dates herein given, and some of the facts, relating to the original organization of the artillery regiments, are taken from the "Army Register"; Hamersly's "Complete Army and Navy Register"; the historical sketch of the Third Artillery, by Lieut. Wm. E. Birkhimer, Regimental Adjutant, *Journal of the Military Service Institution of the U. S.*, for March, 1893; and the historical sketch of the Second Artillery, by Lieut. W. A. Simpson, Regimental Adjutant, *Journal of the Military Service Institution of the U. S.*, for July, 1893.

be withdrawn and corrected. The entire artillery arm, including the heavy as well as the light artillery, seems at this time to have been practically wiped out of existence; since the provisions of the law then made for arming and equipping the four so called light artillery "companies" was ignored for many years, and all the companies of artillery were armed and equipped, and they served as infantry. In 1838 the four companies were equipped as light artillery, and subsequently, under authority conferred by the Act of March 3, 1847, a second company in each of the four regiments was also equipped as light artillery. The fifth regiment of artillery was organized by direction of the President May 4, 1861, confirmed by Act of Congress July 29, 1861. It was originally organized as a regiment of light artillery, but since 1866 all of the five artillery regiments have had practically the same form of organization, and only two batteries in each are now equipped as light artillery. Our infantry has always been infantry, although infantry commands have sometimes been mounted temporarily for rapid movements. Our cavalry has always been cavalry, notwithstanding its dismounted action, and the fact that European critics persist in misunderstanding it. But nearly all of our artillery (especially in the cases of the heavy "companies" or batteries) has been compelled to spend so much of its time as infantry—serving and fighting as such in the War of 1812, in the Mexican War, and in some of our Indian wars,—that its very name would seem to have been saved to it only by a dispensation of Providence. Note the advice given to artillery officers by Colonel H. L. Scott, Inspector General of the United States Army, in a "Military Dictionary" published by him in 1862. After speaking of the artillery companies authorized by law to be equipped as "harnessed batteries," he says (page 61): "The remaining companies are, from supposed necessities of service, usually employed as infantry, *but their name, and liability at any time to become artillerists, must cause officers not to neglect such knowledge of their arm as may be derived from books*, and the establishment of the school of practice at Fort Monroe cannot fail to have the happiest effects in making skillful artillerists." (The italics are ours.)

The only argument in favor of the organization of 1821 seems to have been its supposed economy. At that time the population of the country was only a little over 9,600,000, while now it is more than 65,000,000,—nearly seven times as large. The wealth of the people *per capita* was then less than $400, now it is about $1000,—about two and a half times as great, making the present aggregate wealth enormous. So there can be very little weight left in the argument of economy, even if it ever had any. But there is not and never was any true economy in maintaining at a price never so low, any system of organization by which the desired object is not accomplished. In this case such object is supposed to be a high degree of efficiency in the small force of artillery we see fit to maintain. The fact that the force is so very small should enable us to obtain this at a very low price in dollars and cents, if its value is to be so judged. And, with our increased population and greatly increased wealth *per capita*, and our very greatly increased aggregate wealth, it certainly could not be very much of a burden upon the people, if the force were also increased somewhat beyond its present strength. The truth is that we now have a force carried on the rolls as "artillery," and wearing crossed-cannon and scarlet trimmings, giving the impression at first glance that they are such, but with an alleged "organization" that splits the light artillery into small independent and isolated commands; which does not now and never can give us any efficient force, either of light artillery or of coast artillery :— *an "organization" without a head, without a body, without substance.* Then why longer retain such a system, or lack of system, based as it is upon no correct principle whatever, but known to have been born of false economy nearly three-quarters of a century ago? Why retain a system of light artillery "organization" brought into being very nearly half a century before Vionville, Saint Privat and Sedan, with their important tactical lessons? Why retain a system of light artillery organization diametrically opposed to that fundamental and vitally important tactical principle which requires the action of light artillery in masses? The present system having been established by law, legislation, of course, will be necessary to change it. Has not the time for such legislation arrived? Has not the time come when the necessities of the service demand a separation of the field from the coast artillery; the formation of an organized force of light artillery and a corps of coast artillery; and that each branch of the arm shall have, not only such special organization as is most conducive to the development of its greatest efficiency, but also a chief with proper rank and authority?

In considering the question of proper organization in so small an army as any we are likely to maintain, the siege artillery may be omitted in time of peace, so far as its *personnel* is concerned, although the due preparation of *materiel* should not be neglected. The disposition is continually increasing to depend in war more and more upon the animate defense of armies, rather than the inanimate strength of materials in fortifications. And the adoption of the principle,—"troops first, works auxiliary,"—that military works should aid and protect armies in the field, instead of the old notion that garrisons should prctect and defend materially strong fortifications whose narrow limits confine them, —has caused the importances of sieges greatly to diminish. Lieutenant A. M. D'Armit, of the Corps of Engineers, in his paper on "Intrenched Camps," recently read before the International Congress of Engineers at Chicago, says, referring to Lenchy on Fortification, page 484, as his authority:—"From the tenth to the eighteenth century there were more sieges than battles, from 1741 to 1763 the ratio was as 69 to 100, during the French Revolution as 26 to 100, while during the empire it fell as low as 16 to 100.* These facts, and the history of all modern warfare point to the growing importance of light artillery. In any event the training that should be had under proper organizations of coast artillery and light artillery would without doubt give us officers fitted for service with artillery of position in the field when needed in war. Siege artillery and all field artillery of position, when organized, should, as a part of the field artillery, and as distinct from the heavy artillery organized for coast defense, be at all times under the chief of field artillery of the army;—the "field artillery" being divided into the "light artillery," intended to maneuver with the troops, and the "heavy

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artillery," composed of the siege artillery and all field artillery of position, with the artillery ammunition and supply trains.

The peculiar functions and importance of coast artillery have become more and more generally recognized in this country, until it would seem that the absolute necessity for the existence of a separate corps for coast defense must soon be realized. In this connection we are met by two important questions :—Should the coast artillery be attached to the navy? If not, should the coast artillery and the *personnel* of the Ordnance Department of the army be united? Both of these questions affect the organization of the coast artillery and are of grave importance. But this article is not designed to cover the entire subject of artillery organization. The light artillery alone furnishes a subject far too broad for the space now available. The other points are touched upon because they bear upon the question of separate organization. There are certainly two sides to the question of the advisability of creating a corps of coast artillery and attaching it to the navy. There can, we think, be but one side to the question of the advisability of creating a corps of coast artillery and separating it from the light artillery. Attaching such corps to the navy would indeed bring about a separation from the light artillery. But from a decision of this question adverse to the navy it would by no means follow that separation and organization of the coast and light artillery are not needed. The union of the ordnance corps with the heavy artillery, advocated by some, would not be an untried system of organization. From the time of the reorganization under the Act of March 2, 1821, until the separation brought about by the Act of April 5, 1832, the *personnel* of the ordnance and the artillery were united in the artillery, artillery officers being detailed for ordnance duty. There are some of the strongest reasons for advocating a union between the ordnance corps and the coast artillery, which we think ought to receive fully as serious consideration as the question of attaching the coast artillery to the navy.

There is no doubt that a separation of the light artillery from the coast artillery would greatly benefit the latter as well as the former. Experience has demonstrated that the battalion and regimental organization is tactically the best for light artillery.

Such organization, however, is not the best for heavy artillery designed for service in fixed coast defenses. Nor should the battery organization be the same in both of these branches of the service. But the discussion of the question of the best organization for coast artillery will not be entered upon here. The point to which attention is now directed is the fact that, with a separation of the coast defense from the light artillery, there can be given to each just such special organization as will be most conducive to its efficiency. And there can also then be given to each that without which any real efficiency can never be reached, namely, a head or chief? The attention given of late, in this country, to coast defense and the creation of a navy, has aroused much interest in the important subject of coast artillery; and at present much more attention is devoted to this than to light artillery. Indeed this subject seems to be treated much as if the light artillery question were a mere collateral issue. In this country, throughout all arms and branches of the service, a kind of lethargy seems to exist in regard to light artillery organization. This is by no means the case abroad. Many foreign ideas on this subject might well be adopted here; they are fully as important as the braiding of a blouse or the shape of a forage cap. There is no doubt that a properly organized and trained corps of coast artillery is imperatively necessary in this country; but the importance of our having a properly organized and efficient force of light artillery is fully as great, and should be equally recognized. The one branch of the service differs so radically from the other in its functions, that any comparison as to relative importance is precluded. Each has its own peculiar sphere of action, and both are vitally important. No nation can safely depend upon its coast or other fixed defenses alone. Armies in the field are also necessary. Indeed we must remember that in war well trained men are more important than masonry, and efficient armies are stronger than armor. And the very great and continually increasing importance of a properly organized and efficient force of light artillery in war must not be forgotten. Compared with the best infantry and cavalry of the present, as well as with the light artillery of the past, the power of such a force on the battle-field to-day is far greater than ever before. *Efficient light artillery can now truly be called the arbiter of battles.*

(TO BE CONTINUED.)

COAST ARTILLERY FIRE INSTRUCTION.

First Lieutenant Charles D. Parkhurst, 4th Artillery.

SOME OBSERVATIONS ON SEA-COAST GUN PRACTICE.

PART II.

The experience of many officers at the various stations required by our system of gun practice would seem to call for some comment upon the character, and known defects of the instruments in use for observation, etc., etc., with suggestions looking to their improvement. Many points in the system also need attention and modification, hence, with all due deference to the opinions of others, the following is submitted, for what it may be worth.

It is to be remarked that the good work done at gun practice during the summer of 1894, was not because of a perfect system, or instruments, on the contrary the good results obtained were in spite of many serious defects. No system was ever perfect on its inception, nor are instruments so good but that they may not be better. "Nothing is too good" should be our motto, instead of that old and hackneyed saying "that is good enough". With this introduction the following is presented.

I.—Ammunition.

Much as has been done towards improvement, much yet remains to be done before we shall have a standard cartridge. It has been proved time and time again that the key note of all successful shooting is in the careful making up of the cartridge. As was shown, during the past season, hardly any two batteries had cartridges that were alike as to style, size, and uniformity of density of loading, and it would seem as though the next step forward would be to bring the size, style and density of loading down to a *standard*, and thus assure uniformity throughout the entire service, eliminate the variable factor due to variations, and bring the results down to a basis of comparison.

It would seem to be evident that the old style of filling the bags and tying the choke is not reliable. From observations made upon such cartridges, as carefully made as was possible, they were *not* of an uniform length, and did not give uniform density of loading. Some projectiles are harder to seat than others, and they would finally come down upon the cartridge with greater force than those that could be gently slid in. The result was that they went down further before the compression of the cartridge checked them. With those that slid in gently, if they were not down to the proper place at first *simple pressure* would not always move them further in; they would move in and *spring back* until a *blow* was given by the rammer to compress the cartridge and the projectile firmly.

The good work done with cartridges made up with stick and disk suggest this form as a model for the standard, and the following model and remarks are submitted.

(*a*) *An uniform length of twenty-one inches from outside to outside.*

This length is suggested because it has been found that the powder may be easily shaken down to secure it, without any danger of bursting the bags, while any much shorter lengths strain, if not actually burst them.

It was suggested that the bags might well be made a little *larger in diameter*, so as to the more readily secure the length of twenty-one inches. Ten cartridges were therefore made up with bags that had been resewed so as to give a considerably larger diameter. When it came to the filling it was found that the length of twenty-one inches was too easily obtained, *i. e.*, the cartridge was loose and flabby, instead of hard and rigid. Although less than eight inches in diameter, when it came to loading the gun, these cartridges were difficult to get into the gun on account of their want of rigidity, they upset easily and more than filled the bore of the gun at the muzzle. They were worked into the gun and were fired, giving uniform results; but they were not a success for the causes stated; hence it would appear that the present diameter is as great as can well be used, and gives a cartridge that slips into the gun easily and quickly.

(*b*) Use the bags with flannel of seams on the outside, *i. e.*, bags "wrongside out".

(*c*) Secure stick in bottom of bag centrally, with a brass screw and copper washer, the screw, with washer slipped over it being put through the seam and then securely seated in end of stick. This is better than tying, being a smaller and neater fastening, and better than nailing as it will not pull out as a nail may driven into end wood.

(*d*) The use of a light, but *rigid* wooden, (or papier mache) disk with groove turned in same, into which the flannel may be drawn smoothly and securely by simple tying. Such disks should be furnished by the proper supply department. They should be firm and *rigid*, not likely to split or crack.

Tin and pasteboard such as were used during the past season were used mainly as a means of centering the stick, and keeping it in its place. They were not rigid enough to keep the front end of the cartridge from losing its shape under the pressure of the projectile. The experiment has been tried of forcing the base of a shot up hard against the front end of a cartridge with pasteboard disk—the cartridge firmly held on a bench and the projectile resting on the bench and in line with the cartridge—and it was found that the sabot nut at base of shot would press into the disk and deform the front end of cartridge considerably. Hence the rigid disk is recommended to prevent this. This disk should be firmly secured, at its centre, to the end of the sticks, by brass screw and washer.

(*e*) Care and attention must be given to the rear end of cartridge to prevent the bagging out beyond the end of stick. The best way is probably to stand the cartridge on its front end, shake and press the powder back where it belongs, and then sew down the loose flannel. The shape at rear end may perhaps be altered before filling so as to prevent this bagging out, but the shaking back and sewing down of loose flannel will accomplish the same result.

With a cartridge made up as above recommended it will be found that it will slide into the gun easily and smoothly, and will bring up against the bottom of bore almost as solidly and rigidly as a block of wood. And when the projectile is sent home, it too will bring up against the cartridge solidly and firmly; and, if the cartridges have all been carefully made the same length, uniform density of loading will result, with minimum trouble at the gun. The care and trouble taken in making the cartridges will more than be paid for by the ease, certainty and rapidity of loading, and the uniform shooting.

It goes without saying that accurate weighing must be done. To this end accurate and sensitive scales weighing up to one hundred and fifty pounds at one weighing should be provided. Then can the full weight, not only for the 8″ C.R. cartridge but also for that of the 15″ S.B. gun be properly weighed out at one weighing.

While on this point of weighing it may be remarked that weighing projectiles should be done under shelter from wind. It has been observed that weighing done in the open, exposed to high wind, is not accurate. Variation of from one to two, three or four pounds have been observed when weighing or trying to weigh a shot, due to the uneven pressure of the gusts of wind.

Though not "good enough" the 8″ C.R. projectiles now on hand are perhaps the best that can be had for several years, they can hardly be condemned but must be used. Careful selection will however do a great deal to secure uniform weight and results.

In any 8″ C.R. projectile to be made in the future, it is thought that perhaps more care can be exercised in machining to constant weight, the same as is now being done for the more modern projectiles, and more care be given to accurate weighing and marking, so that weights and marks may agree. It has been found to be the exception and *not* the rule to find the actual weight to agree with the marks on the sabot.

(*f*) Sufficient standard pass boxes of zinc, or better still of copper, arranged to permit of hermetically sealing, should be provided, in which to pack and store the cartridges as soon as made.

It does not appear that any argument in favor of the above is necessary. The fact of the necessity is self evident.

Finally, as to ammunition, it may be said that we cannot hope or expect to get a constant I.V. But we can reduce the variation to very small limits, and so as to be pretty sure as to what it is. Even with the best of small arm metallic cased ammunition there is a variation in the I.V. It is so small however as to be practically negligible. We should endeavor to secure the same practical though not absolute constancy.

Through the kindness of Lieutenant Lundeen, 4th Artillery, the following table is given :—

Initial velocities corresponding to different densities of loading, for the 8″ C.R calculated by Equation 17, Ingalls' *Interior Ballistics*.

F assumed as 0.7333 for the Eureka shot. $\omega = 35$ lbs. $w = 179$ lbs.

For the Butler projectiles fired in 1893 F was found to be a little less, or about 0.7300.

Δ or density of gases.	Distance from bottom of bore to head of nut on projectile	Distance from bottom of bore to rim of projectile.	Initial Velocity.
f.s.	inches.	inches	f.s.
0.992	20	19.675	1424
0.9797	20¼	19.925	1415
0.9665	20½	20.175	1406
0.9555	20¾	20.475	1398
0.9437	21	20.675	1390
0.9323	21¼	20.925	1381
0.9212	21½	21.175	1373
0.9103	21¾	21.425	1365
0.8997	22	21.675	1358
0.8893	22¼	21.925	1350
0.8791	22½	22.175	1342
0.8690	22¾	22.425	1335
0.8588	23	22.675	1328

In the calculation of the above table the cubic contents of the chamber was accurately calculated from official drawings furnished by the Chief of Ordnance, giving the exact shape of bottom of bore, and the form of the base of the shot was taken into consideration.

II.—Instruments in Use.

They comprise

A—Quadrants and Tangent Sights.
B—Azimuth Circles.
C—Transits.
D—Protractors, Scale and Deflection Slide Scale.
E—Plotting Board.

A.—The Quadrant and the Tangent Sight.

Experience and use are demonstrating the necessity for a reliable quadrant, reading to minutes, as a means of taking elevations, or to check those taken by the tangent sight.

In old time mortar practice, or in days gone by, a quadrant with a least count of five minutes may have been "good enough". It certainly is not so now, and, as it is known that a quadrant reading to minutes is now made for the 12″ B.L. mortar, there would appear to be no reason why we should not have it, or a similar one for use with our 8″ C.R. or 15″ S.B. gun.

But, with such a quadrant we need, or should have, a proper seat, to which it may be easily and accurately applied. Such a seat should not be "obscure, or easily covered up by paint", but could be an accurately planed and fitted knee upon one of the trunnions, for either the 8″ C.R. or 15″ S.B. gun so placed that the face of the knee to receive the quadrant would be either parallel or perpendicular to the axis of the piece. We then could apply the quadrant with certainty, and with much greater accuracy than is now possible upon the muzzle, or within the bore.

It may appear absurd, and apparently a retrogression, to ask for and use a quadrant for taking elevation, when we already have a tangent sight reading to minutes. But a moment's consideration will explain the anomaly.

As now made the tangent sight must be used as a peep sight, no provision having been made for any other use.

Now no matter how plainly the target may loom up when viewed *with both eyes open, and no effort being made to focus and accommodate the eye to an object close at hand, as well as the target*, when we come to look through the peep, and try *to see the front sight and the target*, hundreds, yes, thousands of yards apart, the vision is so strained that the target becomes very dim, and all but invisible.

It is therefore all but impossible to lay the gun accurately for elevation on the target, when looking through the peep.

But we can lay exactly for elevation by the quadrant, if it is good and properly used; then, having the elevation fixed, we can lay for direction by using the tangent sight simply as a line of metal, looking over it, or through the slit, until we are satisfied the gun is on the proper line.

The best shooting that was done during the past season was done in the above manner. It was found that the only reliable method for giving the elevation was by quadrant, and the shooting showed the benefits derived from a fixed and accurate method of taking elevation as compared with the wholly unreliable natural line of sight through the peep.

Having noticed the loose fit of some of the tangent sights in their sockets some observations were taken as follows:—

Examination and trial of the 8″ C.R. tangent sights at one post showed them not to be interchangeable. Each socket and sight was numbered, and those that corresponded in numbers as to sight and socket fitted, and no sight fitted any other socket to the same fit, *i. e.*, the same amount of insertion. The variation were approximately from ½ minute to 1 minute, *i. e.*, the line of zeros was that much too high or too low, as compared to its height when the sight was in its proper socket.

But examination of sights and sockets elsewhere, show that all sights and all sockets are not numbered and there are all sorts and kinds of fits, except a close, accurate, fine one, and the sight can be wobbled around with ease, or put out of position by the slightest touch, making it necessary, if one does try to use the peep, to be careful that the sight is not moved by contact with the head, or its covering.

B.—Azimuth Circles.

The defects found, and their remedies are as follows:—

1. The wooden tripods, furnished therewith, and to be used except when masonry pillar is available, have no means provided for suspension of a plumb-bob. How one is to set up accurately over a base end without a plumb-bob does not appear from any instruction accompanying the instrument; not only is there no means of proper attachment, but no bob is furnished with the instrument.

The best one can do, is to loop a bob, "begged, borrowed or stolen" from somewhere, over the wings of the thumb-nut of the clamp screw that attaches the instrument to the tripod. A bob thus suspended hangs anywhere except under the vertical axis of the instrument, and careful and accurate setting is therefore "guess work".

It is known how slight will be the possible errors in either target or shot angles resulting from such slight displacement. But that is not the point. The azimuth circle is an instrument capable of being used as an instrument of precision, and slip-shod, hap-hazard methods, "good enough" for backwoods preliminary reconnaissance should not be tolerated in angle reading. Such instruments should be complete and reliable, and up to the XIXth century method.

2. When used on top of masonry pillar at base ends, no centering device or mark is provided by which to *accurately* center over base line terminal set in the top of pillar. The best one can do is to bisect by the eye the thick boss or hub of the standard in planes approximately at right angles, and sight down by the eye to see that the instrument is somewhere near over the base end.

A simple device to correct this would be a screw, with a fine conical point in the prolongation of the head, to run up into the central hole in the boss or hub of standard; then there would be something fairly accurate by which to set the instrument.

3. No clamp or other attachment is provided by which to secure the instrument to the pillar—its own weight is all that holds it in place, and hence the instrument is liable to be thrown out of position at any moment from many causes.

In some slabs on top of pillar conical holes have been drilled, into which the feet of the levelling screws seat themselves. This is better than nothing; but the accuracy of position of the instrument depends here upon too many possible errors, and it cannot be moved or adjusted.

The holes being conical, permit of no play; if they are not accurately spaced and drilled, if one is deeper or wider than another, if the feet or ends of screws are not all the same in size, if they are not all exactly central, or, with three feet, exactly at the apices of an equilateral triangle and the holes in slab the same, then the instrument will not seat itself accurately, or the same in any position of the feet.

It is thought that the proper method is to put in top of slab a set of plates, smooth on top, and as nearly as possible central with the base line terminal mark, and of a considerable size. On these the feet rest evenly, and there is room enough for lateral play and adjustment of the instrument.

A clamp should then be provided, by which one or more of the standards, or the whole instrument can be rigidly clamped to the slab. The necessity for this clamping arises from the following:—

(*a*) Jump of instrument due to shock of discharge of piece.

This has been observed in more than one case. The writer had his instrument jump *seven minutes* from shock of discharge of 15″ gun; and another observer had the same instrument at the same station jump on two occasions *three minutes each time*, due to shock of discharge. In each case the instrument was resting on top of pillar and depending on its own weight only to keep it in place, except that, in the case of the seven minute jump, three bricks had been carefully placed around the standard, so as to bear lightly against its arms, in the hope of preventing this very jump.

(*b*) Displacement of instrument, due to pinching and jamming of vernier clamp.

It is the observation of every one I consulted that has used the azimuth circle, that the vernier clamp as provided is very defective. It will turn or twist and lock itself, even when loose, so that the telescope and vernier plate cannot be moved any more than if the clamp were set up hard and fast. The only way out of the difficulty, with the present clamp was to take it off entirely, or loosen it and free it entirely from any bearing upon the limb.

Even with the instrument firmly on its tripod, and the latter firmly sunk into the ground, the writer has had the clamp stick and cause several splashes to be all but lost, from want of freedom of movement to enable turning the telescope quickly enough to catch it, and after these times of striking, verification of the line of zeros would show it to be out from five to ten minutes.

Now if resting on top of pillar by its own weight only, where would the instrument have been after such a state of affairs? Anywhere but on the line of zeros, and possibly upon the ground; one observer known of had this very thing all but happen to him; the clamp stuck and his instrument went sliding over the top of the pillar.

The cause for this twisting and jamming is plain enough and the remedy simple.

The top surface of clamp has a curved rib, which matches and fits into a corresponding channel in underside of the limb. This rib then slides in this groove, and, the point of application of the power to cause the sliding being away outside of its own body, the moment of this force causes the rib to turn in the groove; the corner of the rib then bites into the side of the groove, and there you are jammed hard and fast and the vernier plate simply immovable.

Examination of *several* clamps shows them all to be worn and polished at the surfaces near the corners of the rib, showing that the friction is there.

The remedy is simple: remove the rib entirely from the clamp; it is not needed, as the dowel pins already provided will keep the clamp from turning around on the clamp screw, though they will not prevent the twisting already mentioned by which the jammiug occurs, no matter what their original object.

If the rib is essential to anyone's ideas of a proper clamp then widen the clamp so as to lengthen the rib, and the twisting will then be much less relatively, though perhaps the same absolutely, and the long slim rib will be found to move smoothly and easily as any long sliding bearing does. Wide drawers of but little depth almost always stick, while narrow long drawers very seldom if ever do so. All machine bearings for sliding purposes are made as long and narrow as possible, simply to prevent the very twisting and binding.

4. The open sight alidade on top of telescope is thought to be not only practically useless, but also worthless.

This arises from its construction as well as the general objection to the use of such a sight by which to catch and measure the angle of a splash.

From its construction the rear sight vane is so far inside the eye end of the telescope, that the eye cannot be brought close to the slit or peeps without bringing the cheek very close to the eye piece of the telescope; unless the eye is close to slit or peep a large field of view cannot be gotten in the front ring, and even with the eye as close as it can be placed, it is conceivable and possible for the splash to be hidden by the metal of the ring, occupying as this does a large space over the field of view, the closeness of the rear vane to the eye shutting out everything except the view through slit or peep.

If the splash is caught through the alidade and the same turned to adjust to the cross-wires, and then the head dropped down quickly to catch the splash through the telescope, the cheek or cheek bones are liable to hit the eye end of the telescope and knock the whole thing out, causing the splash to be lost.

The cross-wires are very delicate and liable to deformation or breaking on the least provocation. It has so happened that I have been called upon more than once to replace broken wires, and I have yet to see an instrument after any use in which the wires were taut and true.

The adjustment of front ring is such that the line of sight of alidade may not be in adjustment with that of the telescope, and perhaps they cannot be made to agree; this may cause a permanent error, to be taken into consideration at all times.

All observers spoken to on the subject agree in saying that the open alidade is of no use to them, and that they do not use it.

The method of observation is to fold the alidade down *out of the way*; with the telescope unclamped as above mentioned, and free to turn, look over the top of telescope and watch for the splash in a wholly unobstructed field of view. As soon as the splash is seen turn the telescope quickly so that its line of metal is under the line of sight to splash, and then look through quickly and every time the splash will be in the field, and almost always no adjustment, or at most a very slight one is required to put the vertical hair upon it. Then letting everything alone read the angle.

The telescope and vernier plate move stiffly enough on all instruments ever used by the writer not to require clamping to read the angle. A positive movement is required to move the vernier, and with any degree of care there is no danger that the telescope will be knocked to one side or the vernier moved, after the eye is taken from the eye piece, where it saw the splash to read the angle measured.

In place of the open alidade two simple cones of metal, as sights by which to fix line of metal of telescope, would seem to be all that is required; even these are not essential though they might be of service.

If the open sight alidade is necessary for the azimuth circle and base end observations, why is it not necessary for observations behind the gun? Here the transit is used by common consent. Do we know where the splash is to be when behind the gun any more than we do at the base ends? If one observer can catch it without open alidade so can another, and either both should have it or neither.

C—Transits.

The question naturally arises, why a transit for observation behind the gun any more than at the base ends? Why not an azimuth circle for all?

And this becomes all the more emphatic when we compare the two instruments, or the two classes of instruments as provided for use. The azimuth circles have splendid telescopes, telescopes that certainly call for no improvement, while those I have seen on transits leave much to be desired.

To say nothing of such as give an inverted image, as being entirely obsolete for transit work, now that erecting pieces are made that admit light freely and give a large colorless field, what can one say of those that cannot be focussed to give a clear sharp image, but do the best one can on a clear day, it is always blurred. Yet that is just the kind provided for use and that I have used. If the target was in focus, a splash 100 or 200 yards beyond could hardly be seen, its image was so faint and blurred, and constant care and attention was needed to be sure that one *did* see the splash.

That this was wholly wrong was shown by the telescope of another transit, giving fully as much magnifying power, in use at the same time, and by the telescopes of the azimuth circles. All of these gave clear sharp images, and had a depth of focus that was simply astonishing. With telescope of azimuth circle focussed on target at 3500 yards, so that the same was clear and sharp, no difficulty was found in clearly seeing all the small details of boats, sails, etc., that crossed my line of sight within two or three hundred yards of the instrument. Acquaintances on board those boats could easily have been recognized without any re-focusing. And that is what we want for transit or "behind the gun" observation, as well as at the base ends.

Then again the azimuth circle has a large limb, the transit generally a small one, with a correspondingly fine graduation on both limb and vernier, making it hard to read even with a microscope. Reading deflection of shots or splashes can be done by vernier much better than by micrometer, hence the azimuth circle is just the instrument for work behind the gun, instead of the usual transit.

If any "transit" work is needed it will be but small in amount, and it is thought that the vertical motion of the telescope of the azimuth circle is all sufficient for what may be called for.

It is to be hoped of course that splashes will not go so wide of the mark as to fall outside the field of the ordinary telescope, when the latter is set with vertical hair on target. But when this does occur how can they be measured by micrometer? They simply have to be measured by vernier and so can all splashes, and the use of micrometers be abandoned.

The want of harmony between shots as plotted and as observed by transit, and by every one at the gun or its vicinity, has led to same unfavorable comment upon both plotting and upon the transit observations, showing that due consideration of width and length of splash has not been given.

Reliable observation by men on tug towing a floating target and also from base ends, shows that the splash may be anywhere from five to ten yards wide, and from twenty to fifty yards long, depending upon the condition of the water as to roughness and character of richochet of the shot. Its general shape is roughly an ellipse, anything but a small point in the water, and anything but easy therefore to always observe in the same manner or the same part.

From the location of base end relative to line of fire, it may be impossible for the base end observers to ever get the front edge of the splash. If they try to get a line tangent to the edge of splash it will be to one side or the other, and the intersection of these lines of sight will not plot the shot where it stands.

It is possible then for the shot to plot anywhere inside of a trapezium of a considerable size, whose bounding sides are the lines of sight from the two base end stations, tangent to the ellipse made by the splash, and an extreme case, readily conceivable may put the shot on the plot many yards from its exact position, and yet be within the limits of careful observation.

With the transit however the observer is behind the gun, or very nearly so; his line of sight can therefore be made to bisect the splash, giving very fairly the *line* upon which the shot struck; with anything like proper observation the deviation thus shown as referred to the range of the target, and not the range of the shot, should be the record by which the next shot is calculated and correction made for deviation; it is not certain but that this record should be the official record also, recognized and recorded, by which the battery record as to deviation is made up. The transit record is more apt to be correct; at times it may operate against as well as in favor of the battery, when compared with the plot, for the plot may show line shots that are not such, as well as shots away out that were really close in, owing to the inherent error of observation and plotting above outlined. But no matter for this, we are not shooting for record but for practice and improvement, and we need and want the facts as near as we can get them, as to each shot, hence the importance of transit observation and why it should stand as the record.

D and E.—Protractors, &c., and Plotting Board.

The main defects with the protractors are the difficulty attending fastening them down accurately, and the character of the verniers.

The trouble in trying to *set accurately* is caused by the character of the counter sinks in the bar of the protractor; they are conical for conical screw heads; hence, when put down and adjusted, putting in the screws to hold it in place may, and in the general case will, move the protractors, and make it out of adjustment with the base, the base end, or both.

This arises from the fact that even the most careful mechanic would have difficulty in centering the holes for the screws exactly in the center of the holes in the bar. Even if exactly centered the screw heads may not be accurate but slightly eccentric, and when drawn down into the counter sinks in the bar, if the screw heads are not exactly true to position or shape, they will draw the protractor bodily to one side and hence put it off the line or base end as mentioned; when once down, or the holes once bored and found not true, any amount of trouble is entailed in getting the protractor properly set, so that it will stay so.

Some put the protractors down hap-hazard, i. e., do not try to get the zero on the line, but are satisfied if the center is on the base end. Even then it is difficult, and when so set unsatisfactory, for a constant error has to be constantly kept in mind. The errors of the two protractors will probably not be the same, hence these errors must be applied, each to its proper protractor, leading perhaps to wrong measurements from the corrections getting reversed in their application.

It is thought therefore that the only true way is to make a true setting at the start and check frequently to see that no shift has been made by use. This may take time in the first setting (an hour has been known to be thus consumed) but the after work is much more satisfactory, and in the end it pays.

This fault in the countersinks and in the consequent difficulty of setting, can be obviated by a little different constructure.

Instead of conical countersinks let them be cylindrical, and the hole for the screw and the countersink both larger than the stem of the screw for one, or the screw head for the other.

Then with broad fillster-headed screws the protractor could be put down quickly and surely; for it could and would have enough lateral play to admit of exact adjustment before the screws were given their final tightening, and the screw heads would have no side thrust to push it out of adjustment when finally set up. They would also hold firmly enough to prevent any slipping sidewise while in use.

For any post with a permanent base line the board could be prepared with holes through it, through which bolts could pass with some considerable play; then with large washers and thumb nuts on these bolts, the protractor could be shifted to proper adjustment at any time and set up securely. This method would evidently not answer for use on a board where replotting was done, or where several different base lines had to be used for it would cut up the board too much.

It is unfortunate that the verniers on our instruments are not all of the same pattern. On the azimuth circle we have the simplest and best, a plain, direct reading vernier, reading to minutes each way. On the protractors, simply to economize space, the vernier is made a double folding or "backaction" vernier, one that may be simple enough in theory but is not so simple in use. Many mistakes have been made with it as I know from personal experience in making them, even with the utmost care and attention. Any little trifle among the many things transpiring at the plotting board, or in its vicinity, may cause distraction of proper attention and the vernier be consequently set wrong, and erroneous plotting result.

We expect or hope to have such work done by non-commissioned officers. Would it not be well then to reduce all verniers to one kind on all instruments? Then the observer has to learn but the one or use but the one, and need not vary from one instrument to another as he goes from one class of work to another. Simplification should be the constant effort, and here in one place to apply it advantageously.

The rule or scale provided is generally not straight, and at many posts this is all there is to be had for use as a "straight edge" with which to draw in base lines, &c., &c. This defect suggests its own remedy.

The deflection scale is very loose in its fit upon the main scale. It can be twisted considerably from a true right angle, and can be made to vary its reading by from one to two yards. To make it slide on the scale by being regularly fitted thereto by a dovetailed seat, with a movable gib to make it fit closely and take up for wear would be an improvement. True enough it could not be removed from the main scale as easily as now; but there is no reason why it should be taken off. It is always wanted to read as a vernier to the main scale even if no deflections are to be read. When not in use it can be slid to one end out of the way.

The pivot for the main scale to be put at the position of the guns, leaves much to be desired. It is flimsy and insecure, works loose easily, and is easily put out of order by bending of the steel points as they are pressed into the wood. A metal stud with screw thread cut upon it, to screw down firmly and permanently would be much better, for rarely does it have to come up after once placing except for a change in the group of guns being used. Our scale is so small that trying to locate the pintle of each gun and put the pivot there, or to make a shift for each gun of a group as each is fired is practically impossible.

And what can one do with the present pivot when the gun pintle plots upon the rim, or bar of one of the protractors as it may happen to do? When that is the case all one can do is to tap a hole in the protractor and screw the pivot into such tapped hole, for of course the steel spurred pivot wont go into the metal unless holes are provided for the spurs, and even this wont be firm.

For use at station with guns and base line all permanently established, a plate of metal should be set upon or sunk into the board, with the position of guns properly laid out thereon, holes tapped for each position and a screw pivot provided that will fit any hole; then a reliable pivot is provided, and one that can be instantly shifted from group to group as one or the other may be used.

A plotting board properly made and laid out into squares, with proper appliances for attaching protractors, &c., &c., is certainly what we need, and what we must have for careful and reliable work.

The boards provided are an honest attempt at giving us a good foundation upon which to work. Probably they are as good as can be provided with the funds available, and we therefore can hope for no better.

To put them in proper condition is however no easy task. Unfortunately paper will stretch and shrink with changes of atmospheric condition, and do the best we can, our work may prove very inaccurate and unsatisfactory after the changes in the paper due to such stretching and shrinking over but a very short period of time.

The best of cross-section paper has been found to be inaccurate and unreliable in its ruling, even before any stretching or shrinking by glueing or pasting upon a board. After such glueing or pasting it is more inaccurate than ever.

Even if paper large enough to cover the board with one sheet could be had it would not improve matters much. It is known that paper stretches more in one direction than in a direction at right angles to it; hence the spacing of the squares will not be the same in both directions after stretching, no matter how accurately they may have been spaced originally.

Now would it not be better to abandon the ruled paper entirely for the main covering of the board, and put on plain paper that can be had in large sheets so as to cover the entire board with one piece?

Then at a time of year when atmospheric changes are a minimum, and the board and paper can be kept at fairly uniform temperature and condition by artificial heat, glue on the paper firmly and smoothly; when dry rule in by hand a set of squares say $3'' \times 3''$ or $6'' \times 6''$ over the entire board, and then varnish the whole surface thoroughly with spirit varnish.

The base line, stations, guns, etc., having all been located thereon the board is then ready for use, except in the location of the 100 yard squares.

To locate these there is no necessity for the whole board to be ruled off into these small squares but only that part covering the channel and water ways of the adjacent waters. This can be done by transfering chart of harbor to the board and locating the line of the main channel, buoys, etc., etc.

Then each gun, or group of guns has but a limited section of fire as a general rule. Such section can then be laid off and within their bounding lines and so as to cover all the channel, etc., the positions of the 100 yard squares can be determined.

The whole board having already the large squares drawn in, all that will then need to be done will be to glue on, or for temporary use fasten on with thumb-tacks, a sheet of cross-section paper to agree with the lines already drawn, and there are the squares—100×100—covering all the field of fire of the guns, and all of the harbor where a vessel such as we must look out for can ever float.

Then when an azimuth has to be measured, we have the main directing lines to go by, and can measure accurately. Any small error in the actual spacing of the small squares, or want of parallism of these lines will be of but little moment, as such lines would not be used for any measurement of angles, but simply to approximately locate the square in which a shot was observed.

By a system such as above outlined the squares for each gun could all soon be determined, or for each group of guns; the azimuths of these squares could then be all measured and tabulated once for all, and become part of the permanent record for each gun, or front of guns. Errors such as are now made from want of accuracy in plotting boards would not occur, and, no matter how the paper or board may become defaced or out of shape from lapse of time, or use, the azimuths would all be available, and all be constant.

Plotting Shots.

Theoretically it is the simplest thing in the world to set two protractors to angles given, and, by the intersection of their arms, to locate the object.

But practically it is far from being so simple, and "the man at the plotting board" sometimes deserves what he does not get, the sympathy, rather than the execration of those interested.

This arises generally from want of proper consideration, on the part of spectators and others, and proper idea of how easily loud talking, questions, remarks, almost anything in fact but silence, can distract one's attention, and cause the proper thread of ideas to be lost, only to be again caught up by going back to the beginning and commencing all over, to the delay and vexation of those waiting for results as determined by the plot.

Accurate, reliable and at the same time *rapid* work demand that the plotter should be as nearly alone as possible, and should work with a regular system. Such a system might be as follows:—

1. He should have a blank (compressed into a convenient pad) upon which he can enter the target or shot angles he receives, and from which he plots, these angles being given him by the operator who receives them (who also keeps a record on proper blanks). These blanks should also have columns for range of shot, distance to target, deviation at target, deviation at point of fall, rectangular co-ordinates, and column for remarks.

Such a blank would then obviate the necessity of one being ruled out by the plotter, or his jotting down memoranda on scraps of paper, to be afterwards lost or destroyed; these blanks should become a part of the records, and be a check upon other records, showing just what angles were used in plotting.

The man at the gun needs the following information, and for the reasons given:—

1st. He wants distance to target, every time the latter is plotted, so that he may not be shooting at a target that he supposes to be at one distance, from its having been plotted there, but that in reality is at some other distance from its having shifted, having been replotted and he not informed of the change.

2d. He wants *exact* range of shot to point of fall, and not distance *over* or *short*; for he may be shooting to hit beyond the target, so as to put all shots in vertical plane, *or the target may replot differently from its distance at which he shot.* He knows the range he calculated for, and if given the range of shot, he knows by simple arithmetic how much he went over or fell short.

3d. He wants *lateral deviation at the distance of the target*, and *not* at the point of fall. Then he knows at once how much he must correct for if any error has been made in allowance for drift etc. If the shooting is close deviation at point of fall will be very near that at the target. But the rule should be made to give him what is above stated.

The plotter knowing what is wanted can then work accordingly, and, as soon as the plot is made should report the result as above indicated.

As target angles change the target should be replotted as soon as any change is reported.

These changes may be small, but they may be enough to gradually move the target a good many yards.

By proper work the target on the plot can be shifted to agree with each set of angles as they come in, and thus be kept in proper position, and the proper distance be kept from which to make calculations.

And the question at once arises, should not the target angles be sent in just *before* each shot, as well as just *after*?

A target may have been plotted, its distance determined, and everything be ready to fire the gun. But in the meantime a ship or something else causes a delay. During this delay the target swings, *but it is not noted*, and the gun is fired by and by, but at what? certainly not at the shifted target, for it was aimed at something else. To what should it be finally referred? in that case to the target *first plotted* and *not as replotted.*

But again the gun is aimed, and fired, and, as I have seen myself when at base end station, the target *had not moved before the shot*, but *did* move after the shot, the wave of the splash having rolled up and broken on the target frame and sent it off quite a distance. Here again the shot should have been referred to the target *before* the shot, and *not* that after.

Therefore it seems to me that the only way is to take both sets of target angles, one before, and one after each shot, and refer the shot to the target at which it *was aimed and fired.* The angles after each shot are necessary to give the new target for the next shot, those taken *just before* will be a check upon any movement of the target, and will show whether perhaps some targets *that may be hit* were in the positions they were supposed to be when actually aimed at and the gun fired.

To emphasize the above a case will be given that fell under my observation.

A target was plotted and its distance measured, and the man at the gun was given this distance, calculated his range, loaded and laid the gun. There was some delay, and, during this delay other target angles came in and the target was replotted. It replotted on the same line, *but some yards closer in.* The man at the gun did not receive notice of this, but, by and by, the gun was fired *as first calculated and aimed.* The shot plotted a certain distance "over" as referred to this *new* position of the target; it only plotted thirteen yards over when referred to the target at which it was actually aimed, and for which the angle was calculated. This thirteen yards was about *one-third* of the distance it went over the new target. Yet the battery and the gunner had the credit of a shot much further over, from their being referred to the second target.

Now suppose this shot had hit and demolished the target, it still should not have counted as a hit, for it was aimed at a target further out, but on the same line; to hit the target as it stood when the gun was fired required the shot to fall short about 30 yards, and "target destroyed by a shot falling 30 yards short of point aimed at" should then have been the record under such circumstances.

If the man at the plotting board does his duty he will find he has his hands full, and he therefore *should be let alone,* and allowed to do his work in peace and quietness. He should be as much alone as possible, and no one be permitted to be in the plotting room except those in authority. His results of observation should be given to the recorder as soon as known, and all information be obtained from such recorder.

Time of Flight.

The best instrument we now have in ordinary use for this is the stop watch, the observer to start and stop it; to say nothing of errors due to bad watches, and faulty observation, let us look at it in another way and see what the limits of the best of observation must be with the best of watches as they are generally constructed.

The remaining velocity at 3500 yards range is, from the table ·949 f.s., for the standard I.V. of 1414 f.s. For convenience of computation, as well as to be on the safe side, let us assume that the remaining velocity is as low as 900 f.s.

Then in every quarter of a second the projectile will move 75 yards. If the time of flight for 3500 yards is say 9 seconds even, then any shot between 3500 yards and 3575 yards will have 9 seconds time of flight; for the second hand stands still at 9 seconds mark for a quarter of a second, and will not jump to the 9¼ second mark until the end of that time. In the meantime the shot may have fallen at a range of any distance from 3500 yards to 3575 yards and the watch will not show the fraction of a second, for it does not read down below ¼ second. Hence with the best of watches and the best of observers, variations in range *over* 3500 yards and less than 3575 yards, will all show the same time of flight, due to want of sensitiveness in the watch.

To show variation in time of flight for ranges varying by 15 yards the watch must beat 20ths of seconds, an evident mechanical impossibility as watches are now made. Some other form of instrument, with a *constantly* and *evenly* moving index, is what is needed to show the minute variations in time due to small changes in the range of shots, and it is simply a question whether *true* time of flight is of enough importance to call for any such instrument.

The above will show however how valueless are our present observations, except for shots that vary greatly in range. At best the whole matter is crude and unreliable, two or more observers at the same time rarely, if ever, agreeing in results obtained.

The Gun and Carriage.

We cannot expect or wish to improve the gun very much. It has shown what it will do if only given the chance. But much remains to be desired as to the carriage, and, so long as the gun will shoot as it has shown that it *can* shoot, it should be given the following simple improvements in its present mount.

This mount is an alteration of the 10'' smooth bore carriage, "good enough" in the days of smooth bores for which it was built; but not "good enough" for any *rifle*.

The defects are in the *play of the top carriage;* a play which is not constant, and is sometimes very excessive in amount.

In smooth bore days it did not make much difference how the top carriage jumped. It was more by luck than by good judgment that many hits were made. But given a rifle of any pretention whatever, and should we not have a carriage to correspond; and, when we can have such a carriage at but small expense and labor, is that not all the more in favor of our having it?

Without trying to alter or thinking of altering the main design of the present carriage, is not the following possible?

The main trouble is in the "play" of the guides to the gun top-carriage. From measurements taken from such a carriage the front guide is only five inches in width, while the transom to which the guide is bolted is seventeen inches in width. Here we have a chance to increase the width of the guide from five to seventeen inches, and at the same time to decrease its play by the following construction.

The top, edge, and under part of edge of chassis rails, to be planed smooth, and to be set up and bolted parallel with each other.

The guide (front) to be increased in width as much as possible, and be planed out to a *close* fit to the edge of chassis rail, and at the same time to be greatly stiffened in its cross sectional profile.

The transom to which the guide is bolted instead of being bolted direct to cheek of top carriage to be bolted to a knee, and the other face of this knee to be bolted to the cheek. This knee face to have a large area, admit of several bolts, *one of which is a pivot about which the top carriage can turn*, the rest, shoulder bolts or studs that hold the knee up against the cheek, and yet admit of the slight rotation necessary by having elongated bolt holes, and enough play of bolts or studs to admit of such rotation.

If top carriage needs further stiffening or strengthening than this, to be done by transom on end face of carriage, across from cheek to cheek, above and approximately at right angles to lower transoms.

We then would have a good *long* guide that grasped the edge of chassis rail firmly, and that would guide the top carriage truly and smoothly.

The rear guides cannot well grasp the edge of the rail, owing to the increase in angle of the rail over which the *rear* of the carriage moves. But they can be made a close, instead of a loose fit, against the inside edges of the chassis, if these latter edges are only planed true and made parallel for them to rest and slide against.

As the carriage then moves to the rear under recoil the front guide would hold it down and guide it truly to the rear, and at the same time permit the carriage to run up on the extra incline of chassis in rear, the front transom swivelling enough to permit it. There is plenty of room for this front guide to slide on the lower incline of the front part of chassis, without striking or riding upon the extra incline in rear; for at full recoil this transom is still well in front of such extra incline.

The rear guide fitting snugly would prevent any side play at rear end of carriage and consequently the carriage as a whole would be truly guided during recoil, and always have a *constant* movement, instead of the variable and anomalous movement that now obtains.

Let us stop a moment and see what target practice at 3500 yards and at our present target means when compared to firing with which we are all more or less familiar.

The present pyramidal target is, from actual measure, approximately 10 feet square, and 10 feet high; the canvas or cloth is 7½ feet wide at the bottom, and forms approximately an equilateral triangle 7½ feet on a side. This of course is all we can see when looking through the sights to aim the gun.

A five cent piece will contain an equilateral triangle approximately $\frac{1}{8}$'' on a side. Then shooting at the 7½' equilateral triangle at 3500 yards is equivalent to shooting at an equilateral triangle inscribed inside of a five cent piece at 75 *feet.*

From Blunts firing regulations we find that the reduced target for gallery practice is as follows:—

Circular bull's eye	1''	diameter	range	50 feet.
" "	1½''	"	"	75 feet.
" "	2''	"	"	100 feet.

If bull's eye 1'' diameter is used at greater range than 50 feet the firing to be preferably held from kneeling, sitting or lying down positions.

Therefore to say nothing of refraction, and all the other difficulties arising from the increase of distance, shooting at 7½' target at 3500 yards is more than twice as difficult as gallery practice at 75 feet; for the 75 foot gallery bull's eye is a full circle 1½'' diameter while our bull's eye is an equilateral triangle only $\frac{1}{16}$'' on a side. Our target "A" has a bull's eye 8''×10''. Shooting at this at 300 yards is about equal to shooting at the 7½ foot target at 3500 yards, and we all know that the 300 yard target is the hardest of all to hit on the range.

Expert pistol practice at 16 metres (52½ feet), calls for a bull's eye 1⅛'' diameter. So rarely is a clean score made that anyone making it gets the "*grand prix*", an honor much coveted and rarely won.

Our 20 foot vertical plane is a little bigger bull's eye than that of either our target "C" for 1000 yards or target "B" at 600 yards and approximates the height of the "4 ring" on these targets. But we all know that anyone who can make fours steadily at either 300, 600, or 1000 yards is a fine shot.

We then have heavy gun practice which excels expert rifle practice when the target we aim at is considered, and equals long range small arms practice when the 20' plane is considered. Is it any wonder then that we want everything the "best" that is to be obtained, and are not satisfied with things "good enough"? The only wonder is that we ever hit the target at all, when we consider everything with which we have to contend. Certainly expert rifle shooting calls for as good a gun carriage as can be made, something better than what we have now.

Figure of Merit.

That there should be some standard of comparison, by which to determine the relative efficiency of shots or of batteries goes without saying, but exactly what that standard is to be remains to be yet determined.

The present standard appears to be "mean absolute deviation". Let us examine this a moment, and see if it comes up to proper ideas, or gives a fair comparison.

When a group of shots is fired from the same gun, under as nearly as possible the same conditions for each shot, *i. e*,, the same elevation, same laying, same density of loading, and *all* the conditions as nearly identical as possible, then "mean absolute deviation" becomes a fair standard from which to judge of the efficiency of the gun, or to show its mean error. Here no attempt is made to hit the target; the gun is aimed at some fixed point, as nearly the same as possible every time, and the shots go where they will: it is intended to see how they will group themselves, and thus show what may reasonably be expected from that gun in future work.

But in heavy gun practice we are trying all the time to hit a target; the aim is never the same twice in succession, unless accidently, for the target is constantly shifting, and we are constantly trying to keep track of it, of the wind, and of all the "variables", so as to get our shots in as close as we can, hence no attempt at identical conditions is made; on the contrary each shot may, and probably does vary in elevation, allowances, laying, etc., etc., from those preceding.

We are trying to learn to hit ships, and are not trying, except perhaps incidently, to determine anything about the mean error of the gun. That should have been determined for us by previous work at the proving ground.

Then should not our standard be one that bears some relation to ships, and should we not be judged by our proved ability to do effective and dangerous work?

The data by which the mean absolute deviation of a group of shots can be at any time determined can do no harm, and may be of value, and will of course be always kept; but it is thought that this should *not* be the standard of comparison.

The following is submitted as the idea that is held by many artillerists. It doubtless can be improved upon, but it is thought to be a move in the right direction.

All direct hits upon the twenty foot vertical plane are of course supposed to have been effective hits at an enemy's vessel. But to be fair, and to come as near as possible to actual service conditions, it is thought that this is not enough, for, though not so effective as direct hits, richochet hits may still do some damage, and hence should count.

Let us then assume a vertical plane or target twenty feet above the water line, and say ten feet below it; then a shot which strikes twenty yards short at 3500 yards range may hit the under water body of a *ship*, or the target, if it goes on through the water without richochet, which it may do under some conditions. If it richochet the chances are greatly in favor of its hitting the ship or target above water; hence it counts for what it may be worth as a hit.

Shots that go forty yards over just miss the top of the twenty foot plane; hence we have the limits of from twenty yards short, to forty yards over for those that are effective.

But a ship has *thickness* as well as height. A shot that just missed the 20′ vertical plane would still hit the deck, hence an allowance in height above the 20′ plane should be made to take in all shots that would fall on the ship's deck. This allowance can readily be calculated for the average beam of war vessels, and the angle of fall due to the range, and the target then becomes divided into three parts, viz: under water target, or richochet hits, hits on side, and hits on deck of ship, each part to have a value given it for hits in that part.

So much for longitudinal variation; we now come to the lateral.

A ship three hundred feet long is not a very large one as ships go to-day, and may perhaps be taken as about the minimum size at which we will have to shoot ordinarily.

Let us suppose then such a ship steaming perpendicular to the line of fire, and at fifteen miles per hour. Miles are used instead of knots, as being more generally plain to landsmen. At this speed she will be going at the rate of twenty-two feet per second.

Let us suppose a gun laid exact for range, and absolutely correct for deviation, *i. e.*, with all allowances for wind, drift, etc; then, if this gun is fired the instant the vessel's bow appears to cut the line of sight, and the time of flight is say ten seconds, the shot will hit the vessel two hundred and twenty feet back from her bow, or eighty feet from her stern.

We here have a practical limit for variation. If she was steaming from left to right an error in deviation *under eighty feet left* would still hit the ship, while an error of *under two hundred and twenty feet to the right* would also still hit her.

It is not intended to advocate any such limits for lateral deviation, for good *line*, as well as *range* shooting should be sought for. But the above shows the practical question, and suggests the following target.

Let its length be three hundred feet; and its *middle part* a *twenty foot square to be the bull's eye*, and the rest of the target on each side to be divided up into an equal number, say nine, of rectangles, of gradually decreasing width towards the ends.

We then can say hits of bull's eye count 10, next rectangle on either side counts 8, and so on down to one, richochet hits to count *half the value of direct hits*, deck hits count at three-fourths.

We here have a target which is plain and simple and that gives something like a fair estimate for the value of hits. Perhaps the bull's eye is too wide, and there should be a value given for hits near the water line greater than those near the top; but without going into any refinements or complications to make the target complex, the idea is advanced for what it may be worth, as a fairer and better standard than that of mean absolute deviation.

When we come to shoot at ships, and moving ships at that, we will probably find we have much yet to learn as to the exact method. It may be that then we may want to hit at bow or stern, outside of her belt of armor; we may want to hit her bulwarks or near her rail to try and dismount guns; we will have to take them as they come, end on, broadside, or at any angle.

It is thought however that the above described target gives proper encouragement for fine line as well as range shooting. If we learn to do that thoroughly well, then when the time comes we can "make allowances" proper to put our shots where we please, at bow or stern, or amidships, or wherever they will do the most harm.

Tables.

Valuable as are the range tables of Major Rodgers, the graphic table of Whistler, wind table of Ruckman, and Millar's latest graphic work in this line, it is thought that much yet remains to be done to harmonize and systematize the work.

Rodgers' works almost entirely in degrees and minutes of arc; Whistler's works in yards of range; Ruckman's also in yards of range; Millar's in degrees and minutes of arc.

Rodgers' works with a shot of 180 lbs. standard weight; Whistler's and Millar's with one of 183 lbs. standard weight, and do not go below that of 180 lbs. weight in connections to be applied, while we all know that this year at any rate, they have run down so low as 178 lbs.

It would appear then as a great desideratum that the work be systematized and brought down to one standard. We have ballistic and mathematical experts enough to do this, and we would then have a practically complete and uniform system for the united service.

In this year's work some went by one, some by another, and some by a combination of two or more authorities. It is thought that the *best work* was done by the use of Rodgers' table, with the "*jump*" as shown by Whistler, and the wind table as devised by Millar. Here we have a combination of three sets of tables, compiled by three authorities, which tables *do not agree*, as the following will show:

Data Assumed.

Range 3517 yds. I. V. 1875 f. s. $\frac{\delta_{\prime}}{\delta} = 1.04$.

Wgt. shot 178 lbs. Wind $\begin{cases} 7 \text{ o'clock} \\ 5. \text{ m. p. h.} \end{cases}$ 8″ C. R.

Wind component $\begin{cases} \tfrac{7}{8} \times 5 = 4\tfrac{3}{8} \text{ m. p. h. accelerating.} \\ \tfrac{1}{2} \times 5 = 2\tfrac{1}{2} \text{ m. p. h. dev. to right.} \end{cases}$

Ruckman's Tables—correction for wind.

$2.91 \times 4\tfrac{3}{8} = 12.73$ yds.—

∴ 3517—13=3504 yds. = range.

Rodgers' Tables.

Elevation for 3400 yds.		6° 39′.2
ΔX for 104 yds. $= \frac{104}{50} \times 7.8$	+	16′.2
		6° 55′.4
ΔV for 1414—1375=39 f.s. $= \frac{39}{50} \times 25$	+	19′.5
		7° 14′.9
$\Delta C = \frac{(1.04 \times 178) - 180}{18} \times 12.8$	—	3.6
		7° 11′.3
Jump (Whistler's)	—	21′.0
Sight angle	=	6° 50′.3
Correction for weight of level of gun and target	= —	5
Quadrant angle	=	6° 45′.3

By Whistler's Chart.

Range		3517.0 yds.
Correction for $\frac{\delta_{\prime}}{\delta} = 1.04 = 4 \times 7.6$		30.4 yds.
		3486.6 yds.
Corrections for wgt. shot, estimated as closely as possible		30.4 yds.
		3517.0 yds.
Corrections for wind $= 4\tfrac{3}{8} \times 2.8$ yds.		12.0 yds.
∴ corrected range	=	3505.0 yds.

Angle of departure for above range and 1375 f.s. I. V.	=	7° 06′
Jump		21′
Sight angle	=	6° 45′
Correction for angle of level of gun and target	=	5′
Quadrant angle	=	6° 40′

By Millar's Chart.

Angle of departure for 3517 yards range and 1375 f. s. I. V.	=	7° 13′
Correction for $\frac{\delta_{\prime}}{\delta} = 1.04$ and wgt. shot 178	=	9′
		7° 04′
Correction for wind		2′
		7° 02′
Jump		21′
Sight angle	=	6° 41′
Correction for difference of level	=	5′
		6° 36′

Here then we have three angles, viz:—

By Rodgers, Whistler and Ruckman	6° 45′
By Whistler	6° 40′
By Millar	6° 36′

These of course cannot all be right, and let us see for a moment what would have been the effect it each had been used:

The above data is from a shot which was actually fired with a quadrant elevation of 6° 47½′ with the following result as to range:

Distance to target	3517 yards.
Range of shot	3530 yards.
Over	13 yards.

It therefore seems that the angle 6° 45′ computed by the first method is about right, for allowing a variation in range of 7 yards for each minute's difference in elevation, the shot if fired with this elevation would have ranged 2½×7=17.5 yards short of its actual range of 3530 yards, or 4.5 yards short of the target.

If fired with 6° 40′ elevation it would have ranged 7½×7=52.5 yards short of 3530 yards, or 30.5 yards short of the target; and if fired with 6° 36′ elevation 11.5×7=80.5 yards short of 3530 yards, or 67.5 yards short of the target.

In the above it will be seen that the correction for wind by Ruckman and Whistler are practically the same. By interpolation Ruckman's coefficient of 2.83 yards is increased to 2.91 yards to agree with the actual range of 3517 yards and weight of shot 178 lbs. This correction for wind was used as it was thought to be more accurate than Rodgers', and more easily applied. Millar's allowance of —2′ for wind is practically the same thing; the same "jump" is taken throughout in order to make a fair comparison.

In this comparison it is to be understood that nothing is intended to disparage anyone's work. No one appreciates the labor that has been expended more than I, and perhaps others may figure more closely and bring out a closer agreement. It is well known that graphic tables cannot embrace everything, and the inevitable inaccuracies of drawing, and the fact that Rodgers works with the standard shot at 180 lbs. and the others at 183 lbs. may account for some of the discrepancy.

In this shot as stated the I.V. was assumed at 1375 f.s. Working backwards by Ingalls' formula the I. V. found (after correcting) for wind was 1375 f. s., or so close to it that the fraction may be neglected. The initial velocity was assumed from Davis's curve of initial velocities corresponding to different densities of loading.

* * * * *

Instruction.

It should be apparent to all that our great need for successful heavy gun practice is constant instruction and practice in all that pertains thereto, so that when the season comes for the actual firing of guns, everything in the whole system is familiar to all.

Actual firing of our heavy guns is so expensive that we cannot reasonably ask or hope for anything like the number of rounds per battery that we would like to have; nor is actual gun firing, that is the larger and heavier guns, necessary to give practice during the year, by which we can become familiar with all the details and workings of our system.

Nearly all batteries can have all the *manual of the piece* they need, and acquire all the information necessary as to handling the gun and ammunition; such instruction, important as it may be is of comparatively little moment. It may look very pretty to see a battery go through the manual of the heavy guns with dexterity and precision; but if that is all it can do its efficiency is low. Many a "crack" organization get the prize for perfection in the manual of small arms, and yet may not be able "to hit a flock of barns" at the target range, and hence would perhaps be of but little use in an active campaign against an enemy.

What we want is thorough and complete instruction in "*vessel tracking*" and all that it implies; we need to use the instruments more frequently than we are now called upon to do by our thirteen shots per annum with heavy guns, and our forty-seven shots per annum with the siege or sea-coast mortars, and the following scheme will perhaps assist in getting the practice.

Nearly every sea-coast fort has a Coehorn mortar on hand, or if not, there are plenty of them to be had at the various arsenals; it is thought that there is plenty of obsolete round shot and shell also on hand that can be fired from these mortars, and there certainly is enough and to spare of old powder.

That being the case, suppose we ask for the necessary authority for practically unlimited Coehorn mortar practice, not for the purpose of "making a record", or trying to "knock out targets", but simply as a means of firing cheap projectiles in a cheap way so that we can shoot plenty of them, and thus get the practice in sighting splashes, and reading their angles from base end stations, in communicating from base end stations to home station, in plotting, in fact in everything pertaining to heavy gun practice except the actual firing of these guns. Would not this be better than stone throwing by hand that was indulged in by two officers as a means of self instruction?

It may sound like child's play, but I am convinced that a great deal of valuable practice could be thus obtained, the practice made interesting as well as instructive, and that we all would be very much benefited thereby.

As a means of creating interest such practice could be extended to firing at a moving target as follows:—

Nearly every fort has one or more barges; let a barge be taken, a staff put up in bow or stern or amidships for that matter, upon which a pennant or flag is displayed; the crew is ordered to pull the barge in any direction desired, the course being given to the officer in charge so as to be fully understood.

As the barge pulls over the course it can be followed and tracked from the base ends, and plotted on the plotting board; the man at the mortar, having loaded up and ready to fire, can be directed to be ready to fire when the barge approaches a certain part of its course, or when it crosses the line of fire of the mortar, or is about to do so. The barge is pulling over a course we will say 1500 or 2000 yards away, *while the mortar is loaded for a range of only 1000 yards or less*, so there will be no danger of hitting the barge. At the proper time the mortar is fired; the shot would be plotted, *and the barge also;* to facilitate this at first orders could be given for the barge to stop and hold its position *as soon as the mortar is fired.* Then if the prolonged line of fire of mortar, through its shot, touches the barge the boat was hit; the prolonged line of fire would also tell how much deviation there would have been if there was not a hit, and the *actual* range of the shot, as compared with the *intended*, or *calculated* range, would give an estimate of the accuracy of range.

If Coehorn mortars cannot be used, then perhaps the 8'' and 10'' siege mortar could be. If neither of these could be authorized then perhaps a simple and yet powerful catapult could be got up for us, by the use of which we could get the same practice and use up the old twelve pounder round shot now on hand, and generally considered as so much worthless old iron, not even worth the cost of shipment to a foundry to be recast.

It has been observed that our mortar practice is considered useless, and absolutely hurtful, on account of the impossibility of doing accurate shooting, with the mortars, powder and ammunition in use, and also because of the loose habits such shooting inculcates. It has even been suggested that such mortar practice is to be discontinued for these reasons. Whether this be so or not is not known; but it is suggested that such discontinuance would be a mistake.

The batteries at Fort McHenry had their mortar practice at their own post, before going down to Monroe for 8'' and 15'' gun practice. Without saying anything about the goodness or badness of the shooting this practice was of the greatest benefit to all, as preliminary practice in the use of instruments for observation. The three batteries firing their full allowance of rounds, and some extra especially authorized as a preliminary to test powder, nearly one hundred and fifty shots were fired, extending over several days; this gave every officer on that duty a chance to be at the several stations twice, if not more, and the details of the system were thus made familiar, and each officer had a chance to get a little practice in the use of the instruments.

It is admitted that mortar practice, as practice for accuracy, or to try and hit a target or make a record, is very disheartening, particularly at a land target. At such target no splash is made of course, no instruments are in use, and it is hard and discouraging work. But at a water target, with the whole system of observation in use, it becomes interesting, and it would be more so if used, as has been above outlined, for the especial purpose of training in certain essential things, trying at the same time of course to see how well the shooting could be done. At any rate *powder would be burned*, and we need to burn powder once in a while to break up monotony, and give a little interest and excitement to the business of learning.

But it is time to bring this already too long paper to an end. In doing so it is to be regretted that there has been so much to criticize that there has not been either room or time in which to commend the many excellencies that obtain. It is evident in many ways that a whole-souled and honest effort has been made to give us improved and accurate instruments for use. Doubtless these will be made better as time goes on, and money becomes available for that purpose. In the meantime we have but to work on and show the importance, as well as excellence, of our work. Soon it is hoped that we may be found at work with our modern high-powered ordnance, and with it, as well as that now in use, demonstrate to all what can be done by honest, painstaking, scientific work in Sea-Coast Gun Practice.

PROFESSIONAL NOTES.

A. ORGANIZATION.

(a) Artillery—France.

Important changes in the strength, organization and peace disposition of the French Artillery took effect October 1st, 1874. Until then it consisted of:

403 field batteries,
57 horse batteries,
20 mountain batteries,
100 foot batteries,

comprised in 19 brigades with 38 regiments and 16 battalions of foot artillery. The protracted detachment from their regiments of a large number of field and horse batteries, distributed territorially to the 6th corps along the N. E. frontier, gave rise to the establishment of 28 batteries to make good the deficiency in the other corps. All regiments were made up alike, having 12 batteries—the divisional regiments of field batteries exclusively—the corps regiments of nine field and three horse batteries. One of the two regiments of each artillery brigade furnishes the artillery for the infantry divisions, the other furnishes the corps artillery, so that each infantry division receives six field batteries subdivided into two battalions; the corps artillery six field and two horse batteries. Besides these the mountain batteries and the batteries detailed for Algiers and Tunis were permanently assigned to the 14th, 15th and 19th brigades.

In deference to an old tradition the two regiments of pontoniers, in all 28 companies, belonged also to the artillery. These were discontinued October 1st, their duties in bridge building being transferred entirely to the engineers who, from then on, were composed of seven regiments with 22 battalions of four companies and seven companies train, including two newly organized regimental staffs, two train companies and the railroad (5th engineer) regiment.

By this arrangement the personnel of the pontonier regiments, of which a small portion only was transferred to the engineers, became available for the artillery, which in consequence could be established free of expense excepting for purchase of horses.

Five horse batteries were simultaneously made field batteries, as the Minister of War considered it admissible to assign two instead of three horse batteries to independent cavalry divisions. Two field batteries already equipped with mountain guns were in addition definitely designated as mountain batteries. Of the 28 newly organized batteries, 27 are field and one is a mountain battery, so that from October 1st the French light artillery, including the staff, newly established at that date for the 39th and 40th regiments, comprised: 40 regiments with a total of 425 field, 52 horse and 31 mountain batteries.

The two newly organized regiments, to which were assigned the batteries serving territorially with the 6th corps, and comprising there the artillery of the 39th and 40th Infantry divisions, the Vosges division, the 2nd, 3rd and 4th Cavalry division and the garrison at Toul, joined that corps, for which a new artillery brigade staff had already, in March, been established. The jurisdiction of the two brigade commanders was defined to the extent that one received supervision of the artillery establishment and train for the subdivision districts Châlons, Reims, Verdun and Mézières, the other for Toul, Nancy Neuf-Château and Troyes. The senior retained concurrently the command of the territorial regiment of artillery in the 6th region.

With the new organization, regiments displayed a very varied arrangement and composition. Divisional artillery regiments, exclusive of those of the 6th Corps, are:

13: each with 12 field batteries.
2: each with 10 field batteries.
1: with 7 field and 12 mountain batteries.
1: with 8 field and 8 mountain batteries.
1: with 12 field and 4 mountain batteries and 4 horse batteries.

The corps artillery regiments, are:

10: each with 10 field and 2 horse batteries.
2: each with 12 field and 2 horse batteries.
1: each with 12 field and 4 horse batteries.
1: each with 9 field and 4 horse batteries.
1: each with 11 field and 2 horse batteries.
1: each with 7 field and 2 horse batteries, and 1 mountain battery.
1: each with 8 field and 2 horse batteries.
1: each with 8 field and 3 horse batteries, and 4 mountain batteries.

A field and a horse battery of the 38th Regiment are in Corsica, and from each of the 12th and 13th Regiments of the 19th Artillery Brigade, there are two field and four mountain batteries in Algeria and Tunis.

Heretofore two or three horse batteries numbered "12," had been assigned to every cavalry division; now two belonging to the same regiment are so assigned and form a battalion under command of a squadron commander.

L'Avenir Militaire No. 1923, gives the following concerning the distribution of the artillery with the 6th Corps:

11th Infantry Division, 6 field batteries, 8th Regiment (Nancy).
12th Infantry Division, 6 field batteries, 39th Regiment (Toul).
39th Infantry Division, 6 field batteries, 40th Regiment (St. Michael).
40th Infantry Division, 6 field batteries, 40th Regiment (Verdun).
Vosges Division, 3 field batteries, 8th Regiment (Bruyères).
Vosges Division, 2 mountain guns, 8th Regiment (Remiremont).
Corps Artillery, 6 field batteries, 25th Regiment (Chalons).

Corps Artillery, 2 horse batteries, 25th Regiment (Chalons).
2nd Cavalry Division, 2 horse batteries, 8th Regiment (Luneville).
3rd Cavalry Division, 2 horse batteries, 25th Regiment (Chalons).
4th Càvalry Division. 2 horse batteries, 40th Regiment (Sedan).
6th Cavalry Brigade, 1 horse battery, 40th Regiment (St. Michael).
Toul group, 3 field batteries, 39th Regiment (Toul).
Five field batteries of the 25th Regiment in Chalons still available.

Aggregate strength of light artillery in the 6th Corps Region:

41 field batteries,
9 horse batteries,
2 mountain batteries.

The law of July 25th, 1893, increased the officers in each regiment by three captains and one chief of squadron; of the former two are available as Adjutants Major and one as Director of the Park. A regiment of twelve batteries has: 1 colonel, 1 lieutenant colonel, 6 chiefs of squadron, 1 major, 28 captains (including the paymaster) and 38 lieutenants.

The large number of officers of and above the rank of captain, renders it possible to furnish commandants from the active list to the reserve and depot batteries, and the park and ammunition sections without unduly reducing the number of officers with the standing batteries and battalions, because the large number of 2nd captains (one regularly allowed for each battery) are detached in peace to the artillery schools and establishments, leaving the former available for the purposes mentioned.

The newly formed field batteries received the number of officers, men, &c., prescribed in the law of July 15th, 1889, i. e., 5 officers, 103 non-commissioned officers and privates and 61 horses.

The "etat-major particulier de l'artillerie," to which all artillery officers not belonging to regiments are assigned, was reduced by six chiefs of squadron and four captains, so that at present it has 37 colonels, 56 lieutenant colonels, 99 chiefs of squadron and 108 captains.

In case of war the light artillery is very considerably increased by the reserve batteries provided for in peace, said to be twelve for each brigade; also by the batteries of the two regiments of marine artillery, having in peace six field and four mountain batteries (besides thirteen foot batteries).

No changes in the organization of the foot artillery have taken place apart from the addition of a captain as Adjutant-Major of each battalion. The 17th and 18th Battalions, already authorized by the Assembly have not yet been organized.

With reference to her number of light batteries, field, horse and mountain in peace, among European powers, France now has 512, and including the batteries of the marine artillery which are horsed, 518. Then come:

Germany with 494,
Russia with 393,
Austria with 254 (exclusive of Ersatz),
Italy with 207,

Great Britain with 48 (exclusive of those in India and the colonies).

It should be remembered in this connection that in war the Russian and Austrian batteries have eight, the others only six guns.

According to the French professional journals, it may be added, experiments which have been going on for a long time looking to the adoption of a single gun for all purposes are said to be nearly concluded. The cost of rearmament is put at 380 million francs.—*Militaer-Wochenblatt*, Oct. 24, 1894.

(b) General Staff—Germany.

According to information published in the best informed German press, the following modifications have just been effected in the general staff:

The geographical-statistic section has been dissolved and distributed amongst the bureaux charged with the study of the different theaters of operations.

Austro-Hungary has been withdrawn from the first bureau (theater of operations of the West), and the study of these two powers transferred to the fifth bureau, at the head of which is placed the chief of the former geographic-statistic section.

A sixth bureau has been established for special works (*besondere Aufgaben*) and placed under the direct command of the chief of the general staff of the army, in a manner similar to the historical section and the so-called German section (*Deutsche Sektion*), which is specially occupied with the war academy and journeys of the general staff.

The subordinate branch (*Neben-Etat*) comprises simply those officers attached to the geographic service.

Under these conditions the general staff will now be organized as in the following table:

Chief of General staff of the Army.	*Central Section* (personnel accountability, relations with the exterior). *Historical Section.* 6th *Bureau* (charged with special works). *German Section.*

1st QUARTERMASTER GENERAL.	2nd QUARTERMASTER GENERAL.	3rd QUARTERMASTER GENERAL.	4th QUARTERMASTER GENERAL.
Second Bureau. (Germany). *Bureau of Railways.* *Railway Troops.*	*Fourth Bureau.* (Fortifications.) *Fifth Bureau.* (Austro-Hungary and Italy.)	*First Bureau.* Theater of operations of the East (Russia, Sweden, Norway, Denmark, Balkans and Asiatic Russia). *Third Bureau.* Theater of operations of the West (France, Switzerland, Belgium, Holland, Spain, Portugal, England, America and Asia).	*Geographic service* comprising: 1st A trigonometrical section (triangulation and geodesy). 2nd A topographical section (maps with plane-table to a scale of $\frac{1}{25.000}$). 3rd A cartographic section (the construction of charts, reports, etc.).

The effective of officers employed on the *Prussian Grand General Staff* comprises according to the *Annuaire* of 1894:

	68	officers of the general staff corps.
	9	officers detached.
	14	superior commissary line officers.
	6	" " railway officers.
	74	barrister lieutenants.
And for the geographic service	57	officers of the *Neben Etat.*
	4	officers detached.
Say a total of	158	officers of whom four are Wurtemburgers.
and	74	barrister lieutenants.

To this number are to be added 4 Saxon officers and 2 Bavarian officers } attached to the grand general staff at Berlin.

—*Revue Militaire de l'Etranger*, November, 1894.

(c). **Army—Greece.**

Considering the inhabitants and financial condition of this small country the Greek army is a small one. Its budget amounts only to about 16,338 drachme (= 1 franc).

The army has to contend not only with this small appropriation, but with various other drawbacks to its progress, such for example as the extended frontier service against smuggling and robbery. By the laws of June 21st, 1882, and May 28th, 1887, compulsory service was introduced into Greece. The time of service in the standing army begins at the 21st year and lasts two years, eight in the reserve, eight also in the national guard (ten in cavalry) and ten in the reserve national guard (in certain cases eight). The total annual enlistment of recruits is determined by the Minister of War; those left over are, in consideration of a tax of 100 to 1000 drachme, dismissed after having served three months in the supply reserve.

The peace organization of the Greek Army is, broadly speaking, as follows: The army is under the command of the King and under the general inspectorship o the Inspector General Division General Saponuzakis.

Through their inspections, the Crown Prince Constantine, Duke of Sparta, from Athens, Brigadier General Zimbrakakis from Larissa, and Brigadier General Karaiskakis from Missolongi, undertake the recruiting intended to lay a foundation for the army in time of war. The troops are divided into: 10 regiments of infantry of 3 battalions of 4 companies, altogether 406 officers and men and 7 horses, further: 3 Jägerbattalions of 4 companies, including 443 men and 13 horses armed with the Gras rifle, model 1874.

Three cavalry regiments, each of 4 squadrons with 120 men and 96 horses, armed with sabers and Gras carbines. Three field artillery regiments, that is 2 regiments of 4 field batteries of 132 men, 64 horses, and 6 Krupp 87 mm. guns, 6 wagons, beside 3 mountain batteries of 122 men, 48 horses and mules, 6 Krupp 75 mm. guns, 7 baggage wagons and one regiment of 6 field pieces.

One company of ordnance (*Zeugartillerie*) of 218 men and 61 horses; 1 company of laborers of 4 officers and 139 men; 1 engineer regiment of 2 battalions of 4 companies (119 men); 1 railway and telephone company with 118 men and 45 horses; 1 fireman company of 141 men and 37 horses; 1 artillery baggage train with 54 men and 60 horses; 4 intendance—inspection and 2 ambulance companies of 224 men and 25 horses.

The peace strength of the Greek Army comprises 38 battalions and 856 officers, 15,808 non-commissioned officers and men, 1,263 horses and mules; 12 squadrons with 93 officers, 1,515 non-commissioned officers and men and 1,263 horses; 20 batteries and 2 artillery companies with 224 officers, 3,158 non-commissioned officers and men, 1,271 horses and mules and 120 guns; 10 engineer companies with 101 officers, 1,368 non-commissioned officers and men and 158 horses. An intendance, etc., baggage and ambulance companies with all told 357 officers, 819 non-commissioned officers and men and 140 horses and mules.

In time of war the infantry and engineer companies are to be brought up to 250 men, the squadrons to 175 men and 150 horses, and 15 new infantry battalions, three squadrons and 8–10 batteries organized, the latter of peace strength, as well as an engineer battalion, so that the war strength of the Greek Army numbers about 68,000 men, 6,000 horses and 174 guns.

Although Greece has recently made important expenditures in connection with her army, its condition still leaves much to be desired. The continued use of troops for police work and tax collecting, indeed for all the work that is done in other countries by the police, injures the service, and prevents the instruction of the army. After one to three months delay with troops, the recruits are told off into detachments which wander about the country, so that often even in the strongest garrisons but few men are available. Notwithstanding this fact the frontier companies rarely hold more than fifty men, and these have to watch over an extent of several miles. The few men who have been longer in garrison possess no education fitting them for war, nor are they trained to endure its fatigues, as field service is little practiced and even little shooting is done. The men of the detachments which move about the country are trained in these things, but they lose much of the discipline and knowledge of service which they have acquired. The detachments are thrown together without plan and composed of different sorts of troops; some infantry, jägers and gendarmes. The proper military unity and *espirit de corps* suffer greatly, and weapons and uniform are often in defective condition. Further the greatest calamity to the Greek Army exists in the non-commissioned officers. For the sake of economy most of the excellent non-commissioned officers of long service have been dismissed, and replaced by men promoted after two month's service, who, naturally uncertain in their knowledge of service, command little respect from their subordinates, so that insubordination and insolence toward non-commissioned officers frequently occur. This spirit of insubordination toward the non-commissioned officers is carried even toward the officers. The personnel of the Greek Army can in general be counted as very good, and with requisite training in endurance of fatigue and privation gives excellent results, following willingly when commanded by reliable officers. It lacks only proper continuous education and sufficient practice in large combinations,—briefly war training. The number of the officers is too large for the available men at hand; they often lead idle and inactive lives, and like the French officers of Napoleon's time fill the *cafés*.

The border service is made up of jägers and infantry. Whole battalions are posted along the frontier instead of being divided into detachments. It is necessary to prevent smuggling and robbery on the frontier, but the frontier guard really consists only of small parties of troops sent out to lonely points, often far distant from each other, where except in isolated cases of interference they remain inactive, for they, it is almost impossible to believe, do not even send out patrols or post pickets at night; thus the end and aim of the frontier guard is largely illusory.

To be just, in regard to the second task, the suppression of robbery, the Greek troops are even more powerless, for the Greek robber bands are organized so that they appear like lightning, assemble, perform their raids, separate as quickly, and disappear amongst the ordinary population, amongst whom they pursue their every day occupations.

To permanently combat such a system successfully, most energetic action on the part of the troops, and quick and willing assistance of the authorities are required; but the suppression of robbery is prevented by the fact that in every district the frontier forces are commanded not only by a chief of gendarmes, but also by an officer of the standing army, whose circles of action are not sufficiently separated.

Thus the picture given of the condition of the Greek army is not a particularly favorable one, and it remains to be wished that the activity of the King and his government, aided by the Duke of Sparta, whose service in a guard regiment of the Prussian army has enabled him to collect experience, will succeed in time in subjecting the Greek army to a well grounded reorganization.

C. INSTRUCTION.

(a). Artillery Notes—Maneuvers 1893—Germany.

* * * * *

First and foremost, be it noted, it was not always possible to overcome the difficulties connected with a prompt and simultaneous deployment of artillery in masses. "Leaders seem to lack experience in disposing of large numbers of guns, in placing them quickly and properly, in concentrating the troops promptly and with precision at selected points." This is, indeed, true enough. As already noticed in the paper (No. 97–1893) "maneuver notes of a light artilleryman" an opportunity for practice marches with masses of artillery is rarely offered our higher artillery commanders. * *

—*Allgemeine Schweizerische Militärzeitung.*

Our remarks will be confined therefore to the discussion of what the artillery should do to open a united and unexpected fire as soon as possible after receipt of an order to do so. * *

In the days of black powder the occupation of a position was comparatively simple. It was purely a matter of finding a place from which the object could be seen; and objects were the more plain as little importance was then attached to cover. The position chosen, the batteries usually took it at a run and unlimbered, caring little or nothing whether observed by the enemy or not. And these tactics were justifiable. What difference does it make—was asked—whether the movement be concealed or not seeing that the first shot discloses the position clearly; in addition to which the smoke which hung over the enemy's guns was often an ally, for it concealed from him many an audacious move. With the adoption of smokeless powder matters were different. * * In 1889 * when smokeless powder was first used in our maneuvers the Emperor made this criticism that the artillery must attach greater importance to occupying a position unperceived. Of course, everyone endeavored to live up to this notice; but not without admitting a slight misunderstanding. Here and there "the screened occupation of positions" was taken to be the same as "the occupation of screened positions." As often as not the artillery of both sides played hide and seek and selected positions from which they could blaze away but hardly shoot, seeing that there was no possibility of observing. At maneuvers the faults of positions like these were not apparent as blank cartridges, only, were used; on the contrary the artillery was frequently praised for the clever way in which it selected positions and occupied them unobserved and from which it delivered an unexpected fire. Positions such as these are extremely seductive; easily found, more easily explored and occupied without any trouble whatever. * * The choice, examination and occupation of positions which permit of direct fire and at the same time offer cover is, of course, much more difficult and dilatory. There is one kind of position only which answers both requirements. The time necessary to find it must be allowed under any circumstances; undue haste in this matter would surely revenge itself in the course of the action. * * *

The most important consideration is to withdraw the batteries at once from the column of march as soon as it is intended to place them. In a general way the commanding general will be able to indicate the positions; if not, and he can indicate only the objective, then the artillery commander must himself look for them. In any event, as soon as the direction of fire is known in a general way an advance must take place and battery commanders must go ahead to the front to explore. * * As simple as all this is it is frequently violated. Often, it may be noticed, the position is first explored, and then the batteries are brought up, thus losing valuable time. * It is a great error if the batteries do not stand ready to take up their positions at once as soon as these have been examined. * *

In order to give battery commanders time enough for thorough search they should be, together with their scouts, at the head of the column; in advance of the corps artillery in large bodies of troops.

Very important is it for individual leaders to reconnoitre in the proper way. Regimental and battalion commanders must do so, each in his own way. Time is lost if these attend to matters which belong to their subordinates, yet how often they do this. The chief should convince himself that the position as a whole is a suitable one from which to attack and is extensive enough to admit of the deployment. He must ride over all of it; then, only, will he be able to point out to each subdivision its place, or rather to indicate the region it is to control with its fire and whether this is to be directed against the hostile guns or against other troops. Battalion commanders, in turn, must familiarize themselves thoroughly with their terrain that no important objective escape them, so that no battery commander may remain in doubt as to what he is required to do. These latter must receive such explicit instructions as to their sphere of activity as to leave them little choice as to the actual placing of their guns. * They will see that they have suitable intervals from batteries next to them, to avoid crowding and the danger of losses which attend it. They will indicate to the range finders the exact objective, especially if it be obscure; otherwise they can do little or nothing. At the same time they must make up their minds as to the best way of coming into battery and consider how to dispose of the carriages. All this must be done without hurry or confusion and before the batteries actually occupy the position. A little additional time devoted to reconnoitring never does any harm; it is much better for the battery to wait, if by doing so they will be better enabled to come into action and open fire in an orderly manner.

From what has been said it is evident that a whole series of considerations should lead up to the choice of positions. If Napoleon demanded of his cavalry officers that they "réfléchir au galop", the advice is no less applicable to the modern artillerist. This prompt habit of mind and correct eye for terrain, however, can only be acquired by much practice; practice which cannot be acquired on the ordinary drill grounds and ranges. Frequent practice marches are necessary, in which the examination and selection of positions is the object; the hostile positions being indicated by flags or by the firing of guns.

With small detachments at peace strength and at maneuvers, distances are short and no special demands are made on the teams. It is different in war when the corps artillery or a whole corps is on one road and the rear divisions have to cover considerable distances. The strength of the horses must then be husbanded, there is, otherwise, danger of their dropping dead in harness, as, for instance, happened to the artillery reserve of the guard at Koniggratz. On average roads 6 kilos out of 7 can be taken at a trot and hence 15 to 2c kilos, *i. e.* the distance from the rear division to the firing line of the advance guard, can be made without straining the teams. The French assume 8 km. per hour for field and 9 km. for horse batteries, taking the whole march at 30 to 35 km. They employ the gallop along the exposed portions of the road.

The rate from the zone of preparation to the zone of fire must depend on circumstances. If these are near together little is gained by a high rate of speed and much may be lost by the sacrifice of good order and deliberation.

At maneuvers the time between the end of the artillery duel and the final assault is always much too short; as a matter of fact the artillery cannot, in the available time, do that which would be required of it in actual service. Then, for the first time, the attacking artillery is at leisure to deliver its fire against the point of attack. To do this it will generally be obliged to occupy other positions and this alone takes up too much time for the maneuver. The artillery of the defense are even worse off. A few of its batteries at least must be withdrawn from the range of the hostile guns, to keep them in a measure intact in order to have them in readiness at the assault. As the orders for this must come from the commander-in-chief, the execution is usually overtaken by the course of events; for before the guns can be limbered up the enemy's infantry have formed for attack and the guns must stand and hold their own. As a rule it is impossible for them to do this in the position in which they are; better they should take up a new position from which their action would come in the nature of a surprise. Suitable positions from which a flank fire on the attacking infantry may be had may frequently be found on one wing or the other; but the guns must be especially protected against sudden capture. At maneuvers this capture rarely takes place because there is not time enough for it; for the "result" of the artillery fight will have been communicated to the leader and he, in whose favor it is, will have ordered up his infantry. * *

Twice, this fall, I have had occasion to observe newly established intrenchments for riflemen standing; at practice firing and in maneuvers. The intrenchments were intentionally massive, with an especially strong profile, so that they should be discernable from the artillery position. As a matter of fact the officer in charge, who knew exactly where to look for them, found them only by means of outlying small-arm targets which he used for reference. It was due to these auxilliaries which would surely not have been available under service conditions, that he found the range at all at 2200 m. In spite of clear weather the observing was difficult and the results against them zero. In the maneuvers I discovered the intrenchments only within 200 m. * *
I am more and more of opinion that properly placed defenses of this kind, suitably constructed to meet the neighboring features of the ground cannot be attacked by shrapnel either from guns or mortars with any prospect of success.—*Militär Wochenblatt*, No. 94, 1894.

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(b). Superior War School—Spain.

The minister of war has fixed, by a decision on the 22nd of last August, the program of studies of the Superior War School whose creation upon its present basis dates back, as is known, to the month of February, 1893.

The time for the course of studies is three years as in the past. The subjects taught are divided into a certain number of courses of which some are obligatory and others optional as indicated in the following table which in addition gives the program in detail.

FIRST YEAR.

First Course. (Obligatory).

Fundamental principles of artillery.—Descriptive study of artillery material in use in the Spanish Navy and the armies and navies of the principal military powers. Descriptive study of naval material now afloat.

Fortification.—Military bridges.

Second Course. (Obligatory).

Tactical regulations of maneuvers in use in Spain. Comparative study of the tactical regulations and of maneuvers in use among the principal military powers.

Interior service of bodies of troops.

Castrametation.

Third Course. (Optional).

Higher Algebra.—Spherical Trigonometry.—Analytical Geometry. Geography and general history.

Special Courses. (Obligatory).

Tachygraphy.
Landscape drawing.
French.
Fencing.
Equitation and Hippology.

SECOND YEAR.

First Course. (Obligatory).

Elements of Astronomy.—Topography.—Military Geography.

Second Course. (Obligatory).

Political and administrative law.—International law.—Political economy.

Military administration.—Description of the materials belonging to health and military administration.

Third Course. (Optional).

Descriptive Geometry.—Calculus.—Mechanics.—Chemistry.—Powders and explosive substances.—Manufacture of War material.

Fourth Course. (Optional).

English.—German.—Arabic.

Special Courses. (Obligatory).

Photography.—Topographical drawing.
French.
Equitation.

THIRD YEAR.

First Course. (Obligatory).

Railways.—Telegraphy and Telephony.—Aerostation.—Cryptography. Military history.

Second Course. (Obligatory).

General principles of military organization.—Military and naval organization of Spain and the principal military powers.—Military Art.—Service and regulations of the general staff.

Third Course. (Optional).

Astronomy.—Geodesy.—Elements of Zoology and Botany.—Mineralogy and Geology.

Fourth Course. (Optional).

English.—German.—Arabic.

Special Courses, (Obligatory).

Literature.—French.
Equitation.
Field Logistics.

The examination of this program, otherwise very extended, shows that the Spanish Superior War School continues to be very much more a school of high military and general studies than a school preparatory to service in the general staff.

It is in fact only in the third year's course that they begin to teach that which more particularly relates to this special service. It may be further remarked that the instruction at the Superior War School at Madrid, again takes a form almost exclusively theoretical, since only a single journey of practical studies—field logistics—figures in the program at the end of the third year.

—*Revue Militaire de l'Etranger*, November, 1893.

(c). Port Arthur—China.

A powerful fortress has fallen in forty-eight hours before the attack of but slightly superior force—so far as regards numbers. All preconceived notions, therefore, as to the reduction of a fortified position by the tedious process of siege tactics have been set aside. So far as can be gathered, two strong bodies of infantry advanced to the attack, with artillery in the centre, and, under cover of a crushing and concentrated fire from the latter, the former carried all the works, one after another; the resistance or the better-designed permanent works on the Japanese left flank being the only element which prevented the completion of the business before nightfall of the first day. It is clear then that there must be some means of accounting for the ease and rapidity with which the Chinese were swept out of their positions. Granted that they were demoralized by their countrymen's previous defeats; that the Japanese were flushed with victory; that the attention of the fort gunners was distracted by the cruisers steaming about in the offing. None of these circumstances. however, will account for the reduction—practically—in a few hours of a perfectly equipped and fairly well-manned fortress, mounting one hundred heavy guns. We cannot but believe that it is necessary to look quite in another direction for the solution of the problem.

After the investment of Paris in 1870–71, Germany and other continental nations—as a result of observations upon the extent of injury caused to fortified positions by gun fire—went into the matter of providing field artillery regiments with certain batteries of light and short howitzers for moving swiftly upon entrenched positions and works, and crushing them by weight of metal and high-angle fire. Krupp of Essen has produced a field howitzer of moderate size, which throws a shell of 36-kilos weight, though only of 12-centimètres calibre, and a very considerable number of batteries of German artillery are equipped with it. We understand that the Japanese force of artillery, which has been almost exclusively supplied by Messrs Krupp and Sons with field and siege guns, is in possession of many of these howitzers, and that the regular siege train was not employed in any of the recent attacks upon positions. Should our surmise be correct, and the crushing success of the attack upon the Port Arthur batteries have been due—even in part, at least—to the presence of these most potent little high-angle howitzers, the problem is half solved already. The refugees who have arrived at Chefoo report that the fire was so concentrated as to be absolutely irresistible. Such a result is just what we should have anticipated from the weapons under consideration.

One word of warning then. Our artillery, except that of a heavy siege character, is utterly unprovided with a weapon for breaching and destroying buildings or earthworks. To employ an ordinary 12-pounder for this purpose would be absurd. We commend a consideration of the 12-centimètre 36-kilo. howitzer to our artillery authorities at the Horse Guards. It requires a heavy ammunition wagon, and the projectile is very long, almost protruding from the muzzle of the gun, but its effective power is tremendous. It has three separate charges for different angles and ranges. A weapon of this character would, we are persuaded, be of incalculable service to our forces in the event of the rapid reduction of a fortified position requiring to be undertaken.

—*Army and Navy Gazette*, December 1st, 1894.

(d). Fortress Maneuvers—France.

The French fortress maneuvers at Vaujours, under the direction of General Saussier, military governor of Paris, have been interesting, and some in France seem to think them conclusive. General Coste was in command at the fort, and General Giovanninelli conducted the attack. The maneuvers had included two earlier series of operations, the first in which the troops of the intrenched camp had executed measures complimentary to the defence, and the second in which fighting had occurred in the approaches to the fort. In the third series the investment was completed, the siege batteries established, the parallels of approach formed, and finally the assault made. The engineers and artillery accomplished wonders on both sides. Masked batteries, united by Decauville railways, telephonic wires uniting every point, electric projectors, and captive balloons—all these and many other means of siege warfare were extensively used at Vaujours. After a vigorous bombardment the assault was delivered on September 18, in the presence of a brilliant company, including the President of the Republic and a great number of general officers. It was unsuccessful, as had been arranged, but General Giovanninelli, who had accomplished so much, was hardly defeated.

Opinion is divided as to the real significance of the operations. The *Armée Territoriale*, for example, thinks that the approaches to Vaujours never could have been made in actual war, and cites the assaults upon Rome (April 30, 1864), Puebla (May 5, 1862), Toul (August 16, 1870), Verdun (August 24), and the citadel of Amiens (November 29) as showing that the assault was foredoomed to failure. Kars, of course, was an example to the contrary, but the attack was made at night. The *Progrès Militaire*, on the other hand, draws the lessons that the days of sieges are over. "However great may be the resources of a place, however ably its fixed and mobile defences may be directed, it will fall, not after several weeks, as formerly, but within three or four days, unless it can throw superior forces upon the enemy and defeat him in the field, when the siege will have come to an end." Thus our contemporary would not have Frenchman expect more from the vast fortifications on the eastern frontier (except in mountainous country) than that they will delay the enemy for a few days, and give time for the reserves to be formed. Again, Colonel Thomas, writing in the *France Militaire*, while maintaining that a fortress may long maintain its defense, dwells very doubtfully upon the ability of the defenders to break through the ring of investment. He seems to regard the heroic defenses of Barbenègre at Huningue, and of Denfert at Belfort, as the ideals of a fortress commander. But the short series of operations near Paris will scarcely solve in a definite manner the many vexed questions connected with fortress warfare, though they must have done much for the officers and men employed in them.

—*Army and Navy Gazette*, October 20th, 1894.

(e). Navy—Japan.

The captain of one of the American warships on the Asiatic station has written home of some very interesting things that he has seen. Describing a visit to the Japanese field hospital, near Nagasaki, he says:

"There I got a fair conception of the killing and wounding qualities of the new small-bore rifle that all Europe is adopting. The Japanese infantry arm is the Murata, the invention of General Murata, now Chief of Ordnance of Japan. The calibre of the gun is .315, and the bullet weighs 235 grains. I saw a Chinese officer who had been struck in the knee joint by one of these bullets, fired at a distance of about 1,000 yards. The thin steel envelop of the bullet had broken, and the joint was simply a mass of finely-comminuted bone splinters. The knee was perfectly soft, without a bone unbroken in it an inch long. Of course the leg had to be amputated.

"The hospital was the admiration of the French and English surgeons as well as our own. The medical staff were all Japanese, who had graduated in medicine and surgery either in America or England, then taken a post graduate surgical course in Clinics at the Paris and Berlin hospitals. They had the best modern instruments and systems, the newest antiseptics—everything a hospital on modern lines should have. And all this is the work of a generation. Truly the Japanese is a wonderful man.

"I saw something, too, of the effect of the modern shell fire on the cruiser of the period at the battle of the Yalu River's mouth. The *Akagi* was hit several times by 8-inch shells of the Vavasseur-Palliser pattern. One of these fired from the Chinese cruiser *Chih-Yuen* tore off nearly one-half the iron and steel port quarter of the *Akagi*, killing Captain Sakamato, her commander, and killed and wounded a dozen more officers and men.

"A second shell from a 200-pounder made a hole eight feet in diameter in the side of the Akitsüsu. Had the service of the Chinese great guns been equal to that of the Japanese, the *Akagi*, the *Hashidato* and *Matsushima* must have been sunk. The Japanese fire was terribly accurate and deadly.

"The Chinese ship *Chen-Yuen* was hit nearly 100 times. Nothing was left above water of her; of her crew, 460 strong, over 350 were killed or died of wounds. All this was from the fire of 6-inch or 8-inch rifles at a distance of from 1,000 to 1,600 yards. The Chinese had the heavier ships at Yalu, but the Japanese outmaneuvered them and outfought them.

"Man for man, and ship for ship, my professional opinion is that the Japanese commanders are equal to any in Europe. They have courage, a high professional knowledge and a fierce fighting spirit that nothing daunts."

The American commanders attribute much of Japan's success to the fact that so many of her naval officers were educated at the Naval Academy at Annapolis.—*Army and Navy Journal*, December 8th, 1894.

(f). Artillery Fire—China.

The story of the battle of Yalu has now been told in various ways, and the accounts are, on the whole, consistent, so that we can draw some conclusions as to the behavior of heavily armored ships and cruisers, and as to the effects of the fire of guns of new type. That story we have told in another page. The opposing fleets were singularly different in their character. That of China consisted of four fairly modern barbette ships; two, the *Chen Yuen* and *Ting Yuen*, each of 7430 tons displacement, carried compound armor from 14 inches to 12 inches thick, with powerful 12-in. Krupp guns and auxiliary armaments of 6-in. guns and mitrailleuse, but no quick-fire guns. In fact, they were good representative heavy armor-clads of their dates, that is of 1881 and 1882. The *Ling Yuen* and *Lai Yuen* were much less powerful, each only 2850 tons, but were built in 1887, and the *Ping Yuen* is a coast defence ship of

1890. With these were the unarmored cruisers *Chih Yuen*, *Ching Yuen*, *Tsi Yuen*, *Yang Wai*, and other ships of less importance. The main features, then, of the Chinese fleet were heavy guns and thick armor. Their defensive power was in some cases great, and they were capable of striking very heavy blows, but few and slow compared to those the Japanese ships could deliver. Two Chinese cruisers had a speed of 18 knots, but the barbette ships had at most a nominal speed of 16½ knots, and we think that their actual speed fell very far short of this. Of the Japanese fleet we have less particular information. It consisted, however, of armored and unarmored cruisers. Indeed the Japanese only possess one ship carrying more than 4½ inches of armor on a belt, namely, the *Fu Soo*, an old-fashioned central battery ship of 1877, carrying 9 inches of armor, and she counts but little. In any case the character of the Japanese fleet was wholly different from that of China. Some Japanese ships possessed high speed. The *Yoshino* is credited with 23 knots, and carries an armament entirely consisting of 6-in., 4.7-in., and smaller quick-firing guns. The *Akitsuschima* has a speed of 19 knots. The *Naniwa* and *Takachiho* are sisters, of 18.7, and the *Itsukusima* and *Metsuchima* of 17.5 knots speed. Many of the Japanese ships, however, could not have been faster than those of China. The *Akagi*, for example, is a 615 ton ship, of only 12 knots speed; nor could they have carried many powerful quick-fire guns. In short, if we consider the general bearing of the battle on the probable future of the war, it argues very badly for China, for it may be seen that her entire armor-clad force except one gun-boat was engaged, and while the Japanese ships were decidedly faster than the Chinese, the powers of the former, both offensive and defensive, must in many cases have been inferior to that of their adversaries. The commanders appear to have handled their ships at least as well as could be expected. The Japanese captains tried to keep up a running fight at long ranges. Probably from being in better condition, practically the whole of the Japanese ships had the advantage in speed, and being better gunners and sailors, it was to their advantage to fight in this way.

The Chinese tried to close, and the evolutions are described as consisting of the circling of the Japanese divisions round the Chinese, the latter running in smaller circles. The Chinese unarmored cruiser *Chih Yuen*, having a speed of 18 knots, tried to utilise her powers, and ran straight for a Japanese ship, which, the Chinese say, was sunk, though not, it seems, by ramming: indeed, the actual sinking is a little uncertain. Apparently the Japanese *Yoshino*, the most modern and formidable ship in their fleet, was very severely handled. Eventually the *Chih Yuen* was herself sunk as well as the *King Yuen*—armored barbette ship—and a third Chinese vessel, the *Choo Yung*, as well as the fourth ship eventually, both the last apparently of less importance. The two heaviest Chinese armor-clads, the *Ting Yuen* and the *Chen Yuen*, appear to have got into the thick of the Japanese fire, and to have borne the brunt of attack admirably. Their upper unarmored portions were naturally riddled, but the barbettes and vital parts were not penetrated. It could hardly be otherwise, seeing that the 6-in. quick-fire guns are not powerful enough to pierce them, and consequently the hundreds of shot that made holes or indentations 3 inches deep were thrown away. The firing generally was at a long range, and was therefore necessarily not directed to the best purpose, so that much of it was wasted, and we do not doubt that the Japanese had run out of ammunition, and their retirement was a necessity. The Chinese, however, were also running short of shells, and were in some cases using steel shot to bad purpose on their unarmored adversaries.

The first lesson to be drawn seems to us the very obvious one that, if a fight is to be carried out at long range, eventual success greatly depends on the supply of ammunition. Nearly all the injury done was effected by artillery fire, neither the ram nor the torpedo was used to any purpose, indeed, hardly tried, but the action taking place at long range, there was probably little scope for them. Even under these circumstances, the destruction was less than might have been expected. The Chinese appear to have shot very badly. It is, however, to be borne in mind that the fire in each case was that which the enemy could best resist. The Chinese armor was absolutely inpenetrable to the Japanese guns, so that their possible scope was limited to the destruction of the structural parts of secondary importance. On the other hand, the Japanese armor would have been perforated by quick-fire guns, and the entire ships would have been cut away at a great rate, had the Chinese possessed quick-fire guns. Instead of this, they were only exposed to very slow fire. The actual projectiles employed against them were certainly very powerful and a fortunate shell might totally destroy a Japanese ship; but at a long range with bad gunners this was not very likely to happen, so that the Japanese were exposed to a much less severe ordeal than if the enemy had consisted of cruisers of their own type. It must be remembered also that the Chinese ships were only exposed to a very limited number of heavy quick-fire guns, for most of the Japanese ships' armaments, while they consisted of excellent new type pieces, did not include heavier quick-fire guns than 6-pdrs.

On the whole, then, we are forced to the conclusion that the general lessons to be drawn from this battle is influenced by the following facts:—First, that the long range precluded our learning much as to the use of the ram or torpedo, and secondly, that the artillery fire was in each case the kind which the fleet was best able to bear. We fear that in a close encounter, when these peculiar features were not found, the destruction would be very much greater. This would no doubt make it less likely that the fight would end, as we imagine it did in this instance, from the supply of ammunition failing.

The immediate effect on the war is, as we have said, likely to be very bad for the Chinese. Their whole armor-clad fleet having concentrated, the Japanese have not feared to attack it and give a very good account of it, sinking four ships, and demoralising the Chinese navy no doubt. We can fancy a parallel being drawn between their action and that of our fleet, when it fought the Spanish *Armada*. We prefer, however, to confine ourselves to more practical issues. Let us consider what would happen if really brand-new ships and armaments were to engage. Lord Armstrong on September 28th—last

Friday—spoke of the extraordinary ballistic powers that have been developed with cordite. The velocity of 3000 feet has been attained with a 100 pound shot from a long 6-in. gun. A speed of six rounds a minute has been achieved under service conditions when the ship was in motion, and firing with such accuracy as to hit target twelve or even fourteen times out of eighteen. The significant features in this statement are, we think, the speed and accuracy under service conditions, coupled with the fact that there is no smoke. On the very high velocity we lay very little stress, because experience has shown that even for direct fire, projectiles require to be very excellent to hold together on impact at very high velocities, and on service most of them would strike obliquely. The increased speed, accuracy, and absence of smoke, however, would tell so greatly that we think the battle would be brief and terrible, and that it is a question whether a fleet possessing sufficient speed to control the range, and a larger supply of ammunition, would not have the possibility of destroying an enemy by the tactics of long bowls carried out with such success by the Americans against ourselves in our old war. Happily, British ships at present, we believe, carry a larger supply of ammunition tnan those of other navies. Moreover, it is possible that if cruisers tried this experiment against heavy ships commanded by cool men with good gunners under them, they might find some of them were sent to the bottom by the occasional powerful shell that the heavy battle-ships would discharge. Lastly, we would call attention to the fact that the *Ting Yuen* and *Chen Yuen* have not complete armor belts, and that they were exposed to the main attack of the Japanese quick-fire, so that the conditions were those which would fairly try the powers of the horizontal armor, and it appears to have answered its purpose. — *The Engineer*, October 5*th*, 1894.

(g). Bow Fire of Modern Ships.

The following interesting letter from a correspondent of the London *Times* has recently been published in that paper:

As a broadly stated proposition, it is true of the modern British man-of-war that upon an object lying directly ahead of her she can bring to bear a smaller number of guns than can be brought to bear upon a similarly situated object by the modern foreign war ship of corresponding class and less displacement. It is also true, as a general rule, that the British guns thus capable of firing right ahead are, although fewer, somewhat heavier, especially in battleships, than the foreign ones. Apparently it has been assumed by us that, so far as bow fire is concerned, superiority of caliber will compensate, at least to some extent, for numerical inferiority of pieces: and since, even in our latest designs, the principle has been persisted in, in spite of the fact that all foreign countries have adopted the diametrically opposed system, it is important before we lay down any more ships, to inquire whether or not we are herein following a sound and defensible policy. For the proper consideration of the problem it is necessary to bear in mind certain axioms. One of these is that it is desirable, both because of the relative smallness of the target thereby exposed, and also because of the manœuvring advantages that are thereby retained, to fight as much as possible bows on. Another is that smaller guns can be fired with proportionately greater rapidity than larger ones. Another is that multiplication of pieces reduces the risk of the total disablement of the gun armament of a ship. And yet another is that, although a successful shot from a larger gun may be proportionately more destructive than a successful shot from a smaller one, it is easier to make accurate shooting with smaller guns than with larger ones; and that, not only on account of their greater facility of manipulation, but also on account of their greater rapidity of fire, smaller guns may be expected to make more hits than the larger ones. From this it may easily result that in a given length of time a comparatively small gun may do more aggregate damage than a very large one, seeing that the small one is capable of getting rid of the greater number of projectiles, and possibly even of the greater weight of metal, as well as of making the larger proportion of hits. It is further necessary, in order to be able to weigh the question, to assess, at least roughly, the relative thickness of fire of the various classes of guns. It is probably fair to assume that, supposing each weapon to be ready loaded at the beginning of an action, guns can fire as follows, due attention being paid to aim, in a space of 3 minutes: Breechloaders of 10 in. and upward, two shots; of 8 in. and less than 10 in., three shots; of 6 in. and less than 8 in., four shots. Quick-firing guns of 6 in., 10 shots; of 4.7 in. and less than 6 in., 12 shots; of 3.9 in. and less than 4.7 in., 14 shots. In the comparisons which are to be made, guns of less than 3.9 in. (10 centimeters) caliber are not considered, as they do not pierce any formidable thickness of armor. The period of 3 minutes has been chosen as the unit for the purposes of comparison, since in 3 minutes two vessels approaching one another at a speed of 15 knots would reduce the distance between them from 2 miles to ½ mile. In other words, in that brief space of time they would traverse the whole zone in which, while the gun is most dangerous, the torpedo is absolutely harmless.

Here, then, is a statement of what can be done by the bow guns of some typical modern ships in 3 minutes:

	Ships.	Number and Nature of Guns bearing right ahead.	BOW FIRE IN THREE MINUTES. No. of rounds.	Total w'g't of metal thrown.	Total muzzle energy.
				lbs.	ft.-tons
Battleships.	*Royal Sovereign*, 1,4260 tons (British)	Two 13.5-in. B. L.	4	5,000	140,920
		Two 6.0-in. Q. F.	20	2,000	68,340
		4 guns	24	7,000	209,260
	Charlemagne, 11,232 tons (French)	Two 11.8-in. B. L.	4	2,504	119,640
		Six 5.5-in. Q. F.	72	5,040	212,544
		Four 3.9-in. Q. F.	56	1,568	65,632
		12 guns	132	9,112	397,816
	Sardegna, 13,360 tons, (Italian)	Two 13.5-in. B. L.	4	5,000	140,920
		Two 6.0-in. Q. F.	20	2,000	68,340
		Two 4.7-in. Q. F.	24	1,080	37,248
		6 guns	48	8,080	246,508
	Oregon, 10,321 tons (United States)	Two 13-in. B. L.	4	4,400	134,508
		Four 8-in. B. L.	12	3,000	89,976
		Two 6-in Q. F.	20	2,000	64,080
		8 guns	36	9,400	288,564
	Renown, 12,350 tons (British)	Two 10-in B. L.	4	2,000	57,720
		Two 6-in. Q. F.	20	2,000	68,340
		4 guns	24	4,000	126,060
	Jauréguiberry, 11,824 tons (French)	One 11.8-in. B. L.	2	1,252	59,820
		Two 10.8-in. B. L.	4	1,904	51,200
		Four 5.5-in. Q. F.	48	3,360	141,696
		7 guns	54	6,516	252,716
	Sinope, 10,180 tons (Russian)	Four 12-in. B. L.	8	5,848	153,120
		Four 6-in. B. L.	16	1,168	33,280
		8 guns	24	7,016	186,400
1st Class Cruisers.	*Impérieuse*, 8,400 tons (British)	Three 9.2-in. B. L.	9	3,420	77,598
		Two 6.0-in. B. L.	8	800	19,392
		5 guns	17	4,220	96,990
	New York, 8,500 tons (United States)	Four 3.0-in. B. L.	12	3,000	89,976
		Six 4.0-in. Q. F.	84	2,772	84,000
		10 guns	96	5,772	173,976
	Dupuy de Lôme, 6,297 tons (French)	Two 7.6-in. B. L.	8	1,320	63,152
		Three 6.3-in Q. F.	30	3,300	138,960
		5 guns	38	4,620	202,112
	Capt. Prat, 6,900 tons (Chilian)	Three 9.4-in. B. L.	9	2,853	84,690
		Four 4.7-in. Q. F.	48	2,208	93,312
		7 guns	57	5,061	178,002
2nd Class Cruisers.	*Astræa*, 4,360 tons (British)	One 6-in. Q. F.	10	1,000	34,170
		1 gun	10	1,000	34,170
	Chasseloup-Laubat, 3,722 tons (French)	Three 6.3-in. Q. F.	30	3,300	138,960
		Two 3.9-in. Q. F.	24	672	28,128
		5 guns	54	3,972	167,088

Special notice is directed to the astonishing strength of the *Charlemagne*, *New York*, *Jaurèguiberry*, *Capitan Prat* and *Oregon*.

It will be seen that in every case the bow fire of the British ships, tested by this 3 minute standard, is weaker, not only in number of rounds, but also in weight of metal thrown and in total muzzle energy developed, than the bow fire of foreign ships of similar class and of about the same or of smaller displacement. The attention which, especially in France and the United States, has been devoted to the increase of end-on fire has hitherto passed almost unregarded here; but our disparity in this respect has now become so marked that we can no longer afford to disregard the subject.

—*American Engineer and Railroad Journal*, December, 1894.

(h). Army Signaling—United States.

A recent number of the Electrical Engineer contains an interesting article, by George Heli Guy, descriptive of the methods of signaling in the U. S. army, as practiced at Fort Riley, Kansas, from which we make the following abstracts:

The means of communication by day used by the Signal corps are flags, heliograph, and the field telegraph and telephone trains; and by night, the torch, flash lantern, rockets, bombs, and search light. The method of visual signaling by flags consists in waving a flag to the right for a dot, to the left for a dash, and to the front for the space in the American Morse code. The heliograph, in brief, consists of a combination of mirrors by which a beam of sunlight is thrown in the required direction, and the dots and dashes of the Morse code are made by the opening and closing of a shutter placed in the track of the beam of sunlight. The heliograph has been used recently by the corps up to a distance of 182 miles. At night the Morse code is sent either by the waving of a torch or flashes of light from the flash lantern, the illuminant being coal oil.

The telegraph cable cart can be run either by hand or by a horse. It will carry four miles of double cable. A field kit is attached by a flexible wire to the cart, and communication is always possible, whether the cart is at rest or in motion. The field telephone kit carried by the operator is a leather box, 9½ inches long, 8 inches high, and 4½ inches wide. It weighs about 10 pounds, and contains a Morse key on a buzzer circuit, a Berthon-Ader combined transmitter and receiver, and two cells of dry battery. The Morse key is used as a call for the telephone, and—in case the telephone breaks down—to send messages on the buzzer. The receiver and transmitter are in one piece. The box is carried slung over the shoulder, and does not in any way impede the progress of the operator.

The method of erecting the telegraph line is briefly as follows: At the head of the line the battery wagon is stationed; then a "surveyor" marks the general direction of the line. He is followed by "markers" and "pin men," the markers pacing off the distance of about 55 yards and the pin men placing pins, similar to surveyors' "pins," in the ground to mark the location of the poles. These are followed by "crow bar men," who dig holes for the reception of the lances from 18 to 24 inches deep, according to the character of the ground. A lance is delivered from the lance truck, the wire men put the wire, which has been laid on the ground from the wire wagon, on the insulators, insert the lances in the holes, haul taut on the line, and tie the wire about every fourth or fifth lance with a tie insulator. When the line reaches the desired point, instruments are joined on, and communication made with the battery wagon, which has an instrument on the line at all times. In favorable country the train should average at least two miles an hour.

The balloon train at Fort Riley consists of three wagons for the carriage of tubes of compressed hydrogen and one wagon for the balloon and appliances for handling it. The tubes are of compressed steel, one cubic foot in capacity, and contain hydrogen at a pressure of 200 atmospheres. These tubes are charged at the compressing plant, which is located at Fort Logan, near Denver, Colorado. The gas is generated and the tubes filled there and shipped to the point of ascension. The balloon wagon itself has a compartment for storing the balloon, basket, and netting, and at the rear has a large drum with gearing and brake. The drum carries 2,500 feet of steel cable, which has in its core two insulated conductors for use on the telephone circuit. The wagon is of such weight as to hold the balloon when inflated, by its own weight, and after the balloon has once ascended it may be moved over the ground by simply moving the wagon. The balloon itself is of gold beater's skin, of about 13,000 cubic feet capacity, and, when distended, is of spherical shape, with a slight elongation at the neck. The car or basket is of willow wickerwork, light but strong, and sufficiently large to carry two observers, with the necessary amount of ballast and equipment.

The balloon is filled by attaching a linen hose to its neck, inserting the tops of the gas cylinders in the hose, and opening the valves of the cylinders. It takes about 108 cylinders at 120 atmospheres pressure to fill the balloon, and after its inflation the gas is retained for a long period. If there should be an escape of gas overnight, the deficiency is made up from one of the tubes. When the balloon is inflated the maneuvring bar is attached to the end of the cable on the drum of the balloon wagon, and the necessary amount of cable is paid out. The height of the balloon above the ground is, of course regulated by the length of cable paid out, and the observer in the car, having a field kit telephone, can direct the manipulation of the balloon itself as occasion may require.

The equipment of the car consists of an aneroid barometer, prismatic compass, telescope, field glasses, notebook and pencil, telephone, maps of the country, and a camera. The operator is thus fully prepared for photographic work and observation. It may be thought that a balloon would present a good target to the enemy; but the experiments at Shoeburyness with an old captive balloon showed that it is almost impossible to hit such an object with long range musketry fire, or by artillery fire, especially if it be kept moving, which it always would be. It was also shown by these experiments that the balloon, when filled full of holes by a shrapnel, settled gradually and gently to the earth. When struck it was about 2,000 feet high, and it took 27 minutes to descend to the ground.

Scientific American, December 29th, 1894.

D. MATERIAL.

(A). ARMAMENT AND EQUIPMENT.

(a). Quick-Firing Guns—England and France.

Public attention has been called to the fact that the French have succeeded in equipping their fleet with quick-fire guns with great rapidity. It has further been stated that the French fleet is now far ahead of us in this class of equipment in the Mediterranean, and it is hinted that although matters are better if we consider the channel fleet, we are now behind them, and that they have reversed the relative position in which our fleet stood in this matter. It may be interesting to our readers to see how this question stands, as shown by "Brassey's Annual" of the present year.

First, as to actual numbers. We have taken ships "building," as well as those completed, but have excluded ships only "projected" and not commenced. This gives us the following figures:—British ships, total number armored, 80; unarmored, 208. French armored, 63; unarmored, 99. The quick-fire guns for these are,

British Armored.

6-in.	144	213
4.7-in.	57	
12-pounders (3-in.)	12	
6 "	464	
3 "	565	
Total	1242	

French Armored.

16 cm. (6.3-in.)	16	258
14 " (5.5-in.)	163	
10 " (3.9-in.)	79	
6.5 (8.8-pounders)	37	
4.7 cm.	235	
3.7 "	124	
Total	654	

British Unarmored.

6-in.	187	617
4.7-in.	368	
25-pounder (3.5-in.)	6	
12-pounder (3-in.)	56	
6-pounder	445	
3-pounder	498	
	1560	

French Unarmored.

16 cm. (6.3-in.)	74	279
14 cm. (5.5-in.)	88	
10 cm. (3.9-in.)	117	
6.5 cm.	32	
4.7 cm.	213	
3.7 cm.	161	
	685	

If these quick-fire guns be considered irrespective of their calibre, it will be seen that the average number per armored ship is, for England 15.5, against 10.3 for France; and for unarmored 7.5 for England, as compared with 6.9 for France; but it may be seen that in the armored ships France has a great preponderance of heavier and more powerful quick-fire pieces, having in fact 258, against 213 of the English, and those of heavier metal, for we have included the 12-pounder among the English pieces. This gives 2.66 for heavy quick-fire guns per armored ship, and 4.1 per French armored ship. On the other hand, England is stronger in her unarmored vessel armaments, these having 617 heavier quick-fire pieces, as compared with 279 French, which makes 2.96 per English unarmored ship, and 2.81 per French unarmored ship. Thus France has an absolute advantage in one respect, that is in heavy quick-fire guns in the equipment of her armored ships, while she is inferior in the total number of quick-fire guns of all calibres per ship in her armored fleet, and in her unarmored fleet she is slightly inferior both in the heavier quick-fire pieces and in total numbers. When we take into account the fact that we have to deal with 288 ships of all kinds, France with only 162, involving a total of 2802 pieces as compared with 1339, it will be seen that it could not with any justice be said that France is in advance of us in the work of supply if bare numbers only be considered. A mere statement of numbers may, however, be misleading. We have included many ships which are small and obsolete, which would only receive quick-fire guns under special circumstances, and, on the other hand, ships under construction. Both these may affect the results unfairly. The obsolete ships, which naturally have not been well supplied, may pull down the average, and the nation which builds its ships more slowly therefore has more in hand in proportion to her rate of turn out, benefits unfairly by reckoning ships building, yet it seems desirable to take some total number that has been arrived at without reference to our immediate object and on good authority, in order to be clear of bias. It must be understood, however, that our vessels going into action would naturally be so far selected that they would have a much larger number of guns than the average. To pass on next to the character of the pieces. Our own heavier guns are of the Elswick types, with light Hotchkiss 6 and 3-pounders and Nordenfeldt 6-pounders. The French pieces consist in a great measure of converted guns, the remainder being new pieces, chiefly those of Canet. The French converted guns have certain distinct disadvantages, both in being of older type and inferior power to the new pieces, and also in power of quick-fire. The Canet guns are excellent, but there is no justification for the recent attack made on our Elswick pieces in the press. We have brought quick-fire guns to conform to the conditions of service before our neighbors. If a lower rate of fire is claimed for our guns, we believe it will generally be found to be due to the fact that our guns performing at sea under service conditions are compared with continental guns firing on a practice ground.

It may be instructive to compare the case of sample vessels of about the same displacement and date. The *Centurion*, of 10,500 tons, completed in 1893, carries ten 4.7-in., eight 6-pounder, and twelve 3-pounder guns. The *Brennus*, of 11,000 tons, launched in 1891, carries ten 16 cm., four 6.5 cm., and eight 4.7 cm. guns. The French ship with rather more displacement has a decided advantage in weight of metal, but fewer light pieces. The *Royal Sovereign*, of 14,260 tons, completed in 1892, carries ten 6-in., sixteen 6-pounder, and twelve 3-pounder quick-fire guns. As there is but little difference between the 16 cm. and the 6-in. guns, this equipment is decidedly more formidable than that of the *Brennus*; but the vessel is much larger.

The *Charles Martel*—building—11,882 tons, is to carry eight 14 cm., four 6.5 cm., twelve 4.7 cm., and eight 3.7 cm. guns. She is therefore less powerful in weight of metal than the *Brennus*, but has more light guns. Her quick-fire is decidedly inferior to that of the *Royal Sovereign*. Let us now turn to useful vessels of obsolete type. Our *Dreadnought*, 10,820 tons, completed in 1875, carries only six 6-pounder and twelve 3-pounder quick-fire guns. The French *Duperré*, 10,487 tons, launched in 1879, carries eleven quick-fire guns of unregistered calibre—probably light and not yet supplied, and not included in our tables above. Probably these will be of heavier metal than the *Dreadnought's* 6 and 3-pounders; but it is hardly fair to say much of guns not yet supplied, as we cannot but suppose that the *Dreadnought* may receive heavier quick-fire guns bye-and-bye. The French *Devastation*, 9639 tons, launched in 1879, carries only two quick-fire guns, calibre not given. Our own *Devastation*, 9330 tons, completed in 1873, carries six 6-pounder and eight 3-pounder quick-fire guns. In this instance our vessel, much older and smaller than the Frenchman, is the better equipped.

Passing to unarmored ships, the *Thames*, 4050 tons, completed in 1885, carries three 6-pounder and eight 3-pounder quick-fire guns. The *Sybille*, 3400 tons, completed in 1890, carries six 4.7-in., eight 6-pounder, and one 3-pounder quick-fire gun. These are the vessels most nearly comparable perhaps with the French *Cecile*, 5766 tons, launched in 1888, which carries six 4.7 cm. quick-fire guns only. Our first-class cruisers of 9000 tons are too large to compare with the French, our second-class too small. The *Brilliant* may be taken as a representative modern second-class cruiser, 3600 tons, launched in 1891. She carries two 6-in., six 4.7-in., eight six-pounder, one three-pounder quick-fire guns. It will be seen, then, that our unarmored ships more than hold their own remarkably well; they are superior to the French in quick-fire.

On the whole our readers will probably concur with us in concluding from the foregoing figures, that France has by no means overtaken us yet in the matter of quick-fire equipments; nevertheless we think that good work has been done in calling attention to the rapid strides that she has made, enabling her to compare as well as she does with us, seeing what a start we had of her.

—*The Engineer*, November 30th, 1894.

(b). Warships at Yalu.

The various reports coucerning the great naval battle of Yalu are so conflicting in many respects that it is difficult to write on the subject with desirable certainty. The very spelling of the names of the vessels engaged is perplexing. Under the circumstances we can scarcely hope to avoid falling into some error. But there are certain facts which are well known and beyond dispute, and these we propose to put before our readers here. In another page we have dealt as far as possible with the question of gun-fire and its effects as displayed at Yalu. * * *

In September of 1887, a little squadron, consisting of two small battleships and two moderate-sized cruisers, accompanied by a sea-going torpedo boat of the first class, built by Yarrow, assembled at Spithead under command of Admiral Lang, they being destined for the reinforcement of the Chinese Imperial Fleet. These vessels are identical with the four which we have illustrated to-day, and one out of each pair has gone down under the fire of the Japanese guns, the remaining vessels being hulled many times and pierced upon the water line, demonstrating the important part which the whole of them took in the engagement.

The *King Yuen*—sunk at Yalu—and the *Lai Yuen*, two small twin-screw barbette ships, partially armor-belted and intended for coast defense, but capable of making extended passages at sea, were laid down for the Chinese Government by the Vulcan Company at Stettin, and were launched, the first on the 3rd of January, 1887, and the last on the 25th of March, 1887. They were completed in the summer of 1887, and left England, as mentioned above in September of the same year.

The armor was compound, and consisted of a belt for protection of the engine and boiler rooms from 2 ft. above the water-line to 4 ft. below it, and was 9½ in. to 5¼ in. thick. The belt was terminated and reinforced by transverse bulkheads 8 in. thick. A protective deck 1½ in. thick extended over the belt, the extremities of the vessel being protected by an armored deck, sloping down, of 3 in. in thickness. Their heaviest guns were coupled in a pear-shaped redoubt forward of the funnels, with 8 in. of compound armor, whilst a strong steel shield extended over this barbette.

There was a conning tower abaft and above the barbette protected by 6 in. armor. A double bottom extended for about two-thirds of the length of the ship, which was divided into sixty-six separate water-tight compartments, of which those next the ship's side were packed with cork. We shall have occasion to notice these facts when we allude presently to the sinking of the *King Yuen*.

The armament consisted of two 21 centimetre—8¼ in.—Krupp breech loading guns in the barbette, two 15 centimetre—5.9 in.—guns of the same description in sponsons on the beam amidships, seven machine guns, and four Schwartzkopff torpedo dischargers, one in the bow under water, and three above water. There was one military mast. Ammunition carried for each of the large guns, 50 rounds. The principal dimensions, &c., were as follows:—Length, 270 ft.; breadth, 40 ft.; extreme draught, 16 ft. 6 in.; displacement, 2850 tons. The engines were triple expansion, to develop 3400 horse power, giving a speed of 15½ knots with natural draught and a speed of 16½ knots with forced draught. The boilers were cylindrical and four in number. The coal storage 325 tons.

The two twin-screw steel-protected cruisers, *Chih Yuen*—sunk at Yalu—and *Ching Yuen*, were laid down at Elswick in October, 1885. The first was launched on the 29th of September, 1886, and the second on the 14th of December, 1886. They were completed, and went out with the two iron-clads built at Stettin, in September, 1877.

They had a turtle-back steel armored deck from 2 in. to 3 in. thick, and a double bottom beneath the machinery. Two 8 in. 12-ton guns were coupled in the bows upon a Vavasseur mounting, which was protected by 12 in. of steel, and a protective shield. A third 8 in. gun was at the stern, whilst a 6 in. 4-ton gun was sponsoned out on each broadside. They also carried seven 57 mm., two 47 mm., and eight 27 mm. quick-firing guns, six machine guns and four torpedo tubes. The dimensions, &c., were as follows:—Length, 250 ft.; breadth, 38 ft.; draught, 15 ft.; displacement, 2300 tons. The engines were triple expansion, designed to develop 5500 horse power, and the estimated full speed was 18 knots. Coal capacity 450 tons.

A graphic description was given by the Flag Lieutenant of the Japanese Admiral of the way in which the *King Yuen* was fought by her Chinese captain, and her subsequent going down. The error which was made by the Japanese in mistaking her for her sister ship, the *Lai Yuen*, is obvious. We have necessarily transposed the names. The report ran as follows:—"After a time the Chinese Admiral apparently became desperate. His formation was broken, and two or three of his ships advanced against us at full speed." Apparently the *King Yuen* and *Chih Yuen*. "The fighting became furious, but our weight of metal told, and one ship, the *King Yuen*, was crippled in this venture. When the Chinese resumed their line formation our guns were directed upon their disabled ships, particularly the *King Yuen*. She had been riddled by shot and shell, and it was evident that she was sinking. The Chinese gunners worked their weapons to the last. Finally, she went down slowly stern first. Her bows rose clean out of the water, and she remained in this position for a minute and a half before she disappeared in one last plunge. We had used no torpedoes upon her, but sank her by fair shot and shell fire. It spurred all our men to additional effort, aud the officers were naturally exultant. They regarded the sinking of a double-bottom ship like the *King Yuen* by gun fire alone as no mean achievement." No more valuable testimony than this—the report of an enemy—is necessary to afford proof of the gallant conduct of the crew of the *King Yuen*. The Chinese report is laconic. The unfortunate vessel was in a terrible plight, rolling heavily, "when a shell burst through her decks, and with the flames bursting out of her she slowly settled down."

Two conflicting accounts are given of the destruction of the *Chih Yuen*. The first is as follows:—"The *Chih Yuen*, which still bravely fought her guns when she was nothing more than a wallowing wreck, was struck by a torpedo and went down with the brave men on board her." The second, also from a Chinese source:—"Late in the afternoon, the Chinese Armstrong-built cruiser *Chih Yuen*, whose captain had several times displayed a disposition to disregard the Admiral's signals, deliberately steamed out of line, although again ordered to remain in the spot assigned to her, and went full speed at a Japanese cruiser. The latter received a slanting blow, which ripped her up below the water-line, and she soon foundered. But she delivered several parting broadsides at her enemy at close quarters before she sank. The *Chih Yuen* was so injured by the cruiser's guns and by the effects of the collision that she also sank." It is probable that the latter account is the correct one, as the Japanese Admiral positively asserts that no "torpedo was fired" by any of his vessels during the whole of the action.

Only one ship, therefore, appears to have been sunk by gun-fire alone, the *King Yuen*. Probably she had been hulled over and over again beneath and upon the water-line, when she rolled and exposed her bottom. Her sixty-six separate compartments failed to keep her afloat. It would be interesting to know whether, in the exigencies of service during the fight, the water-tight doors had to be left open. Reports say that the pumps of all the vessels were working furiously, and this shows that the engines and boilers were intact. It is possible that the one shell particularly alluded to, which burst through the deck, after which the vessel settled down, may have got into and wrecked the engine or boiler rooms. The stoppage of the pumps would necessarily have hastened the foundering of the vessel.

Whether, however, the vulnerability of the *King Yuen* was due to the thinness of the protective deck over the vitals—that being only 1½ in.—or to failure of the water-tight door system, or to the awful concentration of the efforts which were made to sink her, the fact remains that she did go down under gun fire alone. In this connection it may not be inopportune to quote some remarks which were made by an officer on board of her at Spithead in September, 1887. He was drawing a comparison between her and her sister-ship, and the *Chih Yuen* and *Ching Yuen* turned out by Elswick. The two latter he pronounced to be splendid and powerful cruisers, finished in every respect, whilst the *King Yuen* and *Lai Yuen* were incomplete shells. On inspection, it did certainly appear that there was justice in his remarks.

The sinking of the *Chih Yuen* was clearly due to the folly of employing her as a ram. She was eminently unsuited to such a purpose, and the only wonder is not that she did eventually go down when assailed by a storm of projectiles in her crippled condition, but that she floated at all after her concussion with the enemy. In later vessels of the cruiser class the solid ram bow is not only reinforced in strength by phosphor bronze longitudinal projections, which are built into the cellular mass behind the forefoot, but the armored deck curves down, and is associated with the stem so as to stiffen the whole to a very great extent. The earlier cruisers, however, were too tender in the stem to admit of their sustaining the severe shock of ramming without serious injury. Hence, we are of opinion that the *Chih Yuen* was lost by the mistaken policy of her captain, who appears from all accounts to have been a rash and ill-advised, though undoubtedly courageous, sailor.

Appended is a list of vessels which took part in the action, both on the Chinese and Japanese sides, and remarks are made in the margin as to their subsequent condition, so far as can be ascertained at present:

China.

Ships.		Displacement.	Armament. Heavy	Armament. Small	Speed.	Remarks.
Armored.		tons.			knots	
Chen Yuen	P.3″	7430	6	8	14.5	Belted. Disabled.
King Yuen	P.3″	2850	4	7	16.5	" Sunk.
Lai Yuen	P.3″	2850	4	7	16.5	" } Caught fire; much damaged.
Ping Yuen	P.2″	2850	3	8	10.5	" }
Ting Yuen	P.3″	7430	6	8	14.5	" }
Unarmored.						
Chih Yuen	P.4″	2300	5	23	18.0	{ 10″ steel armor on barbette. Sunk.
Ching Yuen	P.4″	2300	5	23	18.0	" Hulled badly.
Kwang Kai	P.1″	1030	3	8	16.5	} One of these subsequently said to be destroyed.
Kwang Ting	P.1″	1030	3	8	16.5	}
Tshao Yung	. .	1350	6	7	16.8	Destroyed.
Tsi Yuen	P.4″	2355	3	9	15.0	Disabled.
Yang Wai	. .	1350	6	7	16.0	Destroyed.

And four torpedo boats.

The crushing damages that the Chinese squadron sustained are only too apparent. The *Kwang Kai* and the *Kwang Ting*, which were up the river with the transports when the Japanese appeared in sight, are the only vessels not reported to be injured, yet one of these was afterwards found on shore and torpedoed.

The *Sakiomaru* was accidentally present in the engagement, and appears to have suffered severely if not sunk. It seems, thus, that whilst no vessels were actually lost by the Japanese, except possibly the *Sakiomaru*, three were either disabled or terribly injured; and, as the only reports upon their actual condition have been received from Japan, the whole truth may be much more serious than is admitted to be the case. But, clearly, China has come out of the action very much the worst.

Japan.

Ships.		Displacement.	Armament. Heavy	Armament. Small	Speed.	Remarks.
Armored.		tons			knots	
Fusoo	. .	3718	6	5	13.2	Iron ships, old.
Hi-yei	. .	2200	9	–	13.0	Old. Disabled.
Tschiyoda	P.1″	2450	24	3	19.0	New.
Unarmored.						
Akagi	P.	615	2	2	12.0	. . . .
Akitsuschima	P.2″	3150	13	6	19.0	. . . .
Hasidate	P.2″	4277	12	12	17.5	12″ steel on barbette.
Itsukusima	P.2″	4277	12	22	17.5	" " " "
Matsuchima	P.2″	4277	12	22	17.5	" " " " Disabled.
Naniwa	P.3″	3650	8	12	18.72	. . . .
Takachiho	P.3″	3650	8	12	18.72	. . . .
Yoshino	P.4½″	4150	12	22	23.03	Much injured.

—*The Engineer*, October 5th, 1894.

(B). ARMOR AND PROJECTILES.

(a). Armor Plates—Behavior under Fire.

In a paper of the above title, by Captain Tresidder, recently published by the Royal Engineers' Institute, the author propounds some very interesting theories in regard to what takes place when a shell strikes an armor plate, and they are of the highest importance, in view of the fact that his almost unexampled practical experience may be supposed to have kept him on the right track, or approaching thereto.

His first task was to form a theoretical conception of the various stages which occur, from the first impact of the shell till it has ceased to act on the plate. He divides these into six, as follows:—1. *Compression Stage.*—Before the commencement of the lip to the front in soft plates, or the corresponding splintering of the face in hard plates. 2. *Entering Stage.*—The production of the lip or splintering to the front before commencement of the back bulge. 3. *Punching Stage.*—The production of the back bulge. 4. *Clearing Stage.*—The tearing asunder of the metal of the back bulge, starting from the apex. 5. *Clearing Stage.*—The bending aside of the walls of the back bulge to allow the shot to pass. 6. *Clearing Stage.*—Overcoming the friction of the sides of hole in the plate (this is a small element also in the four last preceding stages) and the resistance of the backing to penetration.

In the case, say, of a wrought iron plate, the first stage consists in a compression of the metal upon itself, and this immediately merges into the second stage, when the metal begins to flow and form a raised surface around the point of impact; the ring so formed increasing in circumference and in volume as the shell penetrates deeper, and only stopping, generally speaking, when it is as great or greater than the shell in diameter. When the gradually increasing resistance on the part of the plate to this kind of deformation becomes so great as to throw other parts into motion, then the third stage, or formation of the back bulge, commences. This stage continues until the tension on the back of the plate causes the protruding part to split; and this very rapidly, and without much additional expenditure of energy, is followed by the final stages of this sequence.

The author is of opinion that, in the present case, the third stage is the all-important one; in fact, so much so, that in its consummation some 80 per cent. of the entire resistance of the plate is there overcome. It is evident, therefore, that the thickness of the plate has here nearly all to do with its resistance to penetration. The relative importance of all the stages, except the last, which may be considered constant, is probably maintained in a considerable measure for all materials and strengths of plate, provided they are of homogeneous construction, except as regards tendency to crack. The ideal homogeneous plate is consequently that which combines to a maximum degree the maximum breaking strength with a maximum capacity of very rapid change of form without fracture. These requirements, combined with certain other practical necessities, are such that compound plates would appear to hold out much greater hope for success than those of homogeneous character, when, in addition, the causes operating towards the break-up of the shell are considered.

In this preliminary survey of the matter, it has been necessary to imagine the shell as unbreakable, but much depends on its rigidity, weight, and the character of the blow it imparts. Should the pressure be so great on the point of the shell before it is receiving lateral support from the plate it is penetrating, as to cause it to split, a general break-up of the shell is almost certain to follow, accompanied, however, by penetration for a certain distance. It has been observed that when a shell splits up in this fashion, the forward part of it flies off sideways in a highly pulverized form. When a plate can cause a shot to act in this manner, its resisting power is enormously increased. To carry out this principle in practice, it is necessary that the hard face should be adequately supported, both by the rigidity and consequently the thickness of the plate as a whole, and by the firmness of backing holding it in place.

The cracking of plates has not up to the present been dealt with, but it is, by means of repeated blows, to be considered, even with the best plates, an ever present possibility. "Racking" and "wedging" are the two effects of impact which tend to bring this about. Racking may be described as the general shaking up that a plate receives under a blow which is heavy in proportion to the weight of plate that has to share it, and may be taken as at a maximum when the penetration is at a minimum, and *vice versa*. The wedging of the plate is entirely due to the conformation of the shell, and is practically an absent quantity when its point is smashed up. Though, in the case of a hard plate with an unbroken shell, the wedging effect, owing to the great resistance it offers to ordinary deformation apart from cracking, is at a maximum. As a hard plate, then, has more tendency to crack than a soft one, and also has more racking and more wedging strain to bear, *unless it breaks up the shot*, it is clear that this "breaking up" power is the great weapon of defense against shells of hard plates, and when that power can be secured in plates which, being tough in the mass instead of hard throughout, have a minimum liability to cracking, their advantages seem to completely outweigh their drawbacks.

When, however, the shell is able to overcome the resistance of the plate against splitting, the question ot its resistance after that mishap has to be considered. The strength of a plate is not greatly affected by cracks as long as the backing is such as to continue to adequately support it. If a shot which has cracked the plate has sufficient energy to continue in its course, and wedge the sections of the plate apart, then, even in the case of plates such as those of a ship, which are supported on all sides, considerable danger exists of a part of the backing being left unprotected by armor. Whether this takes place or not depends much on the nature of the backing, and the system of bolting adopted, for it would seem that a number of small bolts are more likely to hold a plate in position when it is broken up into several smaller plates, as it were, than a few large ones would be. Another danger, under these circumstances, is to be found in the tendency of the moving sections of the plate to sheer off the holding bolts.

There is a quantity of other interesting matter in this paper, but we have been obliged to give of it only too brief a *résumé* for the benefit of our readers. The author goes on to note the various forms of break-up of a shell, the effect of firing obliquely at a target, and other theoretical reasonings connected with the impact of the shell on armor; while he concludes with a memorandum of the Russian trials with soft nosed shells. If our readers wish further to pursue the subject, we cannot do better than recommend a perusal of the entire paper as acknowledged above.

—*Arms and Explosives*, December, 1894.

(b). Face-hardened—Status.*

The apparent difficulties which at first delayed the development of face-hardened armor in this country, and which were, by some, regarded as insuperable, have either disappeared upon closer inspection or been practically overcome. The difficulty of securing structures to the hard face, in default of knowledge as to the exact location of the fastenings, is also in course of solution It was found feasible to tap and drill holes in the face of the plate at any stage of the process prior to hardening without detracting from the plate's resistance; but, as it was impossible to locate these holes with precision without fitting the armor into place, this method was abandoned in favor of one by which the carbon was prevented from penetrating over certain areas

* Abstract of a paper by Captain W. T. Sampson, U. S. N., Chief of Bureau of Ordnance, read at the recent meeting of the Society of Naval Architects and Marine Engineers.

in the wake of the fastenings. This method also had its disadvantages in that the carbon gases frequently seeped through the protecting material and carbonized the surface beneath. The most satisfactory method, and one which will probably be employed in the future, is that of electrically annealing the surface to be drilled. The greatest objection to the face hardening or Harvey process, and one which seems least likely to be overcome in the immediate future, is its expense.

Dimensions and Shapes of Harveyed Armor Plates now Manufactured for the U. S. Navy.

Length and width. ft. ins. ft. ins.	Thickness of plate. ins.	Shape of sec.	Curvature.	No. plates now mf'd.
16 7 × 7 6	18	Tapered	Shaped to side	27
12 00 × 8 4	17	Rect'ng'lr	28°, radius 15' 10"	52
10 00 × 6 9.5	15	"	60°, radius 14' 3"	16
17 6 × 6 9.5				
20 00 × 6 11	12	Tapered	Shaped to side	21
19 00 × 6 6	12	"	" "	15
25 9 × 4 8 to 10 3 × 4 8	8	Rect'ng'lr	120°, radius 9' 3"	16
"	8	"	103°, radius 11' 00"	6
"	8	"	76°, radius 11' 00"	6
"	8	"	72°, radius 9' 3"	19
"	7½	"	72°, radius 11' 00"	10
"	6	"	120°, radius 9' 3"	46
19 4 × 4 8	4	"	130°, radius 9' 6"	2
8 8 × 4 8	4	"	52°, radius 9' 6"	2
12 00 × 7 10	4	"	Curved to side	31
17 9 × 4 4	3½	"	120°	6
13 00 × 8 6	3	"	Curved to side	32

It would not be proper to dismiss the subject of manufacture without considering the effect of nickel upon it. Mr. Ellis, in an able essay delivered before the Association of British Naval Architects in March last, discusses the advantages and disadvantages of nickel in armor plates as treated by the Harvey process in England. In certain respects the experience in the United States is different. The decision of the Armor Board of 1890 that the Schneider nickel steel plate was softer than that of steel, and allowed greater penetration, was correct for those two plates. Our armor makers, however, have had no difficulty in making oil-tempered nickel steel armor far stronger and more resisting than that of simple steel, while it still retained the characteristic toughness of the nickel. To any metallurgist acquainted with the infinitude of results that may be obtained by a variation in the composition and treatment of simple steel, the advantageous possibilities arising from the introduction of so benign an ingredient as nickel must be apparent. In other words, where simple steel is strong and tough, both qualities may be improved by adding the proper amount of nickel.

The susceptibility of nickel steel to treatment is remarkable, and yet this steel may be abused in the most shameful way without failure. For this reason the smaller percentage of losses in manufacture will go far towards wiping out the increased cost of machining the tougher material. Nickel appears to render the carbon more sensitive to hardening, and hence water hardened Harvey plates of nickel steel are toughened at depths hardly affected in simple steel plates. Not only that, but the hardening is accomplished with less risk to the plate, and it is for this reason that manufacturers have been able to forego entirely oil-tempering armor plates and obtain the increased resistance due to the more severe operation of water hardening.

Doubtless the difficulty of spontaneous hardening, which Mr. Ellis mentions as occurring in carbonized nickel steel plates, is due to the sensitiveness of the alloy after its long heat soaking, the plates being removed from the cementing furnace or uncovered in a cold, moist atmosphere while still at a high temperature. It is very rare that any difficulty of this sort occurs in the United States. In fact, the only doubt concerning the use of nickel in this country is the feasibility of raising its percentage, now 3.25%, still higher, the improvement and cheapening of the processes of reduction having considerably reduced its cost. In this connection, it is well to note that in the Pola, Austria, competitive armor trial of November, 1893, a Witkowitz unhardened plate, said to contain 5% of nickel, defeated five competitors, including a Vickers Harveyed simple steel plate and a Krupp gas hardened plate. These plates contained between 2 and 3% of nickel. Finally, in England, where the nickel in Harveyed armor rarely exceeds 2.5%, its peculiar toughening effect is taken advantage of by employing it for unbacked structures, while the Harveyed all-steel armor, being more susceptible to racking, is now only fitted on backing. There is, therefore, nothing in the present application of the Harvey process, nor its future possibilities, to indicate the disuse of nickel in armor; rather that by increasing its percentage the toughness of the foundation plate and its resistance as a whole may be increased.

The service tests for Harveyed plates for United States naval vessels require them to withstand two shots, the first delivered with the velocity which, according to the Gavre formula, would cause the perforation of a wrought-iron plate 10% greater in thickness, together with 36 inches of oak backing, the requirements being that no crack shall extend from the impact to the edge, or from one edge to another of the plate, and at the same time through the entire thickness of the plate at an edge. The second shot is at the velocity which, according to the De Marre formula, would cause the perforation of a Creusot steel plate 15% greater in thickness, together with 36 inches of oak backing, the requirement in this instance being that the projectile, or any fragment thereof, shall not pass entirely through the plate and backing.

These tests are but 15% more severe than those required for oil-tempered nickel steel plates, and are now 3% less severe than those fixed by the latest contracts in France. It has been claimed that the larger calibres employed in France make the tests more severe. This is hardly the case, as in France cracking is not barred. The plate must resist perforation, no part of the backing must be exposed, and the plate must remain in such condition, as regards cracks, as to enable a second shot to be fired upon it. The velocity of the second shot will be 1.26 as compared with that for ordinary steel as obtained from the De Marre formula, and the blow of this shot shall fall at a point distant three to four calibres from the first. Should the plate stop this shot, a premium of 8% of the contract price will be paid. Should the plate fail to fill the conditions imposed for the first shot, then another shot will be fired with a velocity of 12% greater than that capable of piercing an equal thickness of steel, and if the plate successfully resists this attack, the lot may be accepted, but at a price 8% below that agreed to in the contract. It would thus seem that the minimum requirement in France, after all, is hardly as severe as our own; still there are three grades of quality and three prices under the same contract.

It must be remembered, however, that the tests in the United States do not, as abroad, fix a standard of excellence. They mark the inferior limit, as does the last shot mentioned in the French contract above. The poorest, not the average, plate in an armor group of from 300 to 50c tons must pass this test or the entire lot is rejected. With the careful inspection of the various delicate operations of manufacture, aided by physical and chemical tests, it has been possible for the inspectors to select a Harveyed plate believed in every instance to be less resisting than any other in the group. Our service plates must, therefore, be regarded as generally exceeding the resistance of the plates tested by a considerable amount.

In the United States the necessity of developing the manufacture of armor has prohibited active competition. It was necessary to place orders and formulate specifications before practical business men could be induced to erect the required expensive plants, hence it was necessary at first to borrow largely from experience abroad. In England and on the Continent, where the armor manufacturers were, at the advent of the Harvey process, provided with plants in which the equipment had followed step by step the advance of the art, contracts are awarded to the firms producing the best material, so that an active competition exists. It is to be hoped that an actual comparison of the products of our own and foreign armor makers may be arranged at no distant day, if for no other reason than to correct certain false impressions that exist abroad as to the standard of acceptance in this country. Thus far 28 Harveyed plates, all but 7 being of nickel steel, have been tested in the United States, and 40, all of which but 14 were of nickel steel, have been tested abroad. In addition, 9 plates tested were face-hardened in various other ways. The owners of these special processes of face hardening have, however, in every instance also acquired the right to Harvey armor.

In England about 20,000 tons of armor of this description have been ordered, the latest contract being for 12,500 tons, intended for the barbettes and citadels of five first-class battleships, and Harveyed armor is now being manufactured for three battleships in England, two in France, one Danish vessel, and two Japanese. The great English firms of Cammell, Brown, and Vickers are all provided with Harveying plants, and in France, the St. Chamond, Chatillon-

Commentry, Marrel Freres, and St Etienne makers have adopted the process, the first three accepting contracts to furnish plates up to a thickness of 15.75 inches, St. Etienne making plates under 8 inches in thickness. Schneider & Co. have also acquired the process, as well as the firms of Krupp, Dillingen, and Witkowitz, all of whom had previously employed special face-hardening processes of their own.

Carnegie 6-inch plates have kept out 6-inch projectiles with velocities up to 2,110 feet per second, exhibiting a resistance, as compared with iron, of 1.93; while a Bethlehem 8-inch plate kept out an 8-inch projectile with a velocity of 2,004 feet per second, showing a resistance 2.14 times that of iron. Nevertheless, the unjust and erroneous comparison is frequently made of the severity of the acceptance tests of armor in this country and the comparative tests abroad.

The advent of Harveyed armor, and the necessity of our navy being provided with projectiles capable of piercing it, if such projectiles could be made, were almost simultaneous. The standard of excellence to be struggled for was far in advance of what was, until very recently, regarded as attainable. The improvement in quality, however, has been remarkable. Two months ago our Harveyed armor, as mounted on the ships, was regarded as impenetrable to calibres equalling its thickness up to 8 inches, the impact occurring with service muzzle velocity. This was owing to the smashing of the projectiles on the hardened face. Projectiles of the latest design, however, would probably be able to perforate such plates practically undeformed at a fighting range of 1,500 yards. It has been reported that the Russians so easily overcame Harveyed armor with their special shells that they decided against it in favor of tempered homogeneous plates. They are yet to be heard from in this matter, however, and it is hardly possible that they have followed such a policy.

The theory has been advanced, however, that with the improvement of projectiles, the Harveyed plate will lose its peculiar advantage now due to its smashing the projectile, and will become really less resisting than a homogeneous plate of equal thickness, on account of the softer body and back of the Harveyed plate. This argument is fallacious; the principle of a non-homogeneous hardened face, combined with a decrementally toughened body and back, is correct. The homogeneous plate, as compared with the non-homogeneous, must always be perforated in detail. Should the homogeneous plate of the future be greatly superior to the face-hardened plate of to-day, it will be made still more resisting by employing it as the foundation plate to which the process of face-hardening is applied.

Whatever conclusion is reached, the fact remains that Harveying in its present state has increased the resistance of armor fully 35% and perhaps 50% according to the thickness of the plate. It has also brought about a great improvement in the quality of our projectiles, and in doing so has perhaps lost some of the advantage it held over them at first, when subjected to direct impact. Its superiority under inclined impact is nearly as great as it ever was, and it does not seem possible that in this respect the relation between gun and armor will for a long time to come take the old position held in the time of soft armor. Perhaps the relation may be restored, however, should the thickness of armor be reduced, to a point allowing no more than the old resistance, in order to distribute it over a larger area or divert the weight thus saved to other uses.

—*Engineering News*, November 22d, 1894.

(c). Experiments.

Harveyized Plates—United States.

On the 4th instant, a 4-inch Carnegie Harveyized nickel steel armor plate, curved to a radius of 9½ feet, weighing 6300 pounds, and representing a group of armor of 293 tons for the barbettes of the *Brooklyn* and *Iowa*, was tested at Indian Head. This plate was peculiar in having a large number of surface cracks, some of which were ¾ of an inch deep and .05 of an inch wide. Four similarly cracked plates have already been tested, supporting the theory that such cracks, which were caused by bending the plates, do not decrease the resistance. The plate had 20 per cent. of its thickness consumed in these cracks and the Carnegies wanted to withdraw it, but finally determined to let it be tested.

The first shot was aimed at an uncracked portion, a 4-inch 34-pound Carpenter shell being used with a powder charge of 8.05 pounds, giving a velocity of 1491 feet a second. The head of the shell perforated the plate, going 6 inches into the backing, a fragment remaining in the shot hole, while the body rebounded. The next shot had an impact below the first one immediately in the center of a group of numerous cracks. A Carpenter shell was used with 9.06 pounds of powder and a velocity of 1595 feet a second. The shell was smashed up, flying into minute fragments, showing that the plate was stronger where cracked than elsewhere.

As an experiment a Carpenter shell with a velocity of 1676 feet a second and a charge of 9.8 pounds of powder was then used. The shot struck 10 inches from the second impact in a spot comparatively free from cracks and perforated the plate, but broke up.

These tests sustain a theory of armor experts that plates with cracks may be more effectively Harveyized and hardened, and it is thought that this discovery, if verified beyond doubt, may be utilized in future armor making

On the 6th instant an armor plate made by the Bethlehem Company was tested with satisfactory results. The plate tested was one of a group of Harveyized side armor for the battleship *Texas*. Three hundred tons were accepted. The plate shot at was 18 feet 2 inches by 6 feet 4 inches and 12 inches thick, tapering to 6 inches. An 8-inch gun was used, with Holtzer projectiles weighing 250 pounds. In the first discharge 79½ pounds of powder were used, and the projectile attained a speed of 1678 feet a second. It was aimed at a point 6 feet 6 inches from the side of the plate, and 34 inches from the top. It struck the mark fairly and was shattered, the point remaining imbedded in the plate. It was estimated that the penetration was about 6 inches. Not a crack of any kind was to be seen, and the shot seemed to have no effect whatever upon its target.

—*American Manufacturer*, October 12th, 1894.

Iron Capped Shells—United States.

A 6-inch shell with a soft iron cap was recently tried at the Indian Head proving ground in an attempt to discover the secret of the new Russian armor piercing projectile. Four 6-inch shells were fired at a 6-inch Harveyized plate, with velocities of 1,800, 1,900, 2,000 and 2,100 ft. per second. They were all broken up, and only the last succeeded in perforating the plate. The capped shell did particularly well, but they were all so clearly overmatched by the plate that no definite conclusions were possible.

—*Engineering News*, October 11th, 1894.

Cast Steel Shells—United States.

The recent tests of heavy cast steel shells for high power rifles of American manufacture, made at Indian Head, are described by Ensign Tisdale, U.S.N., in a report to the Naval Ordnance Bureau. Four shells made by Mr. I. G. Johnson were tested. Three shells were fired from a 10-inch rifle against an 18-inch nickel-steel Harveyized plate, which had been somewhat damaged previously by two Carpenter 12-inch armor-piercing projectiles and one Wheeler-Sterling projectile. This plate was secured to a heavy oak backing by 23 3-inch bolts, and the gun was placed 390 feet away. The first shot weighed 494 lbs. and the powder charge used was 250 lbs.; the striking velocity was 1,983 feet per second and the striking energy 13,650 ft.-tons. The shot struck the upper middle of the target and broke up, leaving a hole in the plate of 2x3 feet, widening the old cracks and developing a new through crack. The second shot weighed 502 lbs., and with 250 lbs. of powder developed the same energy as before, or 720 ft.-tons per ton of plate. This shot struck the right-hand side of the plate normally; broke up and rebounded, the largest piece being a section of the body and base, weighing 156 lbs. A through crack, 1 inch wide at the shot hole, and another fine crack extending nearly to the top of the plate were developed. The third shot weighed 501 lbs., was propelled by 250 lbs. of powder, and developed a velocity of 1,980 feet per second and a striking energy of 13,657 ft.-tons. This shot struck the right edge of the plate; buried itself in the plate and broke off, with an estimated penetration of 15½ inches. The body and base of the shell remained intact for a length of 14 inches and rebounded, the force of the shot developing a new surface crack, some through cracks and widening all the old cracks. The fourth shot was fired against a 17-inch Harveyized nickel-steel plate, previously attacked by four 12-inch projectiles, with striking velocities ranging from 1,410 to 1,983 feet per second. The portion of the plate struck was triangular in shape and weighed about 60 tons. The shot weighed 492 lbs. and with 250 lbs. of powder developed a velocity of 1,983 feet per second and a striking energy of 13,650 ft.-tons. The shell penetrated 20 inches of the plate and backing, leaving the base sticking out, but considerably broken. The diameter of the shot hole was 10½ inches, showing that the shell swelled but little in penetrating. The whole of the principal part of the plate was badly wrecked. Ensign Tisdale concludes his report with the following comment:

"The performance of these shots when their penetration, armor-breaking qualities and conditions after impact are compared with those of the 12-inch armor-piercing shell previously fired against these plates, with striking energy 1½ times greater, cannot fail to bring to notice the superior quality of this particular lot, leaving but little to be desired so far as solid shot is concerned."

—*Engineering News*, October 11th, 1894.

Magnetic Shells—Russia.

The armor and projectile trials were renewed on October 4th at Ochta, near St. Petersburg. Two 6-inch Harveyed plates by Messrs. John Brown & Co. and Messrs. Vickers respectively, were attacked, says the *Times* correspondent, by the 45 caliber 6-inch Oboukhoff guns. The conditions, so far, seem to have been much the same as in July last, when plates by Messrs. Brown & Co. and Messrs. Cammell, of Sheffield, were under trial, and the result appears to leave Messrs. Cammell still to the front with their Harveyed plates. Messrs. John Brown's plate on this occasion was 6 feet square, and had one corner and a strip all round left unhardened, in order to prove that the Harvey process can be so applied to armor plates as to leave softer spaces for the drilling of holes after the fixing of the armor to the sides of the ship, and this without affecting the quality of the plates. Messrs. Vickers' plate was 8 feet square. Two rounds were fired at each plate in the normal position with a striking velocity of 1,889 feet, the first with ordinary Holtzer shells and the second with Holtzer shells improved by the "magnetic" process of Admiral Makaroff. Both varieties of shell were manufactured at the Putilof works. Every shot passed through the plates. Messrs. Brown's plate cracked considerably at the first round, but the second shot produced no cracks. The first shell fired at Messrs. Vickers' plate passed through both plate and backing; the other was broken up in or behind the backing. Messrs. Vickers' plate was next placed at an angle of 15 degrees, and with the same velocity one round was fired at it with the "magnetic" shell, which broke up in the backing, perforating and cracking the plate severely. The experiments are to be continued, so that judgment upon them must be suspended.

—*Army and Navy Gazette*, October 20th, 1894.

Another successful test of the Bethlehem Iron Company's armor plate was made early in October at the company's proving ground. The plate tried was one representing 300 tons of armor for the battleship *Texas*, and all were accepted by the Government officials. The plate is 12 inches thick at the bottom and tapers to 6 inches at the top. It is 18 feet long and 6¼ feet wide, Harveyized, and weighs 50,000 lbs. Two shots were fired at it from an 8-inch gun. The point of impact of the first shot was 6 feet 6 inches from one side and 34 inches from the bottom of the plate. A 250-lb. Holtzer projectile was shot at the plate with a charge of 79½ lbs. of hexagonal powder, at a velocity of 1,679 feet per second. The projectile was badly upset, and a portion of it remained in the plate, making it difficult to determine the penetration, but the Government officers estimated it at 6 inches. In the second shot 110 lbs. of powder were used, and the same weight and kind of projectile. The velocity was 2,004 feet per second. The point of impact was 40 inches from the side and 31½ inches from the top. The result was almost the same as that of the first shot. The shell was smashed, and a large part remained imbedded in the plate. The penetration was estimated at 8 inches. Neither of the shots caused any bulging of the plate, and there was no disturbance of the backing or springing of the bolts that held the plate fast to the large timbers. The plate fired at was selected for the test because it was believed to be the poorest in the lot.

—*The American Engineer and Railroad Journal*, December, 1894.

(C). ARTILLERY.

(a.) Quick-Firing Guns—England.

At a recent meeting of the Armstrong Company, of England, a striking statement was made by Lord Armstrong in regard to the progress made during the last decade in quick-firing guns and ammunition. As respects the latter, it is shown that cordite makes it possible to get enormous power even with guns of moderate size. Ten years ago with an eight-inch gun a striking force of 5,254 foot-tons was attained, but at present, with the new ammunition, a six-inch gun with a projectile weighing 100 pounds gives a velocity of nearly 3,000 feet per second and a striking force of 5,884 foot-tons. With a projectile of 45 pounds and a very long six-inch gun a velocity of 4,980 feet per second has been obtained—an astounding speed, in view of the fact that 2,000 feet per second was, at a not very remote period, considered a high velocity. A result of this speed, and the flatter trajectory that accompanies it, is increased accuracy of fire. Recently a gun's crew on an English cruiser, which was steaming eight knots an hour, fired in three minutes 18 projectiles of 100 pounds each from a six-inch gun at a target from 1,600 to 2,200 yards distant and hit it 14 times. Another gun's crew got 12 hits out of 18 shots, and a third 12 hits out of 17 shots. This accuracy testifies, perhaps, to the good training of the British man-o'-war's man, as well as to the excellence of his powder.

An eight-inch gun of the *Blanco Encalada*, a cruiser just built for Chili, fired recently a 216-pound projectile four times in 62 seconds with a gun's crew that had never before handled the gun. Ten years ago an eight-inch gun could fire but four rounds in five minutes and its projectile had an energy of 5,245 foot-tons, as against an energy of 10,500 foot-tons possessed by the projectile impelled by the new powder. Added to this is the fact that the new gun is operated by 8 men as against 18 required for its predecessor. The heaviest guns, thanks to the new hydraulic mountings, combine rapidity of fire with accuracy to an astonishing degree. A 13½-inch gun of the *Royal Sovereign* fires seven rounds, with projectiles of 1,250 pounds, in twelve minutes, and while the ship is going at an 8-knot speed hits a target 2,000 yards off six times in the seven shots. Such accuracy must, it is evident, make an unarmored cruiser uncomfortable when opposed in action to a first-class battleship. According to Lord Armstrong, the quick-firing principle has been adapted also to field artillery—and with great success. The recoil has been brought under control—a difficult undertaking. In a recent trial with a 3-3-inch quick-firing field-gun five rounds of shrapnel were fired in 53 seconds. Evidently the use of the new artillery must alter the character of future wars. It must seem impossible for men to stand up, much less charge across a field, against streams of missles from magazine rifles, Maxims and quick-firing cannon, to say nothing of dynamite. The army that arrives first, perfectly equipped, at the scene of action would, it appears, hold the trumps.

—*Public Opinion*, December 13th, 1894.

(b). Tests of Machine Guns—United States.

The following information relative to machine-gun trials will be found of interest:

Upon the recommendation of Commodore Sampson, Chief of the Bureau of Ordnance, United States Navy Department, the Secretary of the Navy has authorized the invitation of the Gatling and the Maxim-Nordenfelt gun companies to manufacture respectively one gun each of caliber 6-mm. to be tested in comparison. As the character of the ammunition influences in a very important way the efficiency of the gun, in order to enable the Board to reach a conclusion which gun is best for the navy, it is thought advisible to compare these guns with the ammunition they will use in service. The Driggs-Schroeder firm, who are agents for the Accles gun, have requested permission to make an improved gun of 6-mm. caliber and present it for trial.

The Bureau has recommended that all competitors in the late trial be allowed to present guns of 6-mm. calibre if they desire. In every case the ammunition to be used will be furnished by the Government. The object of this is that all shall use absolutely the same kind of ammunition. It is expected that several months will be required to prepare for this test.

The following is a synopsis of the majority and minority reports on the trial of machine-guns, under order July 5, 1894, begun July 6, and continued till August 4, 1894:

The majority report is signed by Philip R. Alger, Professor U. S. N., and A. C. Diffenback, Ensign U. S. N.

Six guns were submitted, viz: Gatling, Accles, Gardner, Robertson, actuated by hand cranks and of multi-barrel system; Maxim-Nordenfelt and Skoda, automatic and single-barrelled.

The Robertson gun was withdrawn permanently during the progress of test, and the Gatling and Accles were both temporarily withdrawn. The tests were made at the Washington Navy Yard and Naval Proving Ground.

The range was 25 yards at the navy yard, the merit of each gun considered under the following heads: 1. Certainty of fire, ammunition supposed to be efficient. 2. Simplicity of mechanism and its liability to get out of order in service. 3. Accuracy and facility of aimed fire. 4. Rate of fire. 5. Weight of gun. 6. Method of feed and ammunition supply. 7. Ease and convenience of manipulation. 8. Crew required.

Relative value of the above features, the final order of merit, is submitted as follows:

Maxim-Nordenfelt (Maxim is an American inventor), Gatling, Accles, Skoda, Robertson, Gardner.

Taking up the guns in the inverse order of merit as above determined, the advantages and disadvantages of the various systems are as follows:

Gardner.—Disadvantages: 1. Low speed of fire in proportion to weight. 2. Great derangement of aim by the effort on the crank and its location. 3. Liability to damage through hang fires. 4. Gravity feed and frequent jams of feed. 5. Insufficient power of extraction and play of extractor, permitting slipping off rim of cartridge, causing failure to extract and loss of several unfired cartridges each time the gun is cleared. 6. Intermittent fire. 7. Unserviceable character of charger, due to instability and liability to damage from weather and transportation. 8. Number of men required in crew.

Advantages: 1. Simplicity of mechanism. 2. Comparatively light weight.

Robertson.—Disadvantages: 1. Insufficient support of cartridge at the chamber, due to the design of feed wheel and belt, causing ruptured cases and jams. 2. Derangement of arm by crank effort. 3. Liability of feed belt to jam through bending or displacement of links. 4. Lack of facility of slowage of ammunition, due to design of feed belt. 5. Liability to damage by hang fires.

Advantages: 1. Lightness and consequent mobility. 2. Shock of recoil not communicated to mechanism, but taken on frame. 3. Simplicity of mechanism.

Skoda (Austrian).—Disadvantages: 1. Gravity feed and consequent interruptions, jams, and liability to premature explosions. 2. Failure to work automatically unless the chambers and cartridges are lubricated. 3. Complexity of mechanism. 4. Small range of working limits with diminished pressures, due to deteriorated ammunition. 5. Slight derangement of aim due to pressure required to overcome spring on charger in feeding. 6. Weight and cumbersome character of chargers. 7. Liability to temporary inaction from damage to single barrel. 8. Impracticable cooling device for barrel.

Advantages: 1. Lightness and consequent mobility. 2. Freedom from damage due to hang fires. 3. Great directive facility, due to absence of disturbing influence of crank effort. 4. Two men only required in crew.

Accles.—Disadvantages: 1. Great weight, making the gun inconvenient for boat or landing purposes. 2. Derangement of aim by pressure required on charger to overcome spring of lever which throws feed mechanism in action. 3. Liability to hang fires. 4. Very small actual volume of fire in proportion to number of barrels and weight, due to gearing down of crank at trunnions, crank effort, and intermittent character of fire. 5. Complicated, heavy, and cumbersome feed mechanism, and its liability to jam by loose cartridges, and also the time, effort and skill required to clean. 6. Unsuitability for service use of chargers for the reason that if the charger becomes bent or wet its rigidity is destroyed, and the cartridges lost through inability to use in the guns. 7. Intermittent fire and large intervals between the fire of chargers. 8. Number of men required in the crew.

Advantages: 1. Capability of use with any number of barrels less than the full number, in case of damage to barrel or lock, but with the probability of a jam if fired at depression under these circumstances. 2. Adaptability to motor power. 3. Familiarity of the service with this type of mechanism.

Gatling.—Disadvantages: 1. Great weight, making the gun inconvenient for boat or landing purposes. 2. Great derangement of aim by the effort on the crank and the location of the latter. 3. Liability to damage by hang fires. 4. Small actual volume of fire in proportion to number of barrels and weight, due to crank effort and intermittent character of fire. 5. Liability of cartridges in feed strip being displaced, causing a jam. 6. Intermittent fire. 7. Number of men required in crew.

Advantages: 1. Simplicity of charger and hopper, making the clearing of jams easy and rapid. 2. Capability of use with any number of barrels less than the full number in case of disabling lock or barrel, but with a probability of jam if fired with depression under these circumstances. 3. Familiarity of the service with this type of mechanism. 4. Adaptability of motor power.

Maxim.—Disadvantages: 1. Complexity of mechanism. 2. Liability to temporary inaction, due to damage to single barrel. 3. Necessity of renewal of water supply in jacket after continuous firing of about 2,000 rounds, and from leakage.

Advantages: 1. Lightness and consequent mobility. 2. Freedom from damage due to hang fires. 3. Great directive faculty, due to absence of crank effort. 4. Small crew required. 5. Continuity of fire. 6. Facility of packing and stability of cartridges, due to design of feed belt.

The majority concludes that the efficiency of an automatic machine-gun is so much greater than a gun worked by hand, that nothing but a strong presumption that they will not remain efficient in actual service can justify the adoption of the inferior but less complicated gun. Regard was given to the greater skill required to operate the mechanism of an automatic gun. The Board concludes that too much would be sacrificed to fear of lack of skill if the great advantages of the automatic system were put aside.

"That the Maxim-Nordenfelt proved itself greatly superior to all others submitted, the only hitches in the trial being attributed to defects in ammunition. These are found in all guns, and are remediable." This gun has seen actual service since 1888, and was officially adopted in the German Navy. The Board determined to recommend the consideration of two systems, one for use on shipboard and one for landing purposes.

The increase in volume of fire of the Gatling and Accles guns over the Maxim-Nordenfelt proved so slight that the simplicity due to the use of a single barrel outweighed that slight advantage.

"The Board, therefore, recommends the adoption of the Maxim-Nordenfelt gun, and that all machine guns for the naval service be of this type contingent upon the successful test of a gun of 6-mm. calibre."

The Minority Report.—The minority report of the trial of machine-guns, signed by C. S. Sperry, Commander U. S. N., senior member, dissents from the recommendation of the Maxim-Nordenfelt. It states the technical difference between guns of first class requiring hand or motor power for loading, firing and extracting, and the second class or automatic guns utilizing force generated by the explosion of the charge to continue the operations of loading, firing and extracting after the first round has been fired by hand. The report agrees with the Board in placing the Gatling first among guns of its class. With this gun in the beginning the tin charger strips were defective, causing jams. They were remedied. The firing of the Maxim was frequently interrupted by the transverse rupture of the cartridge shell. In the final test, the minority declares that, with an experienced crew, 1,200 rounds were fired: one belt of 250 was fired without interruption; one belt with only one interruption, and of the remaining 700, 30 per cent. failed. The report adds: "If the peculiarities of a gun are such as to require a perfection of ammunition, it is not serviceable, and its failure cannot be ascribed to defective ammunition. Four years have shown that this defect is not unprecedented in this gun." An officer witnessing the trial of a gun manufactured for the German Government reports that it stuck badly.

Test No. 9 shows as follows:

Targets 12 feet high, 30 feet long.

Gun.	Rounds fired in four minutes.	Hits.			Percentage of hits.
		500 yds.	1,000 yds.	Total.	
Gatling . . .	1,547	305	207	512	33
Accles	795	215	149	364	46
Gardner . . .	538	104	52	156	29
Maxim	720	275	124	399	55
Skoda	875	207	234	441	50

The Skoda gun was fired for 2 minutes and 45 seconds only, the ammunition supply giving out. The Gatling was fired without interruption, and the Maxim had five interruptions in the last two minutes. The Gatling scored 512 hits and the Maxim 399, but it is not to be supposed that the 1,035 rounds from the Gatling, and 321 rounds from the Maxim, which did not score, would have been entirely wasted in firing at as large a target as a ship. The minority report states that obviously the advantage is with the gun which fired the greater number of rounds. If a gun will not deliver its fire when

called upon, the most phenomenal efficiency at some later but uncertain moment cannot redeem the situation. The minority concludes: "The Gatling gun has been in use in the naval service for many years, and I have the honor to recommend that it be retained as the gun likely to prove serviceable."
—*Journal of the Royal United Service Institution*, November, 1894.

(c). Army Guns—England.

The following return, which has recently been issued, shows the actual cost, &c., of the various rifled iron and steel guns supplied by the War Department to the Land Service during the year 1892-93:—

Numbers.	Description.	Name of Designer.	Maker or Place of Manufacture.	Actual Cost. Each (average). £	s.	d.	Total. £	s.	d.	Remarks.
	B.L.:—									
4	10-in . . . . . III.	Roy. Gun Factory	Whitworth & Co.	6,479	18	8	25,919	14	8	India.
1	9.2-in . . . . . . I.	" "	Roy. Gun Factory.	2,614	14	9	2,614	14	9	
2	6-in . . . . . . IV.	" "	Armstrong & Co.	1,081	11	7	2,163	3	2	Colonies.
1	6-in . . . . . . VI.	" "	" "	1,115	16	7	1,115	16	7	"
2	6-in . . . . . . VI.	" "	Roy. Gun Factory.	1,233	4	10	2,466	9	8	"
12	5-in . . . . . . V.	" "	" "	634	1	8	7,608	19	10	India.
18	4-in . . . . . . VI.	" "	" "	485	14	4	8,742	18	1	"
191	12-pr . . . . . . I.	" "	" "	273	19	4	52,327	19	5	169 for India. 4 for Colonies.
	R.M.L.:—									
6	2.5-in	" "	" "	108	11	10	651	11	0	
	Quick-Firing Guns:—									
10	4.7-in . . . . . II.	Armstrong & Co.	Armstrong & Co.	666	5	10	6,662	18	4	
2	Nordenfeldt . . II. 6-pr.	Nordenfeldt . . .	Roy. Gun Factory.	399	16	7	799	13	2	India.
2	Hotchkiss, 6-pr.	Hotchkiss	" "	256	2	3	512	5	4	Colonies.
22	" "	"	Hotchkiss	252	9	11	5,554	18	2	
33	" 3-	"	"	205	14	5	6,788	15	9	
24	" "	"	Roy. Gun Factory.	190	2	9	4,563	6	0	

—*The Army and Navy Gazette*, September 22d, 1894.

(d). Auxiliary Appliances and Service—Rifling.

The heavy cost of modern guns is largely due to the time and labor which are necessarily expended upon the operation of rifling them. The material itself is relatively cheap, but a rifled gun, besides being much more costly, is, speaking broadly, more short-lived than a smooth bore. It is extremely difficult so to build the gun and the projectile that the soft driving bands of the latter shall, at the moment of discharge, accurately fit into the grooves of the bore and allow no gases to pass ahead. When these gases do pass ahead of the projectile they score and injure the interior of the gun. and where the new powders are used and the gases of combustion attain an extraordinary degree of heat the process of deterioration, especially in weapons of large calibre, is frequently very rapid.

The London *Times* mentions that a Swedish engineer, W. T. Unge, has devised a method by which he hopes to save, not only the cost of rifling, but to do away in a large measure with the interior wear and tear incidental to rifling. He proposes to construct all guns as smooth bores, and to fit the projectiles with gas checks which shall render it practically impossible for any gases to rush past them. In order to convey to the projectile an axial rotary motion, such as is at present conveyed to it by the action of the rifling, he has invented a mechanical arrangement which, at the instant of firing, gives to the gun itself an axial rotary motion. This may be either constant or increased. He has satisfied himself that the effect upon the projectile is exactly the same as is produced by the constant or increasing twist of an ordinary rifled gun; and he is of opinion that the adoption of his system, while giving equal or even improved accuracy of fire, will reduce the cost of heavy guns by one-half and add fully 100 per cent. to their endurance.

—*The Iron Age*, December 6th, 1894.

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(E). TORPEDOES AND TORPEDO BOATS.

(a). An Aluminium Torpedo Boat.

Ten tons with steam up and coal in the bunkers; twenty and a half knots speed; 300-horse power. Ten years ago—perhaps five years ago—the man who suggested the possibility of producing a boat which could live in a sea and satisfy the conditions embodied in the first lines above would have been regarded as a lunatic by those who had not watched the progress of events. On Saturday last Mr. Yarrow demonstrated on the Thames the possibility of producing such a vessel, when, with a small party of guests on board, he ran an aluminium torpedo boat, which he had just completed for the French Government, from Greenwich Pier to Crossness and back. The boat, which has not yet received either a name or an official number, is the largest vessel yet built of aluminium. Indeed, she is the largest structure of any kind yet produced in that metal, a small yacht and an arctic boat, recently illustrated in our columns, being her only predecessors. The torpedo boat is of the second class. She is 60 feet long and 9 feet 3 inches beam. Thus she has 9 inches more beam than the English 60 foot boats, a most important improvement in many respects. The object of what is termed a second-class torpedo boat is to be carried on deck of large men-of-war, to be lowered in the water and to act, when necessity requires, as a scout to watch the movements of the enemy's torpedo boats, or for the use of the ship for landing and embarking the officers. The ordinary armament of a second-class torpedo boat consists of one or two machine guns placed forward and a torpedo launching tube aft.

It is self-evident that lightness of construction is of paramount importance in craft of this kind, not only because reduced displacement secures increased speed, but, considering that the boat has to be lifted and lowered by the tackle available on board the ironclad or other vessel, it is clear that the weight to be handled should be reduced to a minimum. Moreover, as these boats are placed high up on a ship's deck, any reduction of top weight increases the stability of the ship to which they are attached. In the English Navy a large number of these second-class torpedo boats is used to form part of the standard equipment of all men-of-war. The French naval authorities, however, up till last year had not adopted them, and, as they were desirous of introducing them into their Navy, they invited tenders for the best torpedo boat of this class which modern improvements enabled constructors to build, to serve as a type to be followed in the future. The primary conditions imposed were good sea-going qualities and lightness, combined with the highest obtainable speed. The proposal submitted by Messrs. Yarrow and Co. was the one accepted, as they were prepared to guarantee a higher speed and lighter weight to be lifted than any other firm, mainly in consequence of having determined to adopt aluminium for the construction of the hull. The boat illustrated is the first aluminium vessel built for the French Government.

Comparatively little has hitherto been known about aluminium as a structural material, and before adopting it Messrs. Yarrow and Co. carried out a series of elaborate experiments on the metal to obtain information. The great and uniform success of this firm in all their ventures is largely due to the elaborate system of experimenting carried out at Poplar. The trials of aluminium referred to its stiffness, best working temperature, corrosion, &c. It was found, in the first place, necessary to alloy the metal, by which its tensile strength was raised from 9 tons per square inch to about 18 tons. The alloy is mainly 6 per cent. of copper. As regards stiffness, &c., a general result was arrived at. All scantlings were increased 25 per cent. over that allowed for steel, and as aluminium weighs about one-third of steel, it follows that a reduction of about one-half was effected in the weight of the hull, which was reduced from about four tons for steel to about two tons for aluminium. In order to arrive at some precise information concerning corrosion, two aluminium plates were accurately weighed, and then secured on the sides of a wooden coppered sailing ship, the copper being removed and replaced by the aluminium. This ship made a voyage round the world, then the aluminium plates were removed, weighed, and found to have suffered no appreciable loss. The great foes to aluminium are alkalies, which attack it powerfully, and heat. It fuses at a moderate heat, and loses much of its strength at comparatively low temperatures. In the case of a torpedo boat there is no trouble incurred in avoiding both sources of risk. No plates or angles were touched by the fire; everything was bent cold. The frames are a little closer together than they would be if of steel, the extra cost of material in the use of this particular boat being £1000 as compared with that of steel. In return there is a saving of about two tons in weight and a gain of about 3½ knots in speed over vessels of the same class and dimensions in the British Navy, which steam under the like conditions at 17 knots. The boat is built in the usual way, and triple-riveted with aluminium rivets. Her machinery consists of a set of triple expansion engines, driving an aluminium bronze propeller at 580 to 600 revolutions per minute. These engines are balanced without bob weights, on Mr. Yarrow's principle, at two points only, the balance weights being fitted at properly calculated angles to the cranks. The boiler is of the ordinary Yarrow water-tube type.

The official trial took place on the 20th of September, the French Government being represented by a Commission, of which Captain L. Clerc was the president. We give below a copy of the official report of the trial:—

Official Trial of Aluminium Second-class Torpedo Boat for the French Government by Yarrow and Co. Dimensions, 60 feet, by 9 feet 3 inches.

The trial consisted of a continuous run of two hours' duration in the estuary of the Thames. Weather, calm; number of persons on board, seventeen; total load on trial, three tons.

No. of run.	Steam in boiler.	1st receiver.	2nd receiver.	Vacuum in condenser.	Air pressure in stokehold.	Revolutions per minute.	Time on knot.	Speed.	First means.	Second means.	Mean of means.
				in.	in.		M. S.				Knots.
1	185	72	12	24	2½	600.36	2 42	22.222			
									20.893		
2	185	72	12	24	1¼	598.80	3 4	19.565		20.807	
									20.721		
3	175	72	12	24	2⅜	593.40	2 45	21.877		20.566	
									20.412		20.503
4	175	62	11½	24	1½	578.16	3 10	18.947		20.299	
									20.187		
5	180	65	11	24	1½	586.80	2 48	21.428		20.341	
									20.496		
6	185	70	12¼	24	1¾	591.48	3 4	19.565			

During the trial of two hours' duration the engines made 70,948 revolutions, being at the rate of 591.2 revolutions per minute, corresponding to a mean speed during the entire run of 20.558 knots per hour. The boiler—Yarrow's patent water-tube—made ample steam without priming, and the engines worked without any heating. The vibration was very slight, and not appreciable.

During the trials of this boat, the absence of vibration and of noise in the engine-room has been most noteworthy. On Saturday she was run at various speeds from dead slow up to the highest attainable, and at none was the slightest vibration to be felt in any part of the boat forward, aft, or amidships. The only thing of the kind perceptible was a species of purring thrill. Part of this is no doubt due to the construction of the engines; but much remains to be explained by the metal. Although aluminium is in some forms one of the most sonorous in existence, in the shape of a torpedo boat it is wanting in that resilience and vibratory stiffness peculiar to steel. This largely explains the comparative silence of the engines. In a thin steel hull every sound is magnified, in the aluminium boat it is deadened—the new metal behaving apparently very much like wood. Nor is this silence without its value. Such a boat as this of which we write might be able to creep alongside an enemy and take him unawares, where the ordinary boat would be detected in the stillness of night by the clank of its machinery.

Beyond all question Mr. Yarrow has achieved a remarkable success. Many wise men shook their heads when he suggested the use of aluminium, and did not hesitate to say he was courting failure. The result has, however, more than justified him; he has succeeded in producing the best torpedo boat of the size that has ever been built. It now remains for the makers of aluminium to improve their processes and cheapen their material, so that the use of the new metal may be widely extended.

—*The Engineer*, October 5th, 1894.

(b). Experiments—United States.

1. *Visibility and Audibility.*

Experiments as to the visibility and audibility of torpedo boats at night have been made off Newport by the United States torpedo boat *Cushing*, which had been previously painted with a suitable color. In the first experiment the *Cushing* steamed out from shore at night, having a powerful search light from the land directed upon her. At a distance of a thousand yards she became invisible from the shore, although it was light enough on the *Cushing* herself to read. The second experiment was to determine the distance at which the boat could be detected by her noise. The report says: "Eight hundred yards is the maximum torpedo range, and a speedy craft would make great progress inside of this before guns could be trained upon her; so it is still questionable whether the search light is much of a safeguard against an attack from torpedo boats.

—*The Engineer*, November 30th, 1894.

2. *Dirigibility.*

A dirigible torpedo has been invented by Lieut. N. J. L. T. Halpine, U. S. N. As described, the thin copper hull is cigar-shaped; has a spear-like arrangement at the front end and rudder and propeller at the rear, the latter driven by a 4-HP. electric motor. In the forward part of the hull is a detachable case holding the explosive. What Lieutenant Halpine proposes to do, though no actual test seems yet to have been made, is as follows: When the spear-head strikes the net usually surrounding a warship in action, the meshes strike two projecting arms, which release the case, holding about 175 lbs. of dynamite, or a proper charge of gun cotton. The spear-head remains fixed to the net and the case is suspended from it by a chain and sinks below the net The contact of the water with a bit of potassium fires a rocket which impels this case forward and upward, the purpose being to make it strike the ship's bottom, and 40 seconds after release from the torpedo hull the explosion is fired. The hull, meanwhile, is connected by a light wire with, and is under control of, the operator on shore, or on another ship, and is supposed to back away and return to its starting point. A dry-land test has been made in Boston of a working model. How it will act against a ship is a later story.

—*Engineering News*, December 13th, 1894.

3. *Speed.*

The British Admiralty is adding a large fleet of fast torpedo boats to the navy, several of which, already completed, are faster than any boats in the world. The latest example is the *Ardent.* This boat is 200 feet long, 19 feet wide, 14 feet deep. Her engines are 5,000 horse power, built by Thornycroft & Co. On trial November 9, making two runs with and against tide, her mean speed was 29.18 knots per hour, or a little over 33½ miles per hour—the fastest velocity ever attained by a steam vessel. At the above speed there was an absence of the usual vibration and but little flame at the tops of the chimneys. The *Ardent* is a wonderful boat. We need not enlarge upon the importance to our own navy of the possession of vessels equal in speed to those of other nations, and it is to be hoped Congress will lose no time in providing for their construction.

—*Scientific American*, December 8th, 1894.

(F). POWDERS AND EXPLOSIVES.

(a). Experiments.

1. *Velocity of Combustion.*

Many years ago Mons. de Saint Robert carried out some curious experiments with gunpowder, with the view of determining the velocity of its combustion. Briefly, his method was to fill a leaden tube with powder, and cut it into equal lengths; these lengths were then burned at various heights above the level of the sea. From the observations made, it was concluded that the velocity of combustion of gunpowder varied directly as the two-thirds of the pressure of the surrounding medium. Captain Castan has verified the increase of velocity of combustion with pressure by means of experiments with a tube containing powder. The tube was punctured with a hole for the escape of the gas, and by changing the size of this hole the pressure within the tube could be varied. Lieutenant Glennon has now arrived at a formula by means of purely mathematical analysis, which shows a close agreement with the results of de Saint Robert's experiments. This formula is

$$V = K' P^{.7},$$

where V is the velocity of combustion, K′ a constant, and P the pressure of the gaseous surrounding medium outside the issuing stream of combustion gases. When the powder is burnt in guns, the formula

$$V = KP^{\frac{1}{2}}$$

is a sufficient approximation to truth. Expressed in words, the principle involved in the equation is the following, viz: the velocity of combustion of gunpowder varies as the square root of the pressure of the surrounding medium. This principle is due to Mons. Sarrau. For smokeless powders, and for other explosives leaving no residue, in process of combustion as distinguished from detonation, the above equations should hold with exactness.

—*Arms and Explosives*, May, 1894.

Mons. P. Vieille has amassed some experimental values for the mean speeds of combustion obtained with various explosives under pressure, increasing from 100 kg. to 2,500 kg. per square centimetre. All the powders, except the colloidal powders, were first pulverised and sifted through silk gauze; they were then compressed into grains of known dimensions under known pressures, so as to ensure their combustion by parallel surfaces:

Nature of the Explosive.	Densities Attained.	Combustion Speed per Second.
A. Black or Brown Powders.		
Mining Powner	Superior to 1.900	5.09
Brown Powder (French)		4.45
Brown Powder (German R.W.P.)		5.70
Black Powder (French $\frac{2}{3}\frac{6}{4}$)		8.50
Common French Sporting Powder		9.48
Fine		13.74
B. Colloidal Powders.		
Pure Cotton Powder (German)	Bordering upon 1.600	5.89
Cordite (English)		20.49
B. N. Powder (French)		7.58
Ballistites (Nobel's)		20 to 40
C. Various Explosives.		*according to samples.*
Nitrommanite	1.765	23.3
Diphenylene hexanirate	1.620	6.19
Picric Acid	1.708	5.32

From these results it appears that the speeds of combustion of compact black powder are of the same order as those of the colloidal powders, having a cotton-powder base, pure or nitrated, and very inferior to those of colloidal powders made with a nitro-glycerin base. The high combustion speeds of cordite and the ballistites are very striking, especially those of the latter.

It is perhaps a little disappointing that Mons. Vieille, whose recent work on this subject we have here reproduced, should have been unable to see his way to some satisfactory statement in the nature of a law connecting the speed of combustion with the density of a powder. The only statement, so far as we are aware, that exists is attributed by Salvati to Piobert, and is as follows: Given equal conditions, the velocity of combustion varies in inverse proportion as the density of the grains. In other words, the product of the velocity of combustion by the density of the powder equals a constant. The constant varies for every kind of powder, and depends upon the nature of the powder, of this kind and quality of the ingredients, on the physical state of the grains, on the degree of trituration, and in part also on the proportion of the mixture. This law refers to black powder only, and, moreover does not invite confidence, inasmuch as its statement is unaccompanied by experimental results. The fact is, there is a singular dearth of literature on this subject. However, now that Vieille has demonstrated that a very close relationship exists between density and combustion speed, it will be surprising if those experts who are competent to investigate the subject should not at once engage npon it.

—*Arms and Explosives*, June, 1894.

2. *Heat of Explosion.*

The following brief resumé of experiments recently conducted by Messrs. Macnab and E. Ristori, possess peculiar interest in the present phase of development of smokeless powders:

First it may be premised, as a proof of the extreme accuracy of the experiments, that the average weight of the products of explosion, calculated from the results obtained, amounts to 99.7 per cent. of the weight of the explosive fired, the extreme limits being 100.5 and 98.9 per cent. E.C and S.S. powders left some mineral residue, and Troisdorf a slight B. N. and Rifleite a considerable, carbonaceous residue, which were not accurately determined.

In the first table are given the heat in calories per gram; the volume of permanent gases, of aqueous vapor and of total gas (at 0° and 760 mm.) calculated at c.c. per gram; the percentage composition of the permanent gases; and the co-efficient of potential energy, this being the product of the number of calories by the volumes of the gas, the last three figures being omitted for simplicity's sake. The following are some of the results:

	Calories.	Permanent gases.	Aqueous vapor.	Total gas.	Coefficient of potential energy
E. C.	800	420	154	574	459
S. S.	799	584	150	734	586
Troisdorf	943	700	195	895	844
Rifleite	864	766	159	925	799
B. N	833	738	168	906	755
Cordite	1253	647	235	882	1105
Ballistite (German)	1291	591	231	822	1061
Ballistite (Italian)	1317	581	245	826	1088

A series of experiments with combinations of nitro-glycerin and nitro-cellulose of various degrees of nitration proved that the use of more highly nitrated cellulose increases the quantity of heat developed and decreases the volume of permanent gases. These again are altered in composition, an increase in the carbonic acid and a decrease in the carbonic oxide and hydrogen being noted. A similar augmentation of the heat was shown by another series of experiments when increased percentages of nitro-glycerin in compounds of nitro-cellulose and nitro-glycerine were employed. When 5 per cent. of the nitro-cellulose was replaced by vaseline, a marked decrease of heat was noted, a mixture of nitro-glycerin 40 per cent. giving 1,347 calories; while 55 per cent. of nitro-cellulose, 5 per cent. of vaseline, and 40 per cent. of nitro-glycerin gave 1,134 calories.

In another series the part played by the oxygen of the air was very clearly shown. These experiments were performed in an inexhausted closed vessel, and demonstrated that where a smaller proportion of explosive to air is present, more complete combustion results, with increase of heat and a modification of the composition of the gases.

—*Arms and Explosives*, August, 1894.

(b). Manufacture.

1. *Destruction of Defective Dynamite.*

In the manufacture of various nitro-glycerine compounds, a considerable amount of dangerous "waste" is usually made. Even the sweepings of the floors, and the residues left on the filters, must be regarded as belonging to this category, whilst the mud from the washings is of a decidedly dangerous character. All the refuse, and also every ounce of defective dynamite, should be carefully destroyed. It is the practice in some works to lay such refuse out in a train and then ignite it; but although it will burn quickly for some time, it is liable to suddenly explode. Before igniting such a train it is a good plan to soak the refuse with paraffin oil, which is poured over every part of it. The train of refuse can then be ignited without danger, and it will continue to burn without explosion until the whole is consumed.

—*Arms and Explosives*, April, 1894.

2. *Use of Acetone.*

The use of acetone in the manufacture of smokeless powders at once, paradoxical though it may be, constitutes a danger and a safeguard. Its use as a solvent is of course of prime importance; but when the mass of "powder" is being worked up into sheets, discs, threads, grains, &c., the acetone exercises the function of a safeguard, for traces of this almost always remain. When the ingredients of the jelly-like mass have become thoroughly incorporated, it leaves the mixing machine, and is subjected to a partial evaporation. It is here that the acetone constitutes a danger; for the vapors which arise as it is being evaporated oft are of a highly explosive character, and possess the property of spreading over a large area, somewhat in the same manner as ether vapor will. Special care should therefore be given to the manufacture of smokeless powders during the evaporation stage, and the precautions should be so arranged that the explosive vapors are safely conducted away to cooling apparatus where they can be condensed.

—*Arms and Explosives*, April, 1894.

3. *Smokeless Powder.*

The U. S. Smokeless Powder Co., San Francisco. An improved explosive compound for use in guns and other weapons composed of ammonium chromate. potassium or sodium picrate, and ammonium picrate. These materials are mixed in the proportion of about 20 parts by weight of ammonium bichromate, 25 parts of potassium picrate and 55 parts of ammonium picrate. In compounding this powder, the potassium picrate is first ground in a moist condition until it is sufficiently fine for the purpose. The ammonium bichromate and ammonium picrate are ground separately, and mixed in a sufficiently damp condition until they are intimately incorporated. The potassium picrate is then incorporated with the other ingredients in any usual or suitable form of powder mill. When the mass has been sufficiently mixed it is placed in a hydrostatic press and worked into cakes, which are then broken up and granulated as with ordinary black powder. After granulation the powder is dried at a temperature between 100° and 125° Fahr.

—*Arms and Explosives*, May, 1894.

4. *Ammonium Salts.*

The addition of various salts of ammonium to dinitro-benzol has received the sanction of the Home Office authorities, but their use with explosives containing gun-cotton or nitro-glycerin has always been reported against, although an exception has been made in the case of ammonium carbonate. The reason is this: all the salts of ammonium, especially when exposed alternately to the action of moist and dry air, at slightly elevated temperature, lose traces of ammonia, and become more or less acid. Now, nitro-benzol and similar nitro-compounds are little, if at all, affected by the presence of traces of acid, and under such circumstances as the above show no tendency to spontaneous decomposition, such as might lead to ignition. On the other hand, nitro-compounds, like gun-cotton and nitro-glycerin, which are strictly speaking nitric ethers, are seriously affected in their stability by the slightest trace of acids. Decomposition may readily be initiated, and when once started, it progresses to total decomposition, ending in ignition or explosion. Hence, ammonium salts exercise no dangerous action on true nitro-compounds, but may fatally affect the stability of nitric ethers, such as gun-cotton and nitro-glycerin. —*Arms and Explosives*, July, 1894.

5. *Linseed Oil.*

In a lecture by Mr. F. W. Reed before a meeting of the London section of the Society of Chemical Industry, November 5th, 1894, some very peculiar properties of oxidized or boiled linseed oil were set forth, which, in view of the recent use of this material in the manufacture of smokeless powder, are of no little interest. After explaining briefly the more common methods of manufacture of the oxidized oil, he cites experiments extending over a number of years which showed that the process of oxidation continues for some time after it has been applied for various purposes. "In two years it becomes sticky, in three years it begins to run, in five years it is partially liquified, is easily soluble in alcohol and partially soluble in water, and finally it becomes a semi-fluid substance containing vegetable acids."

It is well known that boiled linseed oil has been experimented with quite extensively as a deterrent, and also with the view of partially hardening the exterior of the new powders. One instance was recently brought to my personal notice as follows: A lot of powder was being experimented with, and although perfectly satisfactory in every other particular, it persistently failed to stand the heat or stability test, the discoloration of the test paper appearing within a very few minutes after, and occasionally immediately upon introducing the paper in the tube.

Careful investigation showed that the several ingredients were chemically pure, and each separately stood the stability test with the exception of the linseed oil. Further analysis of the oil discovered the presence of lineolic acid in sufficient quantity to account for the failure of the powder to stand the searching test to which it had been subjected. The same ingredients, excepting the oil, incorporated in the same way, subsequently stood the test without difficulty.

—1st Lieutenant Willoughby Walke, 5th Artillery.

BOOK NOTICES.

Proceedings of the International Electrical Congress held at Chicago, 1893. Published by the American Institute of Electrical Engineers, New York, 1894. Page 488. Price $3.00

The electrical fraternity throughout the world is indebted to the enterprise of the American Institute of Electrical Engineers for bringing out this handsome volume of the transactions of the Chicago International Electrical Congress of 1893. True, most of the papers have already appeared in electrical journals in this country and abroad, but a complete history of the congress, from its inception to the closing banquet, is here presented for the first time in a concise, neat volume, which cannot fail to prove an invaluable book of reference.

It is not the contents of the papers alone which entitles the volume to consideration. The addresses of Professors Elisha Gray, Elihu Thomson, W. H. Preece and W. E. Ayrton, and last but not least the remarks of Dr. von Helmholtz, the unanimously chosen Honorary President of the Congress, have a breadth of thought and a true scientific spirit, the possession of which is not to be compared with the mere mastery of individual memoirs.

The text of these remarks which precedes the papers proper, like Professor Rowland's masterly address on "A Plea for Pure Science" before the Philadelphia Electrical Congress of 1884, will surely bear fruit.

The official report of the Chamber of Delegates, composed of the representatives from the different governments of the world is next given. The Chamber of Delegates considered the important subjects of units and standards, and recommended for international adoption definitions for the following electrical units, viz:—the ampere, the volt, the coulomb, the farad, the joule, the watt and the henry.

Next follows the text of the papers presented which are divided into three sections. Section "A" Pure Theory, Section "B" Theory and Practice, and Section "C" Pure Practice. As the papers show however, this division was an arbitrary one made to facilitate the business of the congress.

The subjects treated cover a wide range, and impress one with the *universal* character which electrical science has assumed and especially during the last decade.

Section "A"—Pure Theory.

On the Analytical Treatment of Alternating Currents, by Professor A. Macfarlane.

Complex Quantities and their use in Electrical Engineering, by Charles Proteus Steinmetz.

General Discussion of the Current Flow in two Mutually Related Circuits Containing Capacity, by Frederick Bedell and Albert C. Crehore.

Explanation of the Ferranti Phenomenon, by Dr. J. Sahulka.

Measurements of the Energy of Polyphase Currents, by A. Blondel.

The Extended use of the Name Resistance in Alternating Current Problems, by Professor W. E. Ayrton.

Section "B"—Theory and Practice.

Signalling through Space by means of Electro-Magnetic Vibrations, by W. H. Preece, F. R. S.

Ocean Telegraphy, by Silvanus P. Thompson.

Materials for Wire Standards of Electrical Resistance, by Dr. Stephen Lindeck.

Some Measurements of the Temperature Variation in the Electrical Resistance of a Sample of Copper, by A. E. Kennelly.

A Pair of Electrostatic Voltmeters.

On a Method of Governing an Electric Motor for Chronographic Purposes, by Dr. A. G. Webster.

Iron for Transformers, by Professor J. A. Ewing, F. R. S.

London Electrical Engineering Laboratories, by Professor Jamieson.

Transformer Diagrams Experimentally Determined, by Dr. Frederick Bedell.

On an improved Form of Instrument for the Measurements of Magnetic Reluctances, by A. E. Kennelly.

Variations of P. D. of the Electric Arc with Current, size of carbons and distance apart, by Professor W. E. Ayrton, F. R. S.

Light and Heat of the Electric Arc, by M. J. Violle.

On the Maximum Efficiency of Arc Lamps with Constant Watts, by Professor H. S. Carhart.

The Periodic Variation of Candle Power in Alternating Arc Lights, by B. F. Thomas.

New Researches on the Alternating Current Arc, by A. Blondel.

On the Source and Effects of Harmonies in Alternating Currents, by Professor H. A. Rowland.

Section "C"—Pure Practice.

Rotary Mercurial Air Pumps, by Dr. F. Schulze-Berge.

Underground Wires for Electric Lighting and Power Distribution, by Professor D. C. Jackson.

Various uses of the Electrostatic Voltmeter, by Dr. J. Sahulka.

A New Incandescent Arc Light, by Louis B. Marks.

Direct Current Dynamos of very High Potential, by Francis B. Crocker.

Multiphase Motors and Power Transmission, by Dr. Louis Duncan.

Exhibit of Tesla Polyphase System at the World's Fair, by C. F. Scott.

Discussion of Powers Transmission.

A Novel Method of Transforming Alternating into Continuous Currents, by Dr. Charles Pollak.

The Tesla Mechanical and Electrical Oscillators.

Many of the papers as their titles indicate are highly technical in character, and it would be unprofitable to further consider them, other than to make the perhaps unnecessary statement that they are of the highest order of merit, fitly representing as a whole the advanced state which electrical science has reached in the development of the world's progress. G. O. S.

Dictionnaire Militaire. Encyclopédie des sciences Militaires rédigée par un Comité d'officiers de toutes armes. 1re Livraison. A—Arm e. Berger-Levrault et Cie. Paris, 1894.

The house of Baudoin having published in 1893 a military dictionary,* it is not surprising that Berger-Levrault should follow suit. The latter firm has accordingly begun the publication of an ambitious work, to be completed in twenty parts, appearing at intervals of about two months. With only the first of these papers before us, it would be as unjust as it is impossible to forcast the character of the whole. From the prospectus, however, some information of the general scope may be had. In this prospectus the publishers seem to apologise for calling their venture in sub-title, an encyclopædia. They need have no fears; if an inference from one part only be justifiable, the work bids fair to have some at least of the defects apparently characteristic of all encyclopædias. When however, the publishers go so far as to say that at a pinch (*au besoin*) their dictionary will be so complete as to make it possible to dispense with special treatises, and that in this sense it may take the place of a whole library, they assuredly go too far.

A useful feature is the attention bestowed on services other than the French. Our own service is, however, completely ignored, an omission that is indefensible in an *encyclopædia.* Moreover the compilers—as claimed by the publishers—have given the equivalent of each work of military science in the five essential languages: German, English, Italian, Spanish and Russian. But this claim is simply not well founded. In many cases no translation whatever is given, e. g., *allongement*, *ancienneté de grade.* In other cases only one or two of the five languages are represented. So far as our own speech is concerned, errors are numerous and disgraceful. For example: *abattu* is translated by 'to case springs'; *abrevouir* by 'horse-pond'; *adjutant de bataillon* (in our own sense of the combination) by 'warrant office'; *aiguillette* by 'schoulder (sic) knot'. The most charitable view possible will not convert "angle of descen*d*," "wind-*g*age," "lajing apparatus" into misprints, unless the proofreading is very bad.

These errors are a real blot in what will otherwise prove a very valuable work of reference. The publishers owe it to their own credit to prevent the occurrence of similar mistakes in the parts yet to be published.

In other respects the work will be found well done. The information given

*See this *Journal*, July 1893, page 453.

is full and is systematically arranged; the page is sufficiently clear and open, and convenience of reference has been kept in view by ample spacing, and the use of heavy-faced type and of italics in the respective arguments.

If we may judge from the four examples given, the illustrations will have a good deal to be desired in both number and quality. C. DeW. W.

The Story of the Civil War. A Concise Account of the War in the United States of America between 1861 and 1865. By John Codman Ropes. New York. G. P. Putnam's Sons, 1894. Pp. xiv, 274, with maps and places.

Mr. Ropes has written a remarkable book. It is distinguished from all others dealing with our civil war, first by the point of view, and next by the manner in which the subject is developed.

To write the story of the civil war is a most serious undertaking. The author runs the risk either of foundering in a sea of detail, or of splitting on the rock of barrenness. In the one case the clear view of the whole is possible: in the other the scale is reduced to indistinctness. To avoid both of these dangers is no easy matter; it becomes still less easy when to the strictly military narrative is added a co-ordinated discussion of the current political and personal influences in play. Yet it is this extremely difficult task that Mr. Ropes has successfully accomplished; his story, *quâ* story, is clearness itself; it is within self imposed limits, complete; and it derives these qualities, we venture to believe, from the happy combination of events with influences by which alone, in the general case, may historical phenomena be appreciated.

It is impossible to read this book without the conviction that its author has but one aim: to seek the truth, and having found it, to tell it without fear or favor. It is his purpose, accordingly, "to write of the subjects treated from the stand-point of each of the contending parties," because, in his judgment, "the war should not be depicted as to imply that the north and the south differed and quarrelled about the same things."*

This purpose, it is firmly believed, will commend itself to all fair-minded men. It commands attention by its novelty, and converts attention into interest by the master analysis of the subjects treated. For the author has not produced a chronicle, he has not described a campaign or set of campaigns; he has no cause to plead, no pre-conceived ideas to establish. Throughout the whole of his book a spirit of judicial inquiry is evident, and the object of the inquiry, we do not fear to repeat, is to present the main events of the civil war, as shaped by the forces and influences that brought them into existence. This is worth far more, not only to the general reader, but also to the student of *American* military history, than any amount of campaigning on paper.

If these points are insisted on, it is because the very qualities that appear to us so commendable have been made the object of severe criticism.

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* Preface.

The *Story of the Civil War* is to consist of three parts, each complete in itself. The first of these deals with events to the opening of the campaigns of 1862. But Mr. Roper has selected his events; if the expression be permissible, he has followed the axis of events. Thus the attack on Fort Sumter is thoroughly and slowly analyzed, while the struggle in Missouri is all but ignored. Similarly the campaign of the first Manassas is made the subject of exhaustive study, while McClellan's operations in West Virginia are passed over in silence. The wisdom of this choice is self evident; at no sacrifice of continuity, the attention is entirely concentrated on significant operations. To make further mention of special excellences would be nearly to index the book; but in any case the chapter on Lincoln and McClellan must be noticed; in no other is the author's courageous love of the truth so conspicuous.

By his latest effort, Mr. Roper has added to his well-deserved reputation as our first military historian, and he may rest assured of a warm welcome for the remaining volumes of his work. C. DeW. W.

Les Armes a Feu Portatives des Armies Actuelles et leurs Munitions. Par un Officier Supérieur. Paris, L. Baudoin 1894. Pp. vi., 251.

This is a convenient and useful book. The development of military small arms has of late years been so rapid, that a student of the subject was compelled to turn over many periodicals in order to bring together the various results accomplished. Bornecque's work was good as far as it went, but it is now and has been for some years obsolete, in the sense of being behind the times. The work under notice is therefore welcome, especially as it does not confine itself to descriptions only of the various service weapons, but furnishes in addition, chapters of a more general character, such as a historical sketch of magazine rifles, conditions that military small arms must satisfy, smokeless powder, supply of ammunition on the battle-field, &c., &c. In all this, there is of course nothing new to the special student, but even he, we should think, would be glad to have at hand, in compact form, a summary of the present state of development of small-arms.

The text is illustrated by 131 cuts, more or less coarse of execution, but sufficiently clear for general purposes. It is the opinion of the author, that the Lebel rifle is still the best in the world, and that no other nation has a smokeless powder as good as the French. As is too frequently the case with French books, an index has been thought unnecessary. C. DeW. W.

Steam: Its Generation and Use, with catalogue of the manufactures of the Babcock and Wilcox Co., 28th edition. New York and London. April, 1894.

Although this book is naturally and properly a highly developed advertisement of the products of the Babcock and Wilcox Co., it is anything but a mere commercial advertisement. Written by Mr. G. H. Babcock of the firm of Babcock and Wilcox, it is really "a scientific treatise . . . on the commercial conditions of the production and use of steam." Handsomely printed and thoroughly illustrated, its worth is attested by the number of editions through which it has passed, and by the fact that it has been translated into French and into German. C. DeW. W.

Electric Lighting Plants, their cost and operation. By W. J. Buckley. Chicago. William Johnston Printing Company, 1894. 275 Pp. Price $2.00.

To the investor, or the would-be constructor of an electric lighting or power station, the great question is "will it pay?" Not being in the business "for love" or "for his health," but for whatever profit there is to be derived therefrom, first cost, and cost of operation must go a long way in one's calculations as to the advisability of venturing on such an investment.

Heretofore information on these points was to be obtained only perhaps through interested parties who had goods to sell, or a scheme for some kind of lighting system to exploit, whose financial judgment might be warped by their desire to sell their goods, or to see their scheme in operation.

But in this little book it would appear that an honest attempt has been made to give such information from an impartial standpoint, and in terms that the non-expert can readily comprehend.

The data given in the work claim to be compiled from reports received from almost all the electric lighting plants in the United States and Canada, particularly those of moderate capacity, employing overhead circuits; a wide field is therefore covered, and the variation in cost of construction and maintainance due to locality, and variation in cost of fuel, etc., etc., have been all considered, thus reaching conclusions based upon general facts, and not upon a few specific cases.

Besides giving information as to *cost*, many important points are mentioned as to the best *manner* of construction as shown from the experience of the wide field covered by the above mentioned reports. And the inventor, engineer, or anyone interested can but profit by taking heed of these sources of expense, which no matter how charged up, go to cut down the ultimate profits of the concern.

The question of fuel will probably always be one of locality and relative cost. But coal, wood, oil, natural gas, and water power are all fairly considered, showing the advantages or disadvantages of each.

Boilers of the various approved types, chimneys, feed water heaters, lagging of steam pipes, and the types of engines in use all come in for their due share of notice, and many tables and efficiency curves are given that will repay even an expert for the time taken in their careful study.

Besides considering the general subject of dynamos, motors, incandescent and arc lamps and lighting, by the direct current, or by the alternating current with its transformers, several examples are given of the average cost of construction and operation of plants ranging from 750 lights up to 3000 lights, and various arc-light plants from 15 lights of 2000 C.P. each up to one of 85 lights.

Very complete wiring tables are also given and valuable instructions for line and station men, together with underwriters rules, and those of the N.E.L.A.

The book is made still further complete by a collection of finely executed plates, giving plans of various plants in operation, from small to great, and containing many valuable points upon the best manner of building and installing.

Typographically the book is well executed and well indexed. C. D. P.

Military Information Series. Nos. 2, 3, and 4.

It has been stated on good authority many times, that nearly every good thing possessed by the Navy, has been had after the Army had taken the initiative. That this is open to question goes without saying, but certain it is that the idea of a Bureau of Military Information was first agitated in the Army, but the Navy through their bureau systems were able to first carry out such a need. The Army Bureau, notwithstanding its short existence, has more than proved its great value, and with the present competent head will doubtless continue to gain in worth and importance.

Notes No. 2, on the organization of the German Army, is the work almost entirely of Major Schwan, Assistant Adjutant General. It gives a very complete idea of the actual units composing the German army in peace, and what it can put forth in time of war. In one particular it is lacking, but that is, perhaps, a subject that no officer outside the German army can well describe. I refer to the methods of recruiting. While touching on this, yet this pamphlet, in common with every description of the German army of modern date, whether by American or Continental writers, seems to have omitted a full explanation of the various sub-bureaus of the Recruiting Department as well as the regulations governing the enlistment or rejection of recruits. The book is exceedingly valuable to military students and it is hoped that numbers on all other of the great powers will be issued in detail, similar to this.

Notes No. 3, on the organized Militia of the U. S., is the first attempt to gather together and publish under one head the various reports of the officers detailed by the War Department to the militia of the various States. It is noticed that several important States are missing. Thus, much might be gleaned from Nebraska whose militia did such excellent service in the Sioux war of 1891–92, and again many points might be given by the little Guard of Nevada, which has held for years the championship in target practice, with a record unequalled by any eastern state. Much of the information is given by young officers who are not well qualified for their duty and therefore some of the information is of no use. It is understood, however, that these notes are to be issued yearly on the Militia, and it is therefore probable that in a few years a fairly good idea of the real value may be had of these organizations which may be depended on.

Notes No. 4, on Organization, Armament and Military Progress, is an exceedingly well put together pamphlet on the organization of the principal European armies, and several of America. It is presumed that these notes are gathered from the reports of military attachés abroad, but in that case it is also certain that they are not always sure of their information. This is positive, since these notes differ, in one or two particulars as regards numbers, from the reports of the Military Information Offices of England and Germany. But the pamphlet taken as a whole is a most valuable one, though it is to be hoped that the various armies it treats of may be given in more detail in future notes. Moreover the quotations of foreign newspapers are as apt to be unreliable when speaking of other than their own armies, as our own. The most valuable part of this pamphlet is the latter, relating to equipment, together with tables of fire-arms used by the various powers. W. R. H.

Manual of Military Field Engineering for the use of Officers and Troops of the Line. Infantry and Cavalry School, Fort Leavenworth, Kansas. 273 pp. Price $1.75.

Of this manual little but praise can be said. Prepared at the Infantry and Cavalry School for use there as a text-book, it will be of general utility to officers of all arms. It covers the ground more fully and satisfactorily than any existing publication of which we have any knowledge.

Taken in connection with other works published by officers connected with the Infantry and Cavalry School, and which have been widely adopted as authorities, this little book indicates that the school is doing a most important work. As Captain Mahan's celebrated works on sea-power were the direct result of his connection with a post-graduate school of the Navy, so it is hoped that our army post-graduate schools may become the centers whence officers may be supplied with the best professional literature. The preparation of professional manuals can probably be done at these schools better than anywhere else. The instructors have ample time for the elaboration of their courses, with the added advantage that the text can have the practical test of actual use in the class-room and of the criticisms of young intelligent officers.

A manual of this sort, like a text-book, is necessarily a compilation. Its value will depend almost as much on what is left out as what is put in. The tendency is too often in the direction of encyclopædic completeness, at the sacrifice of really useful practical information. In a manual for field use certain mechanical features, of little moment in a library book, become here of considerable importance. The manual should be clearly printed on thin strong paper, and durability should be the first aim in the binding. The plates should be numerous, legible, of size of page, and disposed throughout the text instead of at back of book. The index should be very full and the book of a convenient size. The selling price is also a consideration.

The above considerations are fairly met in the book before us. The typography and plates are excellent, and plates are numerous and right where they are needed in body of the book. Readers of Tidball will appreciate this feature. The binding is not up to the standard it should be; although of handsome external appearance, the sewing is so poorly done that a short period of use suffices to loosen the leaves. The paper should also be stronger. The price of the work is such that the purchaser has a right to expect the best workmanship.

The principal chapters are on Intrenchments, Field and Siege Works, Defense of Localities, Bridges, Roads, Demolitions and Camping Expedients. The field-level described in page 18 seems unnecessarily complicated. It would be difficult in the field to lay off the exact lengths. It would be better if made an equilateral triangle similar to the well known miner's level, with which much good has been done in the west. Any convenient length of arm can be used and distance between centers is not considered. After boring the two holes in one arm the holes in the other arms are bored by superposing the first arm on them in succession. Equality of distance between centers is thus assured. Suspend a plumb-line from pin at apex. Mark center line on lower arm. Then when plumb-line coincides with center line, the lower arm is horizontal and arms are in proper relation to each other. Angle lines can be placed as in figure.

In chapter on obstacles it would be well if the relative value of the different obstacles were pointed out. In chapter on cordage the use of important knots is not dwelt upon sufficiently. The really useful knots, such as *bowline*, *clove-hitch*, etc., deserve to be fully described as to manner of making and of use. It is one thing to have a correct figure of a *bowline*, but quite another to have it so described and illustrated that when once learned, it can always be made at once without reference to the book.

The chapters on bridges are especially full and valuable, and the chapter on camp expedients supplies many valuable hints that it would be hard to find in any one book, and doubtless some of them have never been published before.

In the portion treating of field-works, there is a noticeable tendency to stick to old stereotyped forms of parapet, etc. Something of the nature of the *Typical Infantry Redoubt* (in Brackenbury) should be given, as its advantages of volume of fire, low relief, and protection to the garrisons will doubtless cause it, or some similar form of parapet, to be much used in future wars.

E. W. H.

DEPARTMENT OF SCIENTIFIC AND MILITARY INFORMATION.

Revue d'Artillerie.

SEPTEMBER.—The influence of the inclination of the thread of the breech screw upon the strength of the fermeture (continued). Material of the German foot artillery (continued). Automatic adjusting keys for fuzes. The adoption of a smokeless powder for field artillery in Austro-Hungary.

OCTOBER.—Apparatus for convergent pointing, for pointing instruction and familiarization with the rules of fire in field artillery.

NOVEMBER.—Distribution of the deformation in metals submitted to stress. The value of the resistance of the air in cases of high initial velocities.

This article by Zaboudski translated from the *Artilleriskii Journal* deals with the question of high velocities, gives formulas for different velocities and closes with a table of the different ballistic functions for velocities above 600 m. Appended is a note by the translator upon the law of resistance of the air with curves of the same.

Pamphlet giving the composition of the French artillery regiments, November 15, 1894.

DECEMBER.—Schneider's system of field material for the 75mm. quick firing gun. Upon the role of artillery in connection with other arms. The distribution of the deformation in metals subjected to stress.

Revue Militaire de l'Etranger.

SEPTEMBER.—The military organization of the Ottoman Empire (continued). The efficiency of the classes of recruits in Italy. *Bulgaria*—The effectives of the army in 1894. *Germany*—Number of men incorporated in 1893. A telephone line between Potsdam and Berlin. Exercises of troops. Purchase of kitchen utensils of aluminum for the corps troops. Prussian military railway. *Spain*—Reduction of the general staff of the army. *Italy*—Opening of the Parma-Spezia railway, that from Rome to

Viterbe, and that of Asti-Ovada-Gênes. *Russia*—Improvements in the railway systems of the empire. Posts of the railway battalions assigned to the Trans-Caspian district.

OCTOBER.—Corea and the causes of the Chino-Japanese conflict. *England*—Composition of the field army. *Austro-Hungary*—Velocipedists during Austro-Hungarian maneuvers. *Belgium*—The new equipment of the foot soldier. *Spain*—The budgetary effectives of the Spanish army for 1894–5. *Russia*—Maneuvers of Krasnoe Selo in 1894. Distribution of the contingent of 1894 amongst the governments and provinces of the empire. *Sweden*—Maneuvers of the Swedish army.

NOVEMBER.—The recruiting and position of non-commissioned officers in the German army. Military organization of the Ottoman Empire. Changes in the organization of the Prussian general staff. New armament of the Spanish army. Programme of studies at the Higher War School.

DECEMBER.—The German colonial troops of east Africa and their methods of combat. The German regulations for service in the field (of July 20th, 1894). The Chino-Japanese war.

Revue Maritime et Coloniale.

OCTOBER.—Sea currents and their origin. Graphic Ephemerides giving the co-ordinates of the stars for use in navigation. Study of the application of water-tube boilers to naval purposes. Influence of sea power on history. Note upon the scintillation of the stars. Vocabulary of explosives.

NOVEMBER.—Note upon a phenomenon observed during the fire of projectiles of great initial velocity.

This is an analytical discussion of the air waves and motions which precede the projectile and is related to Gossot's study of the question. The subjects of propagation, interference, Mach's wave (particular and general cases) velocity and sonorous centers of the waves, are considered. The writer then proceeds to determine the position of the sonorous center and deduces rather complicated equations to express it. These equations are further considered under the divisions. *Transformation of the expressions for the minimum* and geometric interpretation of the maximum.

Note upon the Khamsin and upon the difference of temperature observed at Obock and Djibouti, during the warm season. Report upon the indicator of the direction of rotation of the engines and fire alarm and water gauge upon the American cruiser

Bennington. Torpedo boats. The meteorological theories of M. Duponchel. Electricity in America. Organization of the Italian naval ministry. Chronicles of the port of Lorient.

Journal de la Marine.

SEPTEMBER 29.—The battle of the Yalu. The launching of the cruiser *Descartes*.

OCTOBER 6.—The naval battle of the Yalu. Servo-electric motor.

This relates to the use of electric motors, suitably arranged, to take the place of small engines on board ship and in shops.

OCTOBER 13.—With respect to the battle of Yalu. Aluminum torpedo boat and aluminum construction in France. Safety buoy with electric beacon.

OCTOBER 20.—An American submarine torpedo boat.

OCTOBER 27.—The armored ship *Brennus*. Electrical manipulation of armored turrets.

NOVEMBER 3.—The naval budget for 1895.

NOVEMBER 10.—The death of Alexander III. Electrical projectors.

NOVEMBER 17.—The marine department and the commission of inquiry. Study upon the Italian navy. A naphtha vapor canoe.

NOVEMBER 24.—The effects of artillery at the naval battle of the Yalu.

DECEMBER 1.—The Japanese war. The river flotilla for Madagascar.

DECEMBER 8.—Constructions for 1895.

DECEMBER 15.—The chamber of deputies. The position of the belligerents in the battle of Yalu.

DECEMBER 22.—New naval incidents. The first-class cruiser *Tourville*.

DECEMBER 29.—The armored ship *Magnificent*. The Bazin "roller boat."

Revue du Génie Militaire.

MAY-JUNE.—The attack and defense of positions, which check and deprive an enemy of a line of communications, situated in territory of medium or average contour. Solution of problems of rolling loads by means of tracings. Experimental investigation upon the determination of temperatures of béton cement while setting. Third note upon the design and measure of carapaces in béton cement. Upon the explosion of mercuric fulminate. Effects of a great mine of dynamite.

JULY–AUGUST.—The engineers in Dahomey in 1892. Upon the work of drawing up reconnaissances in travels of exploration.

SEPTEMBER–OCTOBER.—The origin of the camp of Chalons.

This subject fills the entire number, giving history of the camp with its importance in war, especially that of 1870–71. The author goes into details of the general construction, organization and administration of such camps.

The fortifications of Copenhagen.

La Marine de France.

OCTOBER 1.—The direction of the personnel. Defense of the nation and of the coasts. A naval battle.

La Marine Française.

NOVEMBER 10.—Defense of coasts. The constitution of the French navy (continued). The military objections to the two-seas canal (continued).

NOVEMBER 25.—The defense of coasts. The promotion of officers in the navy. The decrees of the 10th and 11th of November. The Italian mobilization. Upon the Holland sub-marine boat. Review of the merchant marine.

DECEMBER 10.—The postal service of the Mediterranean. Defense of coasts. Electrical manipulation of turrets. River navigation.

DECEMBER 25.—Battle of the Yalu. Lists of the Italian navy. Naval defense act.

Revue du Cercle Militaire.

OCTOBER 7.—The Chino-Japanese War. The war amongst the Moors. The new discipline regulations in the Portuguese Army.

OCTOBER 14—Range finders (continued). Smokeless powders. The infantry combat. The Chino-Japanese war and the battle of Yalu.

OCTOBER 21.—The Lombok expedition. The Berlin War Academy.

OCTOBER 28.—The recruitment of the *officiers de complement* in Italy.

These officers are destined to fill up the lists of the active army in the field and the lists of subalterns in mobile militia.

NOVEMBER 11.—Infantry tactics. The new recruiting project for the Italian army.

NOVEMBER 18.—Study of an English officer upon the "Lava" of the Cossacks. The infantry cadres in France and Spain.

DECEMBER 2.—Disciplinary punishments of the Swiss Army (continued). Search-lights and their use in war (continued). Infantry tactics (continued).

DECEMBER 16.—Reorganization of the Italian army (continued).

DECEMBER 30.—Géraud compass field-glass.

Revue Militaire Universelle.

OCTOBER.—The war of secession. Technical considerations upon the transformation of modern armaments and upon their employment in combat. The intellectual work of the officer. The bodies of officers of the principal armies of Europe.

NOVEMBER.—Marshal Bosquet. The corps of officers of the principal European armies (continued). The Morvan (continued). The Sardinian expedition and the campaign of Corsica, 1792–94 (continued). Note upon the military slaughter-house of Verdun (continued).

DECEMBER.—The question of Touat.

Revue d'Infanterie.

OCTOBER.—History of infantry in France (continued). Health of the European troops in the Colonies. Lines of concentration of the armies of the triple alliance. Service on a campaign of a company of infantry (continued). A campaign of the Portuguese in Guinea.

NOVEMBER–DECEMBER.—The Chino-Japanese war. The question of fire.

Le Génie Civil.

OCTOBER 13.—The question of coal dust before the English Commission. Safety apparatus for the instantaneous stopping of motors from a distance. Dredging by means of compressed air.

OCTOBER 27.—Manufacture and use of gas as a motive force.

NOVEMBER 10.—Electro-automatic clock regulation. The struggle against diphtheria.

NOVEMBER 17.—Lighting and transmission of electrical energy.

NOVEMBER 24.—Sounding by electricity in the navy. The Dymcoff system of articulated boats.

DECEMBER 8.—Reservoir projects of the Nile. Micrographic analysis of steels. New third-class torpedo boats for the U. S. Navy. An engine consuming explosives.

DECEMBER 15.—Launching of the *Descartes*. Vertical instability of gas balloons.

DECEMBER 22.—Dredgers for the Russian military ports of the Baltic. The Congo Free State at the exposition of Anvers. The gyroscopic horizon of Rear Admiral Fleurais and its new modifications. Gas in the United States. Approximate formula for the calculation of a tube under flexure. Quadruple expansion of marine engines. The new strategic railways of the mountains of the Black Forest.

L'Avenir Militaire.

OCTOBER 2—The equivocal effectives. Soldiers of one year. Corea.

OCTOBER 5.—Bread for soldiers. Army maneuvers. The reenlistment of soldiers. The campaign of 1815. The campaign of Dahomey.

OCTOBER 9.—Strategy of the future. Germans and Frenchmen. Our naval forces in the extreme Orient.

OCTOBER 12.—The effectives of the French army and the German army on the frontier.

OCTOBER 16.—Article 5 of the recruiting law. The effectives.

OCTOBER 19.—The war budget of 1895. Marching discipline. Service of military prisons.

OCTOBER 23.—The visibility of the colors.

OCTOBER 26.—Marshal Bosquet. Recruiting sergeants. Status of naval constructions.

OCTOBER 30.—The expiration of the 8th of November.

A discussion as to the expediency of discharging 37,000 men of the classes of 1891 and 1892 by virtue of circulars already issued in compliance with the new law.

The incorporation of the contingent.

NOVEMBER 2.—The question of the non-commissioned officers camping with aluminum mess plate. The army in parliament.

NOVEMBER 6.—Military memoirs and history. Madagascar. The army under the Revolution.

NOVEMBER 16.—The trial of Captain Dreyfus.

NOVEMBER 20.—The Madagascar expedition. The renewal of the material of field artillery. School of instruction for reserve officers.

NOVEMBER 23.—The future situation of infantry. Difficulties of the expedition to Madagascar. Again the soldier's ration. Note upon the fire instruction for the 12th Corps.

DECEMBER 4.—Our skeleton batteries. Occupation of Madagascar. Transportation by land to Madagascar. The river flotilla for Madagascar.

DECEMBER 7.—Cavalry for all purposes. Non-commissioned officers in Germany.

DECEMBER 14.—General Mercier. Military slaughter-houses.

DECEMBER 18.—The court martial of December 19th. The responsibilities of 1870.

DECEMBER 21.—Anglo-Italian alliance in the Mediterranean. Article 84 of the law of recruiting.

DECEMBER 25.—The two years' service. The Colonial army. Re-organization of land artillery.

Mémoires et Comptes rendus de Travaux des Ingénieurs Civils.

AUGUST.—Application of photography to topography.

This article forms a long and exhaustive treatise of the subject, going into the various methods of photogrammetry with the methods and apparatus used by different men.

The writer considers the problems analytically and illustrates them graphically.

SEPTEMBER.—Rapid firing artillery in France.

A sixty page article describing in detail the Canet system of rapid firing guns with data obtained from recent experiments.

Revue de l'Armée belge.

JULY–AUGUST.—The Russian maritime canal joining the Baltic with the Black Sea. The exterior defense of strong places. The war material of the Cockerill Company. Upon the revision of our artillery service upon the battle field. The dress and equipment of the foot soldier. Military Art at the exposition of Anvers. Permanent fortification and siege warfare.

SEPTEMBER-OCTOBER.—Combat in retreat. The use of bored mines with elongated charges in siege warfare.

The article treats of the subterranean effects of elongated charges, effect upon untamped branches, tamped branches, exterior effects, and analytical treatment of a number of problems under each condition.

The Germano-Russian and Austro-Russian frontiers. War material of the Cockerill Company. Considerations on the infantry gun.

Revue Militaire Suisse.

SEPTEMBER—The maneuvers of the IVth army corps (continued). The Count de Paris. The Association of officers of the Swiss Confederation.

OCTOBER.—The Corean war.

NOVEMBER.—Federal and cantonal fire. The role of chance in the distribution of hits. Health and food of the horse in the field. The Society of officers.

Memorial de Artilleria.

SEPTEMBER.—Investigation upon a special plan of hollow projectiles. Extract from the regulation memoir upon the practical exercises of 1893 by the Seventh Mounted Regiment. Tests of smokeless powder. The gun factory of Trubia. The artillery museum.

OCTOBER.—Force of explosives.

This article, under the head of "Products of the Explosion," treats of (1) simple explosives of complete combustion, (2) simple explosives of incomplete combustion, giving examples of each, with their chemical reactions, volumes of gases produced, and conclusions.

Notes on the manufacture of metallic cartridges. The Gun Factory of Trubia. Politico-military monograph on Mindanao (continued). Upon the recent successes of Melilla.

NOVEMBER.—"Products of the Explosion" (continued).

(1) Products of explosion at atmospheric pressure. *Part II.* Calculations on the subjects of pressure, specific force and covolumen. (2) Temperature of explosion. (3) Applications.

Notes on the fabrication of metallic gun cartridges. The

Siden apparatus for economizing the strength of horses in harness.

Revista Cientifico Militar.

SEPTEMBER 1.—Modifications in the French regulations for field service. History of partisan war (continued).

SEPTEMBER 15.—The health of the soldier. The deadly action of the Italian gun, model 1891.

OCTOBER 1.—Study upon the infantry armament (continued). Test march of speed and endurance, made by the regiment of Cazadores of Talavera.

NOVEMBER 1.—Upon the division of territory into military districts.

NOVEMBER 15.—Electric energy and its applications.

DECEMBER 15.—Military maneuvers and military health. Instruction for field fortifications.

Revista General de Marina.

OCTOBER.—War ships. The craze for high velocities. The English naval maneuvers in 1894. Comments on naval technology.

NOVEMBER.—Units in the electro-magnetic system. Voyage executed by the Cruiser *Don Juan de Austria.* Naval education. Union, science and prudence.

DECEMBER.—Adjustment of needles by observations on the horizontal component. Naval education. Aid to the wounded and shipwrecked in maritime wars. The combat of the Yalu. Floating beacons and luminous buoys.

Boletin del Centro Naval.

JUNE.—Project for a school-ship. Chapter I of the organic regulations of the naval school. China and Japan. The incandescent lamp.

AUGUST AND SEPTEMBER.—Naval maneuvers in 1894. A few historical points upon modern naval war. The corps of assimilated officers of the navy. Reorganization of the Italian naval academy. Preliminary considerations for the text of maritime geography in general, and in particularly for the Argentine Republic.

Circulo Naval, Revista de Marina.

AUGUST.—Twenty years of our military marine (continued). Official tests of some of our warships. Modern naval tactics.

SEPTEMBER.—Study upon the development of the navigating officer and naval instructor.

Revista do Exercito e da Armada.

SEPTEMBER.—Historical study of the campaign of Marshal Soult in Portugal (continued). The exercises in marching formations (continued).

OCTOBER.—On garrison artillery and the future re-organization of the army. A few comments on the last campaign in Guinea. On the shops of the Cockerill Company in Seraing. Problems of applied tactics.

NOVEMBER.—Autumn maneuvers of 1894. The navy. Portugese army.

DECEMBER.—Study on combat tactics.

Revista Militar.

SEPTEMBER 30.—The Count de Paris. A practical cavalry school. The Kionga.

OCTOBER 15.—The colonial question. Infantry and field-intrenchments. Promotion by seniority and scholarship.

NOVEMBER 15.—The army and the colonies.

NOVEMBER 30.—The army beyond seas.

DECEMBER 31.—Equitation for infantry officers.

Revista da Commissao Technica Militar Consultiva.

JULY.—Dictionary of explosives. The future field artillery. Defense of Santos. Artillery of large caliber. Experiments with the pneumatic gun.

AUGUST.—Dictionary of explosives. The army of Uruguay. Carrier pigeons in Brazil. Artillery of great caliber.

Rivista di Artiglieria e Genio.

SEPTEMBER.—Instruction of the recruit in horsemanship in the field artillery battery. Study of the problem of resistance of materials. Coast fortifications. Upon the uniform of the field cannoneer. The Pfund-Schmid land torpedo. The new Russian gun for horse artillery. The Marr telephone.

OCTOBER.—Indirect fire of infantry. The action of artillery in fortress warfare. Foot artillery with teams in Germany. Exercises in attack and defense around Paris. 12 mm. rapid-firing field mortar. Researches upon explosives. The Buffington-Crozier disappearing carriage. Comparative experiments on steel plates.

NOVEMBER.—Fortress warfare: the action of artillery. Upon the density of the air. Study upon a quadrant with accurate level. The employment of artillery upon the battle field, in France, Germany, Austria and Russia. Recent Armstrong field artillery. Armored field turret. Rapid-firing 12 cm. cannon of Bofors establishment. Data upon the recent infantry armament of various states. Researches upon modern explosives. Great initial velocities. The temperature of steel during immersion in a lead-bath. A compass field-glass.

DECEMBER.—Upon the preservation of the material in the regiments of field artillery. Two important considerations with respect to siege artillery. The employment of fortifications by the engineer troops upon the battle field and in the lines of investment. An approximate method of determining the centers of gravity of guns and projectiles. Application of meteorology to the military art. Portable accumulators.

Archiv fuer die Artillerie und Ingenieure Offiziere.

SEPTEMBER-OCTOBER.—Study upon shrapnel-firing of field artillery (Rohne).

NOVEMBER-DECEMBER.—The service of the Russian fortress artillery for the defense of fortresses. The hyperbola as the ballistic curve. A new construction of a wagon-axle. A new quick firing breech mechanism—Austro-Hungary.

Marine Rundschau.

OCTOBER.—The influence of the arrangement of the guns upon the Anglo-American sea-warfare, 1812-13 (continued). The harbors of East Asia from a sanitary point of view at certain seasons of the year, and which should be avoided as most unhealthy (continued). The transport ship *Ida*.

NOVEMBER.—Account of the tests of H. M. S. *Kurfürst Fredrich Wilhelm*. Extract from the reports of H. M. Ships to the Navy

Department. Report of the commander of H. M. S. *Iltis*, corvette, Count von Bandissin, upon the events in Corea (continued).

DECEMBER.—Triangulations by H. M. S. *Möwe* in East Africa.

Jahrbuecher fuer die deutsche Armee und Marine.

OCTOBER.—The Russian cavalry and their employment of cavalry detachments in the Balkan campaign of 1877-8, and the Russian cavalry division in future wars (continued). The drill regulations of the First Republic and the First Empire (continued). The more rigid and methodical development of infantrymen with regard to the principles of rational gymnastics. How can we in a proper degree test the scope of our fire tactics in time of peace? The influence of wars upon the daily wants of the people. Small historical notes upon army matters. Review of military literature.

NOVEMBER.—The Prussian "Leonidas." Exercises of the German navy. Royal Italian army and navy in the first half year of 1894. Austrian views and propositions with respect to the present state of permanent fortifications. Upon the history of cavalry requirements. The Russian law upon officers' duels. At the Centennial jubilee of the Bavarian military service medal.

DECEMBER.—The starting point of the present education and development of our infantry. Improvised fortifications. Firearms. Guns. Quick-firing guns. Armor.

Militaer Wochenblatt.

No. 84.—Count von Wartensleben. Principles of horse training and horsemanship (continued).

No. 85.—Attack of two cavalry divisions against infantry and artillery. Africa—from a private letter. Notes from war archives.

No. 86.—Preparations for colonial service in Africa. Advice on the equipment of the European. The French "foreign legion." Infantry and cavalry school in Portugal. Our infantry drill under Frederick William I (continued). The American cavalry.

No. 87.—Attack of regular troops upon natives. French thoughts upon the course of the Turks in future wars. The service of the military spy in peace and war.

No. 88.—Attack on an African fortification. The organization of the volunteer Hospital Corps for the German army.

No. 89.—The new colors. Report of the French army complement in the year 1893. Remarks upon the *lava* of the Cossacks.

No. 90.—The combat with Witbooi. The new organization of the French artillery. War marches and camp service in Africa.

No. 91.—Retrospect upon the completion of the Emperor's maneuvers, 1894 (continued). New French regulations with reference to the renewal of the ammunition supply. Transformation of the Russian school of infantry (Constantine's) into an artillery school. Pursuit, defense and retreat in Africa.

No. 92.—Field-pioneer service in Africa.

No. 93.—Upon general tactics and the co-operation of the arms. The development of black soldiers.

No. 94.—Result of the French horse-training in 1894. The management of African troops. The arming, equipment and care of the same. Observations upon the artillery maneuvers of 1894.

No. 96.—On the battle of Beaune la Rolande.

No. 97.—Upon the last combats with Hendrick Witbooi. How can the military or civil officer obtain knowledge in the colonies?

No. 98.—The life of Field Marshal Count Reidhardt v. Gneisenau. The French grand maneuvers.

No. 99.—Infantry training. Scouts.

No. 101.—Africa: important rules for living. Once more "The shortest way to Constantinople." Retrospect on the completion of the imperial maneuvers of 1894 (continued).

No. 102.—Questions on cavalry life. Reorganization of the Russian sapper troops. The battle of New Orleans (continued).

No. 103.—Mobilization of the Russian army (continued).

No. 104.—The armor question on the Yalu.

No. 105.—The *Bocche di Cattaro* (continued).

No. 106.—The combat in the woods at Poupry, December 2nd, 1870.

No. 107.—The action of field guns (continued). The riding school.

No. 108.—Artillery notes.

Beiheft zum Militaer-Wochenblatt.

PARTS 9-10.—The campaign through north Germany in 1809 of Duke Frederick William of Braunschweig. Some thoughts by Major v. Roessler.

PART 11.—George Derfflinger's life.

Allgemeine Militar Zeitung.

No. 70.—The history of the November days of Frankfort in 1813 (continued). New uniforms and weapons (continued).

No. 71.—Napoleon's passage of the Niemen in 1812.

No. 72.—The royal war academy of Berlin once more. The effect of the new infantry projectile upon men's bodies. The Russian military posts in the Pamir.

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THE RESISTANCE OF THE AIR TO THE MOTION OF OBLONG PROJECTILES AS INFLUENCED BY THE SHAPE OF THE HEAD.*

BY JAMES M. INGALLS, CAPTAIN, FIRST ARTILLERY, U. S. A.

It is universally admitted as the result of many experiments, that a solid body moving in a medium either fluid or gaseous, experiences a resistance proportional to the area which it presents to the medium normal to the direction of motion. The resistance thus encountered is of two kinds which, being independent of each other, may be considered separately.

1. The force necessary to overcome the cohesion of the molecules of the medium, to which may be added the friction of the particles of the medium against the surface of the body moving through them. This resistance may be regarded as independent of the velocity of the body.

2. The resistance due to the motion impressed upon the molecules of the medium. This resistance is evidently a function of the velocity of the moving body.

One or the other of these resistances will predominate according to the nature of the medium. In very dense media the total resistance depends greatly upon the forces of cohesion and

* Essay presented to the Board of Examination for Promotion, and published by authority of the War Department.

friction; while in the air the resistance due to these forces is nearly insensible—at least for the smooth, symmetrically shaped modern projectile—even for the high velocities employed in gunnery.

The following, which is the ordinary method of calculating the resistance of the air to the motion of a projectile, supposes the particles of air against which the projectile impinges to be at rest, and takes no account of the reaction of the molecules upon each other, nor of the pressure upon the rear part of the projectile of the in-rushing air; in other words both the atmosphere and the projectile are assumed to be non-elastic. The results obtained may not, therefore, be quantitatively correct; but as our object in this essay is simply to compare the resistances sustained by projectiles having differently shaped heads (but in other respects entirely similar), this is no real objection to the formulas which will be deduced.

It is evident that if a body move in a resisting medium (fluid or gaseous) the particles of the fluid must be displaced to allow the body to pass through, and hence momentum will be communicated to them from the moving body. From the assumed equality of the momenta thus lost and gained, Newton deduced the law of the square of the velocity to express the resistance of the air to the motion of a body moving through it.

Let a moving body present to the mass of air against which it impinges and which is supposed to be at rest, a plane surface whose area is S and which is normal to the direction of motion.

Let w be the weight of the moving body, v the velocity with which it impinges against the mass of air, δ the weight of a unit volume of air, and g the acceleration of gravity. The plane surface S will describe in an element of time dt, a path $v\,dt$ and displace a volume of air $Sv\,dt$. Therefore the mass of air put in motion during the element of time is $\frac{\delta}{g} Sv\,dt$. If we consider both the moving body and the air non-elastic, this mass of air will move during the element of time with the velocity v of the impinging body and its momentum will be $\frac{\delta}{g} Sv^2\,dt$. This momentum has evidently been taken from the moving body whose velocity has thereby been decreased by dv. Therefore equating the momenta lost and gained we have

$$-\frac{w}{g}\,dv = \frac{\delta}{g}\,S v^2\,dt$$

or

$$-\frac{w}{g}\,\frac{dv}{dt} = \frac{\delta}{g}\,S v^2.$$

The first member of this last equation is the momentum decrement of the moving body due to the resistance of the air, and is therefore a measure of this resistance. If we call the normal resistance of the air against the plane ρ_n, we shall have

$$\rho_n = -\frac{w}{g}\,\frac{dv}{dt} = \frac{\delta}{g}\,S v^2, \qquad (1)$$

whence we have for the acceleration (retardation in this case)

$$\frac{g}{w}\,\rho_n = -\frac{dv}{dt} = \frac{\delta}{w}\,S v^2. \qquad (2)$$

Since many circumstances accompanying the motion of a body in air have been omitted in deducing equation (1), we must, in order to obtain the true resistance, multiply the second member by a coefficient to be determined by experiment. Calling the coefficient of resistance k, we have

$$\rho_n = k\,\frac{\delta}{g}\,S v^2. \qquad (3)$$

The resistance of the air, therefore, to the motion of a body presenting a plane surface normal to the direction of motion is, according to equation (3), proportional to the area of the plane surface, to the density of the air and to the square of the body's velocity. All these deductions of theory have been abundantly verified by experiment, at least for low velocities. It may be remarked that if we consider the body and air as perfectly elastic, the theory of the impact of elastic bodies would double the above expression for the normal resistance. But as this would simply halve the coefficient of resistance k, we prefer to leave the expression as it is.

Illustration: The weight of a cubic foot of dry air (δ) at a temperature of 62° F. and a height of barometer of 30 inches is

534.22 grains, and if we make $g = 32.19$ (its value in England), equation (3) becomes

$$\rho_n = 0.00237\, k\, S\, v^2,$$

in which ρ_n is expressed in pounds per square foot. Sir Henry James, R. E. in his work on meteorology, gives the following formula for the direct pressure of the wind upon a plane surface:

$$P = 0.00232\, S\, v^2.$$

Professor Unwin adopts this expression in his article "Windmill" in the ninth edition of the Encyclopædia Britannica. As both these authorities hold that the pressure upon a plane surface moving normally to the direction of motion in air at rest, is the same as if the plane were at rest and the air impinged against it, it follows from the above expression that for the normal motion of a plane in air k is practically unity, at least for wind velocities. Its values for the velocities employed in gunnery will be considered further on.

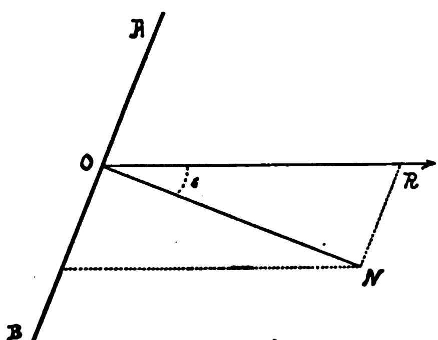

Fig. 1.

If the plane AB, whose area is S be oblique to the direction of motion OR, let ε be the angle which the normal to the plane ON makes with that direction, and resolve the velocity v in the direction of motion OR, into the components $v \cos \varepsilon$ normal, and $v \sin \varepsilon$ parallel to AB. This latter component having no effect upon the resistance (neglecting friction) we have for the normal resistance to the oblique plane AB the expression

$$\rho_n = k \frac{\delta}{g} S v^2 \cos^2 \varepsilon. \qquad (4)$$

In this equation ρ_n is manifestly the resultant pressure between the air and the plane, and the component of this normal pressure in the direction of motion OR is the resistance to the motion of the plane in the direction of motion. Calling this resistance ρ we have

$$\rho = k \frac{\delta}{g} S v^2 \cos^3 \varepsilon, \qquad (5)$$

that is the the theoretical resistance to the motion of an oblique plane is proportional to the product of the projection of the plane $S \cos \varepsilon$, in the direction of motion into the square of the normal projection of the velocity. Equation (5) is the expression usually given for the resistance of the air to the motion of an oblique plane. It does not agree very well with experiment, as it makes the resistance too small except at or near the limits where $\varepsilon = 0°$ or $90°$. We must therefore look to empirical formulas based upon experiment.

In the years 1786 and 1787, Hutton made many elaborate experiments with Robins' whirling machine for the purpose of measuring the resistance of the air to the motion of a plane, set at various angles with the direction of motion from 0° to 90°. He showed conclusively that the resistances for the low velocities which he employed are not proportional to any constant power of $\cos \varepsilon$, but that the exponent of the power must be a variable which is unity (or nearly so) when $\varepsilon = 30°$, greater than one but less than two when $\varepsilon > 30°$, and between one and zero when $\varepsilon < 30°$. Following out this exponential idea Hutton finally deduced the following empirical expression for ρ.*

$$\rho = k \frac{\delta}{g} S v^2 (\cos \varepsilon)^{1.842 \sin \varepsilon}.$$

Colonel Duchemin of the French Artillery, in an elaborate, and for the time exhaustive memoir entitled *Recherches expérimentales sur les lois de la résistance des fluides*,† deduced the following empirical formula, much simpler than Hutton's, but giving nearly the same values for oblique resistance, viz:

$$\rho = k \frac{\delta}{g} S v^2 \frac{2 \cos^2 \varepsilon}{1 + \cos^2 \varepsilon}. \qquad (6))$$

This formula was based upon the experiments of Vince, Hutton and Thibault, and as it satisfies not only these experiments but later experiments also, rather better than any other formula that has been proposed,‡ we will adopt it in what follows.

* *Tracts* on Mathematical and Philosophical subjects, London, 1812. Tract 36.
† Published in the *Mémorial de l'Artillerie* for 1842, pp. 65-379.
‡ See article "*Hydromechanics*" by Professor Unwin, *Enc. Brit.* Vol. xii, p. 518.

Resistance of the air upon a surface of revolution whose axis of figure coincides with the direction of motion—Let $A\,D\,B$, Fig. 2, be the generating curve of a surface of revolution which we will suppose moves in a resisting medium in the direction of its axis $O\,A$. If $m\,m'\,m'' = d\,s$, be an element of the surface whose normal $N\,m$ is inclined to the direction of motion by the angle $N\,m\,v = \varepsilon$, it will, by Duchemin's formula, suffer a resistance in the direction of motion $m\,v$ equal to

$$k\frac{\delta}{g}(d\,S)\,v^2\frac{2\cos^2\varepsilon}{1+\cos^2\varepsilon}=k\frac{\delta}{g}(d\,S)\,v^2\frac{2}{1+\sec^2\varepsilon}=k\frac{\delta}{g}(d\,S)\,v^2\frac{1}{1+\frac{1}{2}\tan^2\varepsilon}.$$

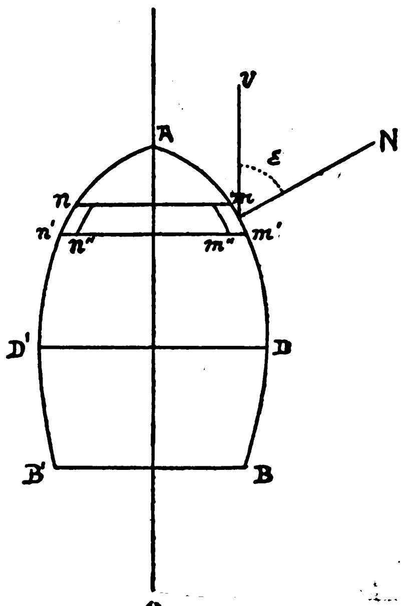

Fig. 2.

The other component of the normal resistance, perpendicular to $O\,A$, will evidently be neutralized by an equal and contrary component acting upon the elementary surface $n\,n'\,n''$, situated in the same meridional section $m\,m'\,m''$ and making the same angle with the direction of motion. It is therefore only necessary to consider the component in the direction of motion given above. It is evident that expressions identical with this are applicable to every element of the zone $m\,m'\,n\,n'$ described by the revolution of the element $m\,m'$ about the axis of figure. We may therefore extend the expression so as to include the entire elementary zone by substituting its area for $d\,S$. If we take $O\,A$ for the axis of X, this area will be $2\,\pi\,y\,d\,s$, $d\,s$ being an element of the generating curve. Therefore the resistance to any elementary zone will be expressed by

$$2\,\pi\,k\frac{\delta}{g}\,v^2\frac{y\,d\,s}{1+\frac{1}{2}\tan^2\varepsilon}.$$

Since ε is the angle which the normal to the curve makes with the axis of X we have

$$\tan^2 \varepsilon = \frac{dx^2}{dy^2},$$

and we therefore have for the resistance upon the surface of revolution between the limits 0 and x.

$$\rho = 2\pi k \frac{\delta}{g} v^2 \int_0^x \frac{y\,ds}{1 + \frac{1}{2}\frac{dx^2}{dy^2}}. \qquad (7)$$

As the heads of all service projectiles are solids of revolution, this last equation will serve to determine the relative pressures sustained by projectiles having differently shaped heads, supposing their axes to coincide with the direction of motion at each instant, and further, that they are moving with the same, or nearly the same velocity. In applying the formula, y and ds will be eliminated by means of the equation to the generating curve. If the origin of coordinates be placed at the intersection of the axis OA with the diameter DD' of the circumscribing cylinder, the limits of integration for the entire head will be $x = 0$ and $x = l$, the length of the head. For this latter value of x, y will be zero. It is evident that at the circumference of contact of the circumscribing cylinder with the surface of revolution, $\varepsilon = 90°$, and that there can be no resistance to the rear of this circumference. As with all ogival headed projectiles the cylindrical surface of the body is tangent to the surface of the head, we have $\varepsilon = 90°$ when $x = 0$, that is, at the beginning of integration. For some other heads, for example, conical and parabaloidal heads (which will be considered further on) ε is less than 90° at the junction of the head with the cylindrical body of the projectile. But in all cases we may determine the value of ε at any point of the head by the equation

$$\tan \varepsilon = \frac{dx}{dy}. \qquad (8)$$

That practically the entire resistance which the air opposes to a projectile is applied to the head, is apparent from the fact that the air by the rapid motion of translation of the projectile through it, is greatly condensed around the head, which it closely embraces with a pressure of several pounds per square inch, and is thrown off from the head in stream lines which unite again in rear of the projectile. This is beautifully shown in the photographs of projectiles moving with high velocities which were recently taken by C. V. Boys, F. R. S., in England. In these photographs the condensed air is plainly visible, the stream lines emerging from the head taking the form of hyperboloids of revolution. These facts show the great importance of having the heads of projectiles as smooth and frictionless as possible. Rust or irregularities of any kind upon the surface of the head increases the friction greatly, and therefore the resistance which the projectile encounters in its flight. It would certainly be a useless refinement to take account of the density of the air at target practice, while using projectiles which are covered with rust.

We will now apply equation (7) to heads of various forms which admit of solution and make comparison of the results,

Application to Projectiles having Ogival Heads.

An ogival head is one-half the solid of revolution generated by revolving a segment of a circle ABD, Fig. 3, about the chord AD. The chord AD is then the axis of the head, and prolonged is also the axis of the projectile of which the head BDE forms a part. BE is the diameter of the base of the ogival head, and may also be taken as the caliber d of the bore of the gun for which the projectile is designed. If n is the ratio of BC to BE the head is said to be struck with a radius of n calibers. We therefore have $BC = nd = 2nR$, R being the radius of the projectile.

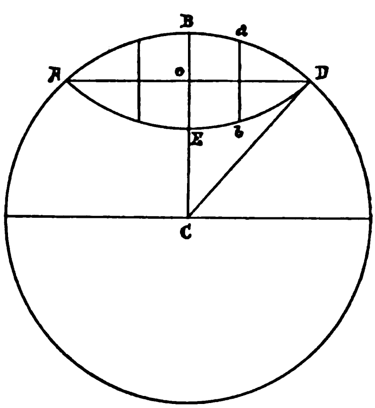

Fig. 3.

If the origin of coordinates be at the centre of the circle C, the equation of the generating arc BD is

$$y^2 = r^2 - x^2 = 4\,n^2 R^2 - x^2.$$

If we change the origin to O whose coördinates are $y' = OC = BC - OB = (2n - 1)R$ and $x' = 0$, we shall have for the equation of the generating arc

$$(y + (2n-1)R)^2 = 4n^2R^2 - x^2,$$

or

$$y = \sqrt{4n^2R^2 - x^2} - (2n-1)R. \tag{9}$$

If in equation (9) we make $y = 0$, the resulting value of x will be the length of the complete head OD. We have therefore

$$l = R\sqrt{4n - 1}. \tag{10}$$

It is sometimes desirable to know the meridional angle of an ogival head, that is, the angle BCD. Calling this angle γ we have

$$\tan \gamma = \frac{OD}{OC} = \frac{\sqrt{4n-1}}{2n-1}. \tag{11}$$

Differentiating equation (9) we find

$$\frac{dy}{dx} = -\frac{x}{\sqrt{(4n^2R^2 - x^2)}}$$

in which if we make $x = l = R\sqrt{4n-1}$ and change the sign, we shall have the tangent of half the angle at the point of the projectile. Calling the angle at the point a we find

$$\tan \tfrac{1}{2} a = \frac{\sqrt{4n-1}}{2n-1} \tag{12}$$

$$\therefore a = 2\gamma.$$

Since $ds = dx\sqrt{1 + \frac{dy^2}{dx^2}}$, we easily find

$$\int \frac{y\,ds}{1 + \frac{1}{2}\frac{dx^2}{dy^2}} = 4nR\int \frac{x^2\,dx}{4n^2R^2 + x^2}$$

$$-4n(2n-1)R^2 \int \frac{x^2\,dx}{(4n^2R^2 + x^2)\sqrt{(4n^2R^2 - x^2)}}.$$

The first integral in the second member is reduced by division to

$$4nR\int\left(dx - \frac{4n^2R^2\,dx}{4n^2R^2+x^2}\right) = 4nRx - 8n^2R^2\tan^{-1}\left(\frac{x}{2nR}\right).$$

In the second integral put

$$\frac{4n^2R^2-x^2}{x^2} = z^2,$$

which reduces it to

$$-\int\frac{x^2\,dx}{(4n^2R^2+x^2)\sqrt{(4n^2R^2-x^2)}} = \int\frac{dz}{(1+z^2)\,(2+z^2)} =$$

$$\int\frac{dz}{1+z^2} - \int\frac{dz}{2+z^2} = \tan^{-1}z - \frac{1}{\sqrt{2}}\tan^{-1}\frac{z}{\sqrt{2}} =$$

$$\tan^{-1}\left(\frac{(4n^2R^2-x^2)^{\frac{1}{2}}}{x}\right) - \frac{1}{\sqrt{2}}\tan^{-1}\left(\frac{(4n^2R^2-x^2)^{\frac{1}{2}}}{x\sqrt{2}}\right)$$

$$\therefore \int\frac{y\,ds}{1+\frac{1}{2}\frac{dx^2}{dy^2}} = 4nRx - 8n^2R^2\tan^{-1}\left(\frac{x}{2nR}\right)$$

$$+ 4n(2n-1)R^2\tan^{-1}\left(\frac{(4n^2R^2-x^2)^{\frac{1}{2}}}{x}\right)$$

$$- \frac{4n(2n-1)R^2}{\sqrt{2}}\tan^{-1}\left(\frac{(4n^2R^2-x^2)^{\frac{1}{2}}}{x\sqrt{2}}\right).$$

When $x = 0$ the integral reduces to

$$n(2n-1)(2-\sqrt{2})\,\pi R^2.$$

We therefore have for the resistance upon any surface $BEab$ bounded by the circumferential intersections of the normal planes BE and ba whose distance apart is x, the expression

$$\rho = 2\pi k\frac{\delta}{g}v^2\left\{4nRx - 8n^2R^2\tan^{-1}\left(\frac{x}{2nR}\right),\right.$$

$$+ 4n(2n-1)R^2\tan^{-1}\left(\frac{(4n^2R^2-x^2)^{\frac{1}{2}}}{x}\right)$$

$$- \frac{4n(2n-1)R^2}{\sqrt{2}}\tan^{-1}\left(\frac{(4n^2R^2-x^2)^{\frac{1}{2}}}{x\sqrt{2}}\right)$$

$$-n(2n-1)(2-\sqrt{2})\pi h'^2 \Big\}$$

If we integrate between the limits $x=0$ and $x=l=R\sqrt{4n-1}$ that is, take the entire surface of the head, we shall have for the total resistance, after making some easy but tedious reductions,

$$\rho = 2k\pi R^2 \frac{\delta}{g} v^2 \Big\{ 4n\sqrt{4n-1} - 8n^2 \tan^{-1}\left(\frac{\sqrt{4n-1}}{2n}\right)$$

$$+4n(2n-1)\tan^{-1}\left(\frac{2n-1}{\sqrt{4n-1}}\right) - \frac{4n(2n-1)}{\sqrt{2}}\tan^{-1}\left(\frac{2n-1}{\sqrt{2}\sqrt{4n-1}}\right)$$

$$-n(2n-1)(2-\sqrt{2})\pi \Big\}$$

It is evident that πR^2 is the area of the base of the head where it joins the cylindrical part of the projectile. Calling this area S, and representing twice the expression within the braces by $F(n)$, we have for the entire resistance to an ogival head

$$\rho = k\frac{\delta}{g} S F(n) v^2. \qquad (13)$$

In what precedes no account has been taken of the action of the particles of air on each other, nor of the friction of the particles against the surface of the head, nor of the condensation of the air in front of the projectile. Moreover as the projectile moves forward it leaves a partial or complete vacuum behind it which the particles of air rush into and occupy, doubtless imparting some momentum to the projectile. For these reasons and for others not mentioned it is very difficult, to say the least, to determine the value of k theoretically. But having once found its value by suitable experiments for a particular velocity (or range of velocity) and form of head, we may make use of equation (13) to determine the resistance for a projectile having a different head and moving with the same, or nearly the same velocity, within certain limits. And where experiments have also been made with this second head, this procedure will enable us to ascertain the degree of confidence we may place in the expression for $F(n)$. The following table gives the values of $F(n)$ for ogival heads of different lengths, varying from one-half to two and one-half calibers. When $n=\frac{1}{2}$ the generating curve

BD becomes a quarter-circle and the head a hemisphere. In this case the expression for $F(n)$ reduces to

$$F(\tfrac{1}{2}) = 4 - \pi.$$

When $n = 1$, $F(n)$ becomes

$$F(1) = 2\left\{4\sqrt{3} - 8\tan^{-1}\left(\frac{\sqrt{3}}{2}\right) + 4\tan^{-1}\left(\frac{1}{\sqrt{3}}\right) - \frac{4}{\sqrt{2}}\tan^{-1}\left(\frac{1}{\sqrt{6}}\right) - 1.840303,\right\}$$

and so on for other values of n.

Table.

n	$F(n)$	Length of head in calibers.	Angle at point.		
0.5	0.8584	0.5000	180°	00′	00″
1.0	.7524	0.8660	120°	00′	00″
1.5	.6752	1.1180	96	22	46
2.0	.6171	1.3229	82	49	9
2.5	.5715	1.5000	73	44	23

Bashforth's Experiments.—Bashforth's experiments prove that for the velocities employed in gunnery exceeding about 1330 f.s., the resistance of the air to the motion of both oblong and spherical projectiles is sensibly proportional to the square of the velocity, and a discussion of the published results of his experiments has shown that within the above limits the resistance to elongated projectiles having ogival heads struck with radii of one and a half calibers, may be expressed by the equation

$$\rho = \frac{A}{g} d^2 v^2,$$

in which d is the diameter of the projectile in inches, g the acceleration of gravity (33.19 f.s.) and $\log A = 6.1525284 - 10$. Whence

$$\rho = 0.0000044137\, d^2 v^2.$$

If now we employ equation (13) to compute the numerical value of ρ we must put $S = \frac{\pi d^2}{4}$ if d is in feet; but if we take d in inches as above we must take $S = \frac{\pi d^2}{576}$, since our units are the foot and pound. Also $\delta = 534.22$ grains $= \frac{534.22}{7000}$ pounds; $g = 32.19$ f.s. and for the heads that Bashforth experimented with $n = 1.5$ and $F(n) = 0.6752$. We therefore have

$$\rho = \frac{534.22 \times 0.6752\, \pi}{576 \times 7000 \times 32.19} = 0.0000087309\, k\, d^2 v^2.$$

Comparing this value of ρ with the experimental value given above, we find for high velocities

$$k = 0.50553.$$

Verification.—It seems reasonable that for two similar oblong projectiles of the same caliber, or of different calibers, varying only in the form of the head and moving with the same velocity, the values of k should be nearly the same for both, so that if ρ_1 and $F(n_1)$ refer to one of the projectiles and ρ_2 and $F(n_2)$ to the other we should have, approximately, the relation

$$\frac{\rho_1}{\rho_2} = \frac{F(n_1)}{F(n_2)}$$

or

$$\rho_2 = \frac{F(n_2)}{F(n_1)} \rho_1. \qquad (14)$$

As an example of verification take Bashforth's experimental value of ρ_1 already given for $n_1 = 1.5$, and by means of equation (14) compute ρ_2 when $n_2 = 2$, that is for projectiles having a longer and more pointed head than those Bashforth experimented with. We have $\rho_2 = \frac{0.6171}{0.6752} \times 0.0000044137\, d^2 v^2 = 0.00000403\, d^2 v^2.$

Mayevski found, by reducing the published results of firing at Meppen, that for the Krupp projectiles which had ogival heads struck with radii of two calibers, and for velocities exceeding 1300 f.s.,

$$\rho_2 = 0.00000409\, d^2 v^2,$$

which differs insensibly from the theoretical value.

As another test of the correctness of our theory we will compare the resistances of projectiles having hemispherical heads with those having ogival heads struck with radii of $1\frac{1}{2}$

calibers. If ρ_1 refer to the first mentioned and ρ_2 to the last, we shall have from equation (14)

$$\rho_2 = \frac{.6752}{.8584}\rho_1 = 0.786\,\rho_1$$

that is, the resistance to the ogival head by theory is 0.786 of that upon the hemispherical head. Bashforth in his latest work* gives tables of the coefficients of resistance determined by experiment, for projectiles having ogival heads struck with radii of 1½ calibers for different velocities (Table III, page 158, and Table XII, page 226), and also for projectiles having hemispherical heads (Table V, page 160 and Table XIII, page 238). From these tables we find by simple division the experimental coefficient of ρ_1 as compared with ρ_2 as follows:

Table.

Velocity of Projectile.	Experimental coefficient of ρ_1.
1100 f. s.	0.801
1160†	.824
1640	.759
1700	.732
1800	.723
1870	.741
Mean	.763

Again theory and experiment agree very closely.

Practical application.—Since the coefficient of reduction c which enters as a factor in the denominator of the expression for the ballistic coefficient C, varies for different projectiles directly with the resistance they suffer, it follows from what has been said that for ogival heads c also varies as $F(n)$. Therefore if we use the Artillery-School tables for ballistic computations with projectiles of the Krupp type (also for our own latest projectiles) we must make

$$c = \frac{.6171}{.6752} = 0.914,$$

* The Bashforth Chronograph, Cambridge, 1890.
† There is a break here in Bashforth's tables.

and if the projectiles are still more pointed so that $n = 1.5$ (which is the case with the Hotchkiss projectiles and some others), then we must make

$$c = \frac{.5715}{.6752} = 0.846.$$

Experience has shown that both these values of c give excellent results.

On the other hand if Mayevski's tables are used, then for the old type of projectile ($n = 1.5$) we must make

$$c = \frac{.6752}{.6171} = 1.09,$$

and for projectiles for which $n = 2.5$

$$c = \frac{.5715}{.6171} = 0.926.$$

Comparison of Ogival Heads with other Forms.

Before we can compare the theoretical resistance to ogival heads with the resistance to other forms for which n has no significance, we must express the resistance in terms of some dimension common to all heads. For this purpose we will take the length of the head expressed as a multiple of the radius of its base. Thus if l is the length of the head we may put in all cases

$$l = a R,$$

and then express the resistance in terms of $F(a)$ instead of $F(n)$. For ogival heads we have found (equation 11),

$$l = R \sqrt{4n - 1} = a R$$

and therefore

$$n = \tfrac{1}{4}(a^2 + 1),$$

and the equation to the generating arc becomes

$$2y = \sqrt{(a^2+1)^2 R^2 - 4x^2} - (a^2-1) R. \qquad (15)$$

Substituting the above value of n in the expression for ρ (equation 13) we have

$$\rho = k S \frac{\delta}{g} F(a) v^2, \qquad (16)$$

in which for complete ogival heads

$$F(a) = (a^2+1)\left\{2a-(a^2+1)\tan^{-1}\left(\frac{2a}{a^2+1}\right)+(a^2-1)\tan^{-1}\left(\frac{a^2-1}{2a}\right)-\frac{a^2-1}{\sqrt{2}}\tan^{-1}\left(\frac{a^2-1}{2a\sqrt{2}}\right)-\frac{a^2-1}{4}(2-\sqrt{2})\pi\right\} \quad (17).$$

Paraboloidal Heads.—If the generating curve is an arc of a parabola $A\,B$ Fig. 4, which revolves about its axis OA, the head will be a paraboloid of revolution. Taking, as before, the origin of coördinates at O in the plane BOC of the base of the head, that is, where the head joins the cylindrical part of the projectile, and making OA the axis of X and BC the axis of Y we evidentlly have for the equation of the generating curve $B\,A$

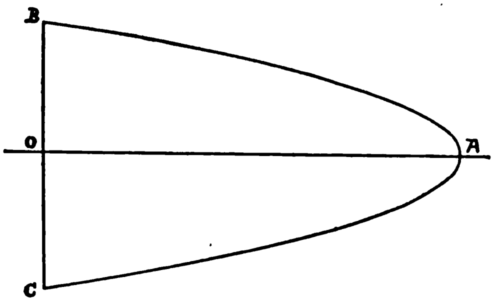

Fig. 4.

$$y^2 = R^2 - 2\,p\,x,$$

where R is the radius of the base of the head OB, and $2\,p$ is the parameter of the parabola. We determine OA the length of the head by making $y = 0$ which gives

$$l = \frac{R^2}{2\,p} \text{ or } 2\,p = \frac{R^2}{l}.$$

If we make $l = a\,R$ as in the case of ogival heads, we have

$$2\,p = \frac{R}{a}$$

whence the equation of the generating curve is

$$y^2 = R\left(R - \frac{x}{a}\right)$$

Differentiating we have

$$\frac{dx}{dy} = -\frac{2\,a\,y}{R},$$

which shows that at the element of the surface where $y = R$,

$\tan \varepsilon = 2a$, and therefore ε increases with the length of the head. At the extremity of the head (A) $y = 0$, and therefore $\varepsilon = 0$. That is, the element of the surface at A is normal to the axis, and therefore this head has a blunt point.

As it is convenient with a paraboloidal head to integrate with reference to dy instead of dx, and as the resistance, beginning at BC, increases toward the point as y decreases, we must take the expression under the sign of integration in equation (7) negative. Performing the necessary operations we easily find

$$\frac{y\,ds}{1+\frac{1}{2}\frac{dx^2}{dy^2}} = -\frac{R\,(R^2+4a^2y^2)^{\frac{1}{2}}\,y\,dy}{R^2+2a^2y^2} = dI \text{ (say).}$$

$$\text{Let } R^2+4a^2y^2 = z^2, \text{ whence } y\,dy = \frac{z\,dz}{4a^2}$$

$$\therefore dI = -\frac{R z^2\,dz}{2a^2(R^2+z^2)} = -\frac{R}{2a^2}\left(dz - \frac{R^2\,dz}{R^2+z^2}\right)$$

$$\therefore I = -\frac{Rz}{2a^2} + \frac{R^2}{2a^2}\tan^{-1}\left(\frac{z}{R}\right).$$

Restoring the values of z and I we have

$$\int \frac{y\,ds}{1+\frac{1}{2}\frac{dx^2}{dy^2}} = -\frac{R^2}{2a^2}\left\{\frac{\sqrt{R^2+4a^2y^2}}{R} - \tan^{-1}\left(\frac{\sqrt{R^2+4a^2y^2}}{R}\right)\right\}.$$

When $y = R$ (which is the inferior limit) the integral reduces to

$$\frac{R^2}{2a^2}\left\{\tan^{-1}\sqrt{4a^2+1} - \sqrt{4a^2+1}\right\}.$$

Therefore

$$\int_B^y \frac{y\,ds}{1+\frac{1}{2}\frac{dx^2}{dy^2}} = \frac{R^2}{2a^2}\left\{\tan^{-1}\left(\frac{\sqrt{R^2+4a^2y^2}}{R}\right) - \tan^{-1}\sqrt{4a^2+1} - \frac{\sqrt{R^2+4a^2y^2}}{R} + \sqrt{4a^2+1}\right\},$$

Making $y = 0$ in order to get the resistance for the whole head, and putting

$$F(a) = \frac{1}{a^2}\left\{\sqrt{4a^2+1} - \tan^{-1}\sqrt{4a^2+1} - 1 + \frac{\pi}{4}\right\} \quad (18)$$

we have, for paraboloidal heads,

$$p = k\, S\, \frac{\delta}{g}\, F(a)\, v^2.$$

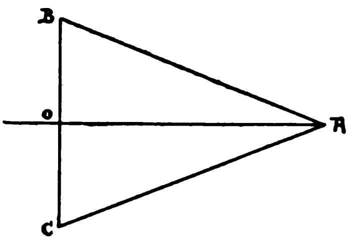

Fig. 5.

Conical Heads.—The equation of the generating line BA which describes by its revolution about OA the conical head BAC, Fig. 5, is, if O is the origin,

$$y = R - \frac{x}{a},$$

in which the notation is the same as for ogival and paraboloidal heads. Proceeding as before we easily find

$$\int \frac{y\, ds}{1 + \frac{1}{2} \frac{dx^2}{dy^2}} = (R^2 - y^2) \frac{\sqrt{a^2+1}}{a^2+2}$$

and for the whole head

$$F(a) = \frac{2\sqrt{a^2+1}}{a^2+2}. \qquad (19)$$

Comparison of Resistances for the Heads considered.

The following table gives the values of $F(a)$ for ogival, paraboloidal and conical heads whose lengths vary from ½ to 1½ calibers. They were computed by means of equations (17), (18) and (19). *

Table.

Length of head in calibers	value of a.	Value of $F(a)$ for Ogival heads.	Paraboloidal heads.	Conical heads.	Remarks. (for ogival heads)
0.50	1.0	0.8584	0.8712	0.9428	Hemispherical head.
0.75	1.5	0.7882	0.7481	0.8484	
1.00	2.0	0.7109	0.6438	0.7454	
1.25	2.5	0.6372	0.5612	0.6527	
1.3229	$\sqrt{7}$	0.6171	0.5405	0.6285	Head of our sea-coast project'l's.
1.50	3.0	0.5715	0.4956	0.5750	Head of Hotchkiss projectiles.
1.75	3.5	0.5132	0.4430	0.5109	Head of Canet projectiles.

* Of course there is a limit to the use of these formulas, and this limit is probably reached in the above table.

Since, as we have tried to prove, the resistance of the air to the motion of an oblong projectile varies with the shape of the head and therefore, approximately, with the value of $F(a)$, this table shows at once the great superiority of paraboloidal over ogival heads. We have already shown that the coefficient of reduction c was reduced from unity to 0.914 by lengthening the old ogival head which was struck with a radius of $1\frac{1}{2}$ calibers, to the one now in use which has a radius of two calibers. An examination of the above table shows that a still greater relative reduction in the value of c will result by changing from the present ogival head of two calibers to a paraboloidal head of the same length. That is, if we consider c unity for the ogival head at present adopted by the Ordnance Department for sea-coast projectiles, then for a paraboloidal head of the same length we should have

$$c = \frac{.5405}{.6171} = 0.876.$$

This means a very substantial advantage in the ranging power of the projectile, and there can be no doubt as to the general

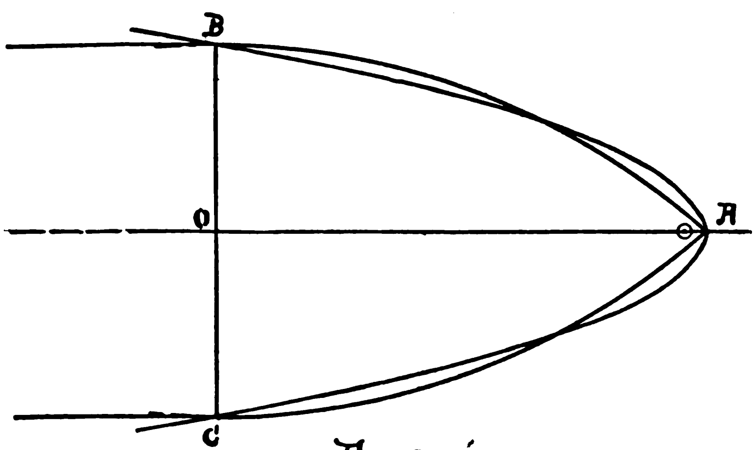

Fig. 6.

correctness of the theory upon which it is founded. An examination of Fig. 6 will give a very clear idea of how this superiority is brought about. In this figure a longitudinal section of an ogival head struck with a radius of two calibers, and also one of a paraboloidal head of the same length, are superimposed for the purpose of showing more clearly the peculiarities of each. It will be seen that the slope of the paraboloidal head from near the point, is, on the average, much more gentle than obtains with the ogival head; and in this fact consists the superiority of the former over the latter for overcoming the resistance of the air.

The volume of a paraboloidal head is, as is well known, one-half the volume of a cylinder having the same base and altitude. That is if V_1 is the volume of a paraboloidal head, we have

$$V_1 = \tfrac{1}{2}\,\pi\,R^2 \times a\,R = \tfrac{1}{2}\,\pi\,a\,R^3.$$

The volume of an ogival head is,* representing the volume by V_2,

$$V_2 = \pi\,F_1(n)\,R^3$$

in which $F_1(n)$ is a function of n, the number of calibers in the radius of the ogive. The ratio of their volumes (and also of their weights) is, therefore

$$\frac{V_1}{V_2} = \frac{a}{2\,F_1(n)}.$$

For service projectiles $a = \sqrt{7}$, $n = 2$, and $F_1(n) = 1.4674$. Substituting these numbers in the above expression there results

$$V_1 = 0.9\,V_2.$$

That is, the paraboloidal head under consideration would weigh 10 per cent. less than the ogival head of the service projectile. For example, the ogival head of a 12-inch cored shot weighs in the neighborhood of 261 lbs. (taking the specific gravity of the metal to be 7.2549); while a paraboloidal head of the same length for this projectile would weigh 235 lbs. The difference in weight (26 lbs.) could easily be made up in the body of the projectile.

The center of gravity of a paraboloidal head is evidently on its axis, and is one-third the distance from the base to the point. If $\overline{x}_1$ represents this distance we have

* See Ingalls' *Handbook*, p. 194, where will be found a table of the values of $F_1(n)$.

$$\overline{x_1} = \frac{\sqrt{7}}{3} R.$$

The center of gravity of an ogival head is found by the formula*

$$\overline{x_2} = \frac{(8n - 1) R}{12 F_1(n)},$$

which when $n = 2$, as in the projectile under consideration, becomes

$$\overline{x_2} = \frac{5 R}{5.8696}$$

$$\therefore \frac{\overline{x_1}}{\overline{x_2}} = 1.0353.$$

That is, the centre of gravity of the paraboloidal head is slightly in advance of the ogival, and therefore the centres of gravity of the two projectiles having the same weight, would be very nearly in the same place.

Other Heads—Curve of Pursuit.—The right hand member of equation (7) can be integrated in finite terms for all of the conic sections, but there are comparatively few equations of a degree higher than the second which admit of complete solution. The problem stated in all its generality would be this:

To determine the form of a surface of revolution so that the resistance of a fluid through which it moves in the line of its axis may be the least possible. The problem as thus stated was first proposed by Sir Isaac Newton and partially solved by him. But the differential equations which he deduced are quite intractable and are of no assistance whatever in the practical solution of the problem.

As an example of a meridional curve whose equation is superior to the second degree, one form of which admits of complete solution, we may cite the curve whose general equation is the following:

$$y = \frac{(a R - x)(a R + b x)^{\frac{1}{2}}}{c \sqrt{a R}}.$$

It will be seen that $y = 0$ when $x = a R$, as in the curves already considered. When $a = 3$, $b = 2$ and $c = 3$, this curve is

* *Handbook*, p. 199.

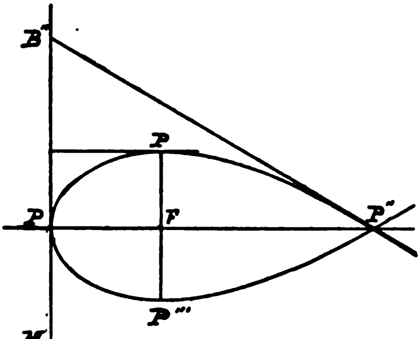

Fig. 7.

one of the forms of the "Curve of pursuit," namely, when the pursuer runs twice as fast as the pursued. That is, Fig. 7, if the pursued is at B'' and travels toward M at a uniform speed, and if the pursuer starts from P'' and travels directly toward the pursued with double the speed he will overtake him at P. This curve was first discussed by the author in 1880 in a paper entitled "Curves of Pursuit," and published in Vol. 7 of *The Analyst*, p. 65. The part of the curve here considered is the arc $P\ P''$, which by its revolution about the axis FP'' describes the head $P\ P''\ P'''$ whose base is PP'''. Taking the origin of coordinates at F, the centre of the base (as in the other cases), the equation becomes

$$y = \frac{(3\,R - x)\,\sqrt{3\,R + 2\,x}}{3\sqrt{3\,R}}$$

which becomes zero when $x = 3\,R$. That is, $FP'' = 3\,FP$, and the head is of the same length as those of the Hotchkiss projectiles. This head seems to be well adapted for penetrating armor, but, of course, this could only be determined by experiment. It is not however so good a head for ranging through the air as a paraboloidal head, though slightly better than an ogival head. Its volume is precisely the same as that of a paraboloidal head of the same length, and its centre of gravity is at a distance from F equal to $\frac{9}{10}\,R$, which is slightly in rear of the centre of gravity of a paraboloidal head. OP, parallel to the axis, is tangent to the curve, and the angle at the point is 60°, which is sharper than an ogival head of the same length (see table on page 202 for $n = 2.5$).

For this head we have

$$F(a) = 4 - 3\log_e 5 + 3\tan^{-1} 3 - \frac{3\,\pi}{4} = 0.5626.$$

Of course $F(a)$ in this case is $F(3)$, and this head can only be compared with other heads whose lengths are three times the radius of the base.

TRAINED ARTILLERY FOR THE DEFENSE OF SEA-COAST FORTS.

By SAMUEL E. ALLEN, First Lieutenant, Fifth Artillery, U. S. A.

The deplorable deficiency of means possessed by the United States for defense against naval attack has been often and vigorously commented upon. It affords some satisfaction to explore the voluminous reports of the various bureaus of the War Department, and learn of the actual materialization in a few forms of iron, steel and concrete masses, of the first appropriations made by Congress to carry out the plan of defenses recommended by the Endicott Board, eight years ago. The progress thus far made is indicated in the report of the Honorable Secretary of War for 1893 (pages 15, 16, 17).

From this it is seen that at New York, Boston, Portland, Oregon, San Francisco, and Fort Monroe, emplacements are completed, as far as can be done until details as to platforms for carriages are decided upon, for several batteries for 12″, 10″ and 8″ guns and 12″ mortars. The only delay in the completion of these partial works is due to the absence of proper carriages.

It is readily seen also that by the end of the century there will be several hundred guns and 12″ mortars, many batteries and mining casemates completed, and a rapidly increasing supply of carriages for all calibers in place and being delivered.

Some of these works and armament, and those afterwards to be completed, will be found in every one of the Atlantic, Gulf and Pacific coast states. except Mississippi and Delaware.

The Secretary of War and Major General Commanding the Army, in their successive annual reports, have reiterated the statement, based on careful computation, that from 85,000 to 90,000 men will be required to properly man the works when finally completed. Whence will these 85,000 men come? It is easy to answer "from our upwards of sixty millions of population." But what would 80,000 raw recruits, officers and men, with 4,000 regulars, be able to do with a modern artillery armament? The contingent of regular troops will perhaps be efficient to care for the armament, keep it in good working order, and keep themselves in a state of efficiency as to its use in action; but one man cannot "leaven" twenty, and more decidedly, creditable officers and gunners cannot be created by simply sewing on new shoulder straps and chevrons.

In this day of profuse pictorial illustration of newspapers, it is surprising that some cartoonist has not seized upon the revised statutes of the United States as an unexplored field, rich in material for caricature.

Some of the militia laws still in force, standing as an exposition of the policy of the government as to national defense, are as curious, obsolete, inadequate and ridiculous, as would be the rules of King Arthur's court in the halls of Congress.

In view of the advancing state of armament and fortifications, the time has come for a revision of our policy on the basis of modern requirements and conditions. Broad principles should be emphatically outlined and proclaimed, and like the principles of the Monroe Doctrine, be respected and supported by all political parties, and held sacred beyond reach of the false economy of infinitesimal appropriations.

It is not believed that the people of the United States will ever consent to the existence of a large standing army. The increasing necessities of the country, due to the threatening development of anarchistic principles in curious variety among the lower classes of the foreign element of our population, are however, leading the intelligent portion of the people to more serious consideration of the military question. To this awakening to internal conditions, which is causing the gradual perfection of the National Guard, we may hope there will succeed a serious realization of external conditions. The interest in self which so largely controls our wealth seeking population, must force the question more and more prominently forward.

In most of the centers of large private interests, attention during the last few years has been turned to the training of men for defense of the fortifications. Boston, New York and San Francisco National Guardsman have taken up the matter; and more or less effort, by instruction and practice in the local fortifications has been made to prepare the National Guard to some extent for this newly recognized necessity. With the growth of this sentiment—and grow it must—there will eventually be developed a system, more or less effectual, of national defense. Will such a system, growing out of the ever-changing, ever-increasing necessities for preservation of private interests, result in that perfection of detail of organization, strength of numbers, efficiency of service, centralization of authority and foundation of discipline, which will be requisite for the emergency when the enemy's threatening fleet comes creeping into our peaceful waters? Manifestly not.

It is then unwise to permit the spontaneous growth of a heterogeneous system which can promise only a deceptive sense of security, while inviting certain disaster.

In the matter of artillery preparation as well as national defense in general, a comprehensive plan or organization should be adopted, specifying the conditions to be imposed upon every large community, district or state, outlining the requirements to be met by the troops organized, providing for the cost of their maintenance and instruction, and prescribing penalties for failure to fulfill the law.

Responsibility of States and National Government for protection.

A broad policy cannot stop short of complete provision for every possible emergency. Who is responsible that the provision is made? Primarily Congress and Congress only, as shown by the following extracts from the Constitution:

ARTICLE I, SECTION VIII.

1st Clause—"The Congress shall have power to lay and collect taxes, imports and excises, to pay the debts and provide for the common defence and general welfare of the United States."

12th Clause—"To raise and support armies * * *."

14th Clause—"To make rules for the government and regulation of the land and naval forces."

15th Clause—"To provide for calling forth the militia to execute the laws of the union, suppress insurrections, and repel invasions."

16th Clause—"To provide for organizing, arming and disciplining the militia, and for governing such part of them as may be employed in the service of the United States, reserving to the states respectively, the appointment of the officers, and the authority of training the militia according to the discipline prescribed by Congress."

18th Clause—"To make all laws which shall be necessary and proper to carry into execution the foregoing powers."

SECTION X.

3rd Clause—"No state shall, without the consent of Congress * * * keep troops or ships of war in time of peace, * * * or engage in war, unless actually invaded, or in such imminent danger as will not admit of delay."

ARTICLE IV, SECTION IV.

"The United States shall guarantee to every state in this union a republican form of government, and shall *protect each of them against invasion* * * *."

The powers enumerated in the constitution being delegated by it to the United States (Article X of the amendments) are no longer "reserved to the states."

There is therefore a responsibility resting on Congress, not only to provide for the common defense and general welfare of the United States (Article I, Section VIII, 1st clause) but "to protect each of them (the states) from invasion." The last is mandatory and there is no division of responsibility between the government and the states.

As constituent elements of the government, however, the supply of the means for executing the plans for national defense falls back again upon the states.

The men and the money must come directly or indirectly from the states. According to the underlying principles of our Federal existence, the burden should be equally distributed in proportion to wealth and population. In the matter alone of defense of *seaports* by *fortifications*, there are two elements for consideration—the relative *strategic* and *local importance of the fortified ports.*

First and most important is the national interest, the protection of strategic points, the security of places of refuge for shipping and of industrial and commercial centers.

Second, is the local interest involved in the possible destruction of life, property and other interests of the inhabitants of centers of population.

Notable among the localities involving the former are Portland, Maine, Narragansett Bay, Hampton Roads and Key West, Fla. Among the latter are Philadelphia, Baltimore, Washington and New Orleans. New York, San Francisco and Boston, recognized and named by the Endicott Board as the most important posts, involve both interests in a high degree.

The seaboard states, which contain all of these places, must therefore have greater interest in protection; and, on the principles of insurance, should contribute a larger share to the defense of the sea-coast fortifications, leaving the greater part of the burden of the other measures for national defense to fall upon the inland states.

Relation between forces required for defense, and local population.

In computing the strength of garrisons, attention is almost exclusively directed to the number of enlisted men required. An estimated total of 80,000 men is assumed and divided according to the number of guns of 8″ or greater caliber proposed by the Endicott Board, or 60 men per gun. In the approved plans of the War Department the number of 12″ and 10″ guns and 12″ mortars is being increased at the expense of the 16″ gun turrets recommended, raising the total number of such guns and mortars to 1500. It is probable that the total strength required for each post will remain about the same as computed on the former basis, reducing the average to about 53 men per gun of 8″ or greater caliber.

This seems a large figure, but when the exigencies of the service are duly considered, the limit is certainly not excessive.

In the table prepared, attention is especially given to the following:

(1) Population within short distance of fortifications.

(2) Number of men of militia age.

(3) Population of white inhabitants of militia age.

(4) Number of troops required, exclusive of officers.

(5) Percentage of same to (3).

(6) Percentage of existing organized militia to white men of militia age in the entire state.

(7) Excess of troops required over the probable number that can be secured by voluntary enlistment in time of peace.

From this table it is seen that each of the following ports might reasonably be expected to furnish its full complement of trained troops, in excess of the number of regulars required for permanent garrison in time of peace, viz:

New York, the Lake Ports, New Orleans, Philadelphia, Baltimore, Washington, New London, Connecticut, Pensacola, Wilmington, N. C., San Diego, Cal., Portsmouth, N. H., New Haven and a few minor ones. The following would require additional troops (including regular garrison) above about 7% of the white men of militia age in the vicinity, to furnish the required quota:

San Francisco	8000 +	7 %
Boston	4000 +	6 %
Hampton Roads	1800 +	7 %
Portland, Maine	4750 +	7 %
Narragansett Bay	3500 +	7.4%
Key West	2000 +	?
Charleston	1200 +	11.7%
Mobile	1800 +	15 %
Savannah	1300 +	10 %
Galveston	1500 +	7.3%
Portland, Oregon	1500 +	8.5%
Total	31350	

The latter list shows that for eleven ports, requiring over 50,000 men in the works, about 20,000 can be supplied from the vicinity, provided the average of about 7% of the number of militia age be counted upon for service, leaving over 30,000 men to be furnished by the regular establishment, and by transportation from inland districts too remote for convenient instruction at the forts. Except the 3,500 additional men for Narragansett Bay, however, the required number for any port would not be an excessive draft on the population of the state to which it belongs, provided means for instruction could be devised.

It is not impossible, therefore, to establish a military system that would require sea-board states to first provide for the artillery defense of the ports within their limits, without imposing upon them an excessive burden.

Under the constitution, by what measures may Congress provide for the training of the requisite number of men to make the defenses effective?

While this question has so many times been replied to, for the sake of continuity a repetition of some of these answers may perhaps be excused. Under the power to raise and support armies, either of the following organizations of national troops might be adopted:

1st. A regular establishment, consisting of a sufficient number of officers and men to man all the works.

2nd. A smaller regular establishment on duty, in connection with a body of reserves (officers and men) who have served for a definite period in the regular establishment.

3rd. A small regular establishment sufficient in strength to preserve the armament, to keep pace with the developments of the science of coast defense, and to act as instructors for auxiliary troops; and an auxiliary organization of national troops to be called into service for special and general instruction for comparatively short periods of time, and subject to call for indefinite service when needed.

4th. Under clauses 15 and 16, Art. I, Sec. VIII (of the constitution) which provide for calling forth the militia "to * * * repel invasion" &c., another alternative exists. In addition to any or all of the above, provision may be made by Congress for the organization by states of a uniformed militia artillery, under their own officers, who may be afforded every facility for instruction and practice that may be requested by the state authorities, and who will be subject to call by the President for service during threatened hostilities.

With either of these systems two distinctive characteristics of organization are presented, i. e., territorial and non-territorial.

There are three features of each of these systems—military, political and practical, which cannot be disregarded.

MILITARY FEATURES.

The officers who direct operations during an engagement between forts and fleets must not only be thorough artillerymen, but be familiar with all the conditions to be met in the fighting of modern ships, their vulnerability to various kinds of fire, possible tactics of the fleet, &c. They must also know every detail of the channels and waters of the harbor, and have intimate knowledge of works and the relations to each other of the different forts and batteries with their armament. Therefore, they must be *professional* artillerymen, assisted by juniors of no less ability and efficiency. There must also be younger officers to take charge of the minor details, who have qualifications of a technical nature.

There must be many enlisted men trained in the details of special services, such as range and position finding, transmission of communications, preparation and service of ammunition, handling of high explosives, torpedo service, &c. The training of officers and men for these duties requires periods of long and continuous service, to be secured only by the existence of a permanent establishment—*a corps of regular artillery*.

Another feature is the service of the guns. The officers must be perfectly familiar with the ballistics of the guns which they serve; the non-commissioned officers well instructed in target practice; and the men well trained in the manual of the gun. The requirements of this service are less varied. They do not necessitate continuous application after a certain degree of proficiency has once been attained. A different organization from that of the regular corps might suffice to develop a body of men who could be depended upon for good service at the guns.

There is one more element of no less importance than efficiency. Whatever the organization of the troops may be, it must permit the establishment of a rigid discipline, under which all will be trained and all subordinate.

Regular artillery establishment.—The first named of the four systems, a corps of artillery 80,000 strong, need not be mentioned, for reasons quite obvious. It would secure all the guarantees that could be desired, but Congress would never adopt it.

Regular artillery establishment with reserves.—In this, the primary considerations are (1) what period of service in the regular establishment is necessary to so thoroughly drill and discipline the soldier, that with short periodic turns of duty during the remaining years of service in the reserves, he will continue to be an efficient artilleryman? (2) What is the limit of the period of service in the reserves, during which efficiency may be maintained by such training? (3) What proportion of the number of men who annually enlist will prefer to remain in the service corps, rather than pass into the reserve corps, thus diminishing the strength of the latter? On the determination of these three points must be based the relative strength of the active and reserve corps. The successful operation of such a system will depend upon securing men of two classes only—those who wish to make the service their profession, and those who intend to return to civil life, and pursue regular occupations in such convenient locality that they may regularly return to the place of training for instruction as members of the reserve. It will require the complete exclusion of that large class from which the present enlisted strength is so largely drawn.

In view of the requirements that our new armament will introduce, it is evident that the entire non-commissioned strength, as well as that for the special and technical duties incident to preservation of modern armament and operations of artillery warfare, should be drawn entirely from the first class or professional soldiers, who remain continuously in the active corps. Any period of enlistment consistent with a reserve system, would at most be sufficient for members of the second class to acquire a fair degree of efficiency in these special duties, when they would be immediately lost to the service by passing to the reserve, where acquired efficiency as specialists would rapidly be impaired. By maintaining a sufficient number of long-service

men, the training of those who are afterwards to pass into the reserves could be confined to the care and service of the guns, ammunition, and ordinary routine in action. Once well instructed, a fair degree of proficiency of these men in this service could be continued by short annual tours of duty.

For disciplinary training, two years in the active corps with energetic instruction might be sufficient. Adding to this about five year reserve service, making a total of seven years, would give about the shortest period that could advantageously be adopted. A longer period of active service or a shorter period of reserve service would increase too greatly the proportion of active to reserve troops, and enormously increase the cost of maintenance. A crude outline of such a system will serve sufficiently well for purposes of comparison with the others.

Eighty-thousand men would constitute 400 batteries of 200 men each, requiring as a minimum 400 captains, 800 lieutenants and about 100 field officers.

To each battery should be, of course, a 1st sergeant, and at least twelve well instructed sergeants and corporals, and say seven specially instructed privates or twenty veterans in all, making 8000 well instructed men required for non-commissioned officers and special and technical work.

		Batteries.	Captains.	First Lieuts.	Second Lieuts.	Lieuts. of Reserves.	Veterans. N.C.O. and privates.	Active Corps. Short Service.	Reserve Corps.
Peace.	Active	1	1	1	1	. . .	40	100	. . .
	Reserve		. . .	. . .	. . .	. . .	. . .	. . .	. . .
			. . .	. . .	. . .	4	. . .	. . .	. . .
	(attached)		. . .	. . .	. . .	. . .	. . .	. . .	250
	Total,	200	200	200	200	800	80,000	20,000	50,000
War		1	1	. . .	½	2	20	50	125
	Total,	400	400	. . .	200	800	80,000	20,000	50,000

In round numbers this leaves 70,000 more men to be provided for. Not allowing for casualties, this would be 20,000 more in the active and 50,000 in the reserve corps, considering two year service for the former, and five years' for the latter.

This would permit an organization abcut as shown in accompanying table.

This would give in peace, batteries of 3 officers and 140 men; during hostilities, batteries of 195 men, commanded by one regular captain or 1st lieutenant, assisted by two lieutenants of reserves, leaving the 200 2nd lieutenants of regulars for special duty and to command rapid fire gun groups, take charge of ammunition supply, &c.

The reserve lieutenants would be appointed from specially recommended non-commissioned officers, who have served eight or ten years as veterans. Extra non-commissioned officers for reserves would also be obtained from the same source, as there would be perhaps 200 or 300 such men leaving the service every year, who would be glad to accept such commissions.

This involves the maintenance in active service of about the following force:

100 field officers,
200 captains,
200 1st lieutenants,
200 2nd lieutenants,
2600 non-commissioned officers, } veterans
5400 privates, }
20000 short service men,

and in reserves, { 800 lieutenants,
50000 privates. }

Regular establishment with national volunteer reserves.—This is similar to the system adopted by England in her militia and volunteer organizations to provide a second line for the army, and for home defense in case of invasion. In its general outline our organization would necessarily be very much the same. A division of the sea-coast states into convenient artillery districts would be natural, each fortified port being the headquarters of its district for administration and instruction purposes. The strength of the regular garrison being proportionate to the armament, would also be proportionate to the number of volunteer troops of the district, and in time of peace would be charged with the instruction of the latter. They would also serve to defend the port against any unexpected arbitrary act of a foreign man-of-war within our harbors, and to protect shipping from destruction by cruisers hastily sent out on declaration of war.

In time of hostilities the regular garrison would be no more than sufficient to supply the experts, officers and men required to take charge of the technical work, and to superintend and direct operations in an engagement.

The handling of the guns, and delivery and service of ammunition would perhaps devolve entirely upon the volunteer troops. The degree of training of the latter must then necessarily exceed that which one or two short periods of drill per year would give. As the directing officers must necessarily be those of the regular corps, the volunteer organizations would not require a larger unit than the battalion, with a major of volunteers in command of each for administrative and executive purposes. All officers would be commissioned by the President.

POLITICAL CONSIDERATIONS.

Fortunately, or unfortunately as the case may be, very important political considerations exist—the conservatism due to our peculiar institutions and form of government, the temper of the people, and the cost in connection with the effectiveness of whatever system may be adopted—all affecting the chance of receiving public and Congressional approval. To what extent will the people support Congress in the adoption of either system? The continuation of congressman in office resting so largely upon the regulation of their public acts by the expressed opinions or known disposition of their constituents, no hope may be entertained for the success of radical measures as to an extensive organization of troops, until public opinion will support them. The sentiment expressed in ex-Senator Ingalls's words, "No gun has yet been built that can fire a shot from the coast into Kansas," finds echo in the breast of many individual voters of the vast inland portion of our territory, who are too selfish to make concessions for the general welfare.

Regular artillery establishment with reserves.—However wise the policy of an artillery organization 25,000 to 28.000 strong, with a reserve of 50,000 men, whose instruction would add somewhat to the expense of maintenance, it is improbable that Congressional support of such a measure can ever be obtained until we have first had a convincing object lesson.

A reduction to one year of active service instead of two, with a force of veterans as suggested, reducing the total active strength to about 18,000 men and 50,000 reserves, might be less difficult to secure. The degree of efficiency of troops under such an organization would be very much reduced, but might not be so unfavorable in comparison with other measures which would be the only alternative.

In comparison with the system of regular reserves, it is probable that the volunteer system would appeal to Congress as one calling for very much smaller annual appropriations, and affording, in their opinion, a sufficient degree of efficiency.

While the protection to the coast is a national interest, it would incidentally be local protection, while the burden of support would be equally distributed. This would arouse opposition in parts of the country not embraced in the protected districts. These people would prefer to have it operate in the opposite way, by throwing most of the expense upon the seaboard states—a measure equally unjust. The state artillery troops might, however, receive liberal assistance from the national government by annual appropriations that would make the burden upon each section proportionate to the benefits it would receive.

The political opposition to Congressional adoption of either of these volunteer systems would probably be small.

PRACTICAL CONSIDERATIONS.

As such there must be investigated, the possibility of securing the necessary number of men, the efficiency and reliability of the troops under the proposed organization, and the methods of instruction that may be applied.

Regular artillery establishment with reserves.—Not considering the casualties that would result from discharge before expiration of term of service, &c., this system, with one or two years of active service and five years in reserves, would require the annual enlistment of about 12,000 men of an exceptionally reliable class. Though no precedent exists on which to base an estimate, it does not seem unreasonable to expect that this number could be obtained. The short term of service, coupled with the small remuneration covering periods of instruction during service in the reserves, constitute conditions which many young men in large cities would willingly accept.

Intending to make their residence permanent, the requirements of service as reserves would not in general be onerous. Coming, as most of them would, from the class of men who cannot afford to belong to the state National Guard, many would consider the short periodic tours of duty as a pleasant relief from their daily work, and would be glad to find this way open to participation in military affairs, and to become enrolled among their country's defenders.

Under a proper system of selection, proper organization and methods of instruction, this would undoubtedly be an efficient one, and would enable us to give to each element of the armament the full fighting power for which it was designed in the plan of defenses.

A reduction of the second class of troops to a single year's active service would affect the efficiency most materially. But if the year is exclusively devoted to artillery instruction under rigid discipline, a better foundation would be laid than could be expected from a body of volunteers, of whatever class, who receive only intermittent weekly instruction in armories, supplemented by annual tours of one or two weeks in the fortifications, and who receive their instruction chiefly from officers of like training. By the nearest possible approach to a territorial system, such regular troops would get all their training at the guns which they are to serve in action, and under service conditions.

National volunteer reserves.—The question of obtaining by voluntary enlistment 75,000 men from nineteen states and the District of Columbia, which now support a total of 69,200 militia, is to be considered. While eleven different ports would require a strength of from 17 to 72% of the neighboring white population of militia age, only five of these, San Francisco;

Portland, Maine; Key West; Narragansett Bay; and Boston (requiring 9½% of militia age), would need more than 15,000 men above about 7% of such population. California, from inland points, *might* raise for San Francisco 8000, Massachusetts for Boston 4000, and Maine for Portland 4000 men above the number that these cities could reasonably be expected to supply, but it is doubtful. The inducements could scarcely be made sufficient for this number of men to join military organizations for service only at points on the sea shore, remote from their homes. Special provision would undoubtedly have to be made to give Narragansett Bay her 3500 and Key West her 2000 extra troops.

To recapitulate—

- 6 principal ports (of 12) and 9 minor ones (of 15) could supply their own quota.
- 1 principal and 6 minor ports (by enlisting 7 to 8% of white men of militia age in the vicinity) could have their quota completed from the state by an addition of 1500 men.
- 4 principal ports could scarcely depend upon the state to supply the full number.
- 1 principal port (Narragansett Bay) certainly could not.

Remembering that the above estimates are based upon the supposition that where needed, in the vicinity of the fortifications about 7% of the number of white men of militia age may be obtained for service, and that the average in the present militia organizations is between 1 and 2% of the state strength (or perhaps 3% in the cities) it is seen that much greater inducements for voluntary enlistment must be offered than exist at present. In New York state, with their handsome armories, possessing all the accessories of a club, it is difficult to maintain the present strength. In Pennsylvania, the Adjutant General of the state reports that double the number could easily be organized, but this would raise their percentage only to about that of New York at present. While there might be temptation to make it, there should be no reduction of national guard infantry troops below their present strength, even if large numbers of artillery troops are organized. The whole time available for instruction of the latter should be devoted to artillery work. If there is difficulty in maintaining the infantry organizations at proper strength, with all the attractions of the armory and social advantages now given to them, how could the artillery organizations, of double the number in some cases, hope to be recruited? Manifestly either at the expense of tne infantry, or by enrolling an entirely different class of citizens for membership.

The question of training of artillerymen is now being agitated among the military men of several of the states prominent in national guard matters, as New York, Massachusetts and California. The serious question with them is, how can we get the men. New York some years ago made the experiment of trying to train a regiment of infantry in artillery work. It was taken up with enthusiasm, but after one tour at Fort Wadsworth it was found that the fascination of this work was not complete, and a regiment with divided interest could not be maintained. The experiment was never repeated.

In Massachusetts the attempt seems to have been crowned with more success. From personal application made to General Dalton, Adjutant General of the state, I have learned that the importance of training artillerymen for emergency in sea-coast forts has received the serious consideration of the officers and authorities of the state, and that they no longer consider the question as debatable. In 1880 or 1881 Congress appropriated $5000 to build a battery on the state camp ground, and supplied two 10″ guns and two 10″ mortars. In 1882 practice was conducted with the mortars, firing at a distance of 1000 yards.

In 1883 the regiment detailed for artillery work prosecuted it under many difficulties in the uncompleted battery. The work was continued, however, and a battery of wood, with wooden models suitable for drill, was erected in one of the large armories; a room was provided for a school for officers, and instruments were provided for scientific instruction and drill. The regiment detailed has had two day practice with projectiles at Fort Warren, and has also performed one full week of duty there.

Permission has been granted by the War Department for the regiment to go to Fort Warren for a week this summer. Everything possible is being done to be ready for any emergency, and this without expense to the general government, and an earnest effort is being made to have the men instructed in handling the guns, in the duties of garrison and in the care of themselves while there. Not only is it contemplated that Massachusetts shall be able to put a full garrison in Fort Warren if needed, but to have a sufficient force for the protection of the present dismantled forts in the harbor.

California has also tried to promote artillery work. The last report of the Military Information Division of the Adjutant General's Office on military organization shows one regiment of artillery, of seven companies of sixty men each, in the organized strength of the latter state, but I understand that it is essentially an infantry organization. The organization of an artillery regiment has not been tried in the east. The officers fear they could not offer sufficient inducement to maintain their full regimental strength, and hesitate to risk the popularity of their regiment by the experiment. These objections pertain more particularly to the large cities, it is true, but it is near the large cities in most cases that the large bodies of artillery troops are required. A system applicable only to the smaller localities will not suffice. The one adopted should be applicable to all alike, if it is to secure a homogeneous organization. These objections refer only to the question of filling up the ranks. No doubts are entertained as to securing the required number of intelligent officers and non-commissioned officers, who would enter with deep interest into the work, and would be willing to devote much time and labor to the perfection of their batteries. A national volunteer organization would naturally become territorial for administration as well as for training. The officer in command of a fortified fort would be the director of all the units to be concentrated under his command for service. These would consist of battalions organized in the immediate vicinity, and in many cases of others in the interior of the state, or at places on the coast not fortified. As a matter of economy as well as for convenience and efficiency, the battalions in the vicinity would have their headquarters at the fort and be assigned to specified batteries of a particular caliber or type of gun, at which all of their training would be conducted. By thus limiting the range of instruction, greater familiarity with their duties, and perfection of service and target practice would be assured. The men and officers would become well acquainted with the works, the relation of their batteries to neighboring batteries, the channels and waters they are required to defend, and the service of ammunition. By observing passing vessels during practice and by firing at targets located in these channels and waters, they would become familiar with the ranges and positions of possible targets during an engagement.

Battalions organized at remote points would be assigned in the same manner, and their elementary training would be conducted with a view to this assignment, though under unfavorable circumstances. Training batteries would have to be erected for this purpose at some place convenient for the troops. A site favorable for a small arms target range being obtained, model batteries could be constructed with magazines similar to those in permanent works. One gun and carriage, to the service of which the battalion is assigned, could be mounted with all the appliances for drill. A sub-caliber tube for small arm cartridges and dummy cartridges and projectiles would have to serve for instruction purposes in the manual of the piece, and in target practice. In addition, one rapid fire gun and a machine gun, properly mounted and equipped, a range-finding equipment and moving target, would give that variety of instruction, as well as diversion, which would be necessary to keep up the interest of the officers and men. If a water front is available, actual target practice and ballistic firing could be conducted. In most of the cases cited before, one or two large inland cities in each of the ten states named could provide all the troops required to complete the complement for the fortifications within its limits, and in such cases, with a suitable site, a very complete training equipment could be supplied for the elementary drills. Such troops could then be assembled annually for a couple of weeks at the forts, and trained in the more general duties and target practice with other troops, under conditions simulating as nearly as practicable those of active service. It is not contended that the degree of efficiency under these conditions would be all that could be desired, but such troops would certainly be more valuable than the untrained, undisciplined recruits that we should have to depend upon in our present condition. Being at all times under control of the government, and directly under the orders of the commander of works in which they are to serve, the assignment of each battalion to its proper place and duties could be made according to a well digested scheme. The battalions from the near localities having the greatest facilities for practice, could be assigned to the heavier guns and more important duties, and could be held up to a higher standard of efficiency.

State militia reserves.—With regard to state troops the conditions are somewhat different. Congress could prescribe the number of troops from each state to be called into service, but could not enforce the training. The assignment of troops to duties might be announced by the proper authorities, but the instruction in these duties could not be demanded—it could only be limited during the time the troops are present at the fortifications. Congress might punish the state for failure to come up to the standard by withholding appropriations, but the states could retaliate by disbanding their organizations. The degree of efficiency of our defenses would thus depend upon the faithful cooperation of states with the government—mutual support which either party might withdraw without penalty, other than the weakening of defenses against foreign aggression.

Assuming, however, an earnest cooperation, an organization of state troops could be effected that would permit the same general plan for instruction as that above outlined for a national body. Officers of the regular establishment could be detailed as instructors, and drills be conducted to a great extent at the batteries and guns of the fort. Special training batteries could be erected in specially designed armories—for armories they would have—when evening drills and sub-caliber target practice with large guns at miniature ships could continue through the winter. Transportation and a satisfactory *per diem* compensation could be authorized during tours of instruction in the works. It is probable that in many states a degree of proficiency might be obtained not less than that which the body of a national volunteer organization could attain. Under either system, special instruction of officers and non-commissioned officers should be provided for by affording facilities for extra drills, opening to them for limited periods the benefits of the artillery school, and encouraging them to join in lyceum work and experimental and ballistic practice. By thus specially educating the officers and non-commissioned officers, the standard of the troops would be greatly elevated.

After this review of the many elements which enter into the question, any positive suggestion as to the best solution may undoubtedly be met by many strong objections. The prominence among nations of the earth to which the United States has attained, certainly warrants and demands a permanent organization for defense, which will insure immunity from foreign aggression—at least long enough to permit a fair measure of our national strength with that of the enemy. We should not leave ourselves open to humiliation at the first blow.

The preparations in the way of fortifications and armament which are now in progress are likely to be effective. As rapidly as they develop we should be prepared to place in them men who can *handle* them effectively. A permanent organization of forces is necessary, based on correct principles of economy, efficiency and permanence. Efficiency cannot be obtained without training, and yet a man's efficiency as a soldier does not suddenly cease with the expiration of his term of service. Economy suggests an active body of men trained and training to service, supplemented by others who, having been trained, have not lost their usefulness—i. e., *an active and reserve force*. I would advocate therefore the organization of a regular corps of artillery, progressive in numbers, until our defenses are completed, but ultimately to consist of about 700 officers and 8000 1st class or veteran enlisted men, with an annual enlistment additionally of about 10,000 men to serve one or two years in the active corps and five years in reserves.

In default of such a system there seems to be little choice. The arguments in favor of a national body of volunteer troops are perhaps overruled by others in favor of the system of state troops, organized under judicious laws, and receiving sufficient financial assistance and practical aid from the government.

The national volunteers would possess the desirable features of unity of organization and regulation of the appointment of officers, and training of troops by those who are to command them.

In the state militia system the advantage of armories, with all their accessories, would prove an attraction to the better class of young men, which would assist in filling their ranks with very desirable material.

No great change in the policy of the government, involving heavy expenditures, seems possible without having first received Congressional investigation. Urgent recommendations of the War Department seem to be considered as matters of personal gratification or glorification only. The evil of this state of affairs is seen in total inaction of Congress on all questions of reorganization of the army that have been so warmly advocated. Now is a good time for Congress to take hold of the whole matter in all seriousness. Let a board consisting of senators, representatives, officers and civilians, be appointed to consider a policy of national military defense, including army organization (and promotion if you choose). Let their report, after a thorough public investigation, be made to Congress, outlining an American policy for American protection, based on principles of American institutions, and let it receive the support of the American people, and be adopted and executed.

(Captain *E. L. Zalinski*, U. S. Army, Retired.)

Lieutenant Allen has forcibly presented to us one of the urgent requirements of the national defense. As the greatest chances of war are from foreign aggressions, we will first of all require large numbers of trained artillerymen rather than of other arms of service. Unfortunately it has been easier to develop infantry and cavalry than artillery, the former being more readily equipped and trained.

I very much doubt if Congress can be induced to devote sufficient time to formulate legislation looking to radical and extensive changes, and to finally carry them through both Houses. Excellent measures have been formulated by the Military Committees of both Houses, time and again, but they have invariably failed even after passing one or the other House, for lack of time and the absence of serious attention of the mass of the legislators to questions of the public defence.

We are therefore constrained to grope about for ways and means to secure our ends by gradual approaches, demanding but little or no special legislation.

Nothing of a radical nature, such as is involved in the scheme proposing a large force of reserves and demanding a large increase of expenditures, can possibly be carried through Congress, except under stress of war. Then it will be too late to fully serve its purpose.

Neither will the states countenance a system which shall deprive their authorities of a considerable measure of control of those which are necessarily territorial troops.

Fortunately, a way of satisfying the conflicting jurisdictions and apportioning the measure of support of State and National authorities has been indicated in the development and character of the organization of Naval Reserves.

Battalions of volunteer heavy artillery could be formed in our seaport and lake cities, the organizations being assigned to definite forts. These should be instructed only with the guns and appliances which they will be called upon to actually manipulate in combat. There should be no attempt to make them "Jacks of all trades" as is now done with the regular artillery.

These organizations should be provided for by joint action of the United States and State authorities. Whilst clothed by the state, they should be provided with arms and equipments by the United States armories, or by the state or municipal authorities, and the state should pay and feed them when performing duties which are solely for the benefit and under the direction of the state authorities. But when at work in the fortifications, they should be quartered, fed and paid by the general government.

Advantageous conditions should be coupled with service in these corps so as to make it desirable and attractive. Business men and men of family do not like to risk the chances of being called away from their homes, although perfectly willing to bear their share of the burden of the defence of their own homes. It should therefore be stipulated that they are not to be called out for service in others than designated harbor fortifications. While subject for duty under the state authorities within the limits of their counties, they should not be subject for duty in suppressing riots beyond such limits. They should be exempt from jury duty while serving, and if their service be honorably rendered for ten years continuously, they should be exempt from such duty for the remainder of their lives. Such exemption will be highly prized by business men, and will be an important element in rendering the service in the heavy artillery organizations desirable. They should be given opportunities of interesting practical artillery work in conjunction with the regular garrisons, participating with them in the artillery firing practice and other operations. Rivalry between the different organizations should be stimulated by prizes and honors conferred for excellence in target practice and other work. The allowance of ammunition should be liberal. A free use of sub-caliber tube firing may be permitted without involving much expense. To constantly manipulate guns without firing is wearisome. There is a great fascination in actually firing the guns at a target of any kind, and this attraction should not be withheld. Last, but not least, of the inducements for joining these organizations, is an attractive dress uniform for parade purpose.

As indicated by Lieutenant Allen, the nucleus of the work and organization in this direction has been well started in several of the states. It requires only agitation, coupled with a favorable disposition of the War Department, to initiate the little legislation which is requisite. It is wise not to attempt too much at first, and to aim to minimize the amount of the appropriations asked for. The average legislator is prone to be chary of expending money in times of profound peace, for military uses. As time progresses and the organizations are well started, more can be obtained, as there will be a body of influential citizens, who are voters, to back up the requests.

Lieutenant Allen's estimates of the number of men required to man the sea coast and lake fortifications are too small. He has not given sufficient weight to the requirements of a region which is continually growing in importance, both from the richness of the adjacent regions and vicinity to the British possessions. I refer to the Puget Sound region. This country will greatly increase in its commercial importance. I predict that the star of empire will move towards the great north-west, as yet undeveloped.

The lakes, also, are not fully provided for in the general scheme of defence. The Canadians have a large number of steamships in both Lake Michigan and Lake Superior. These could be quickly provided with powerful quick and rapid firing guns and seriously threaten our large cities, such as Chicago, Milwaukee, Duluth and others. The Straits of Mackinaw and the passages up into Lake Superior must be strongly fortified, demanding considerable garrisons.

The number of guns to be mounted will in the end exceed largely the number now alloted. This will be particularly the case in the addition to the number of 12″ mortars, and a much more liberal provision of high power quick and rapid firing guns up to 6″ caliber. These last have hardly been provided in the scheme as it now exists.

For example—the Endicott Board scheme for the defence of New York Harbor calls for 144 mortars. I venture to say that this number will, at no very distant day, attain to a magnitude of at least 500. A similar increase is likely to take place in the defences of other harbors.

A large number of mortars are desirable for the reasons that they are capable of doing effective work, are not expensive, either in themselves or in the requisite emplacements, and can be operated by men who are not highly trained, if directed by comparatively few skilled artillerists. The paucity of these latter can be partially made good by supplying a larger number of weapons that can be effectively manipulated by hastily levied troops.

Mention is made of the desirability of the artillery knowing the resisting ability of the armor of the enemies' ships and their especially vulnerable points. While I agree to this, I wish to protest against the attempt to adjust too closely the potentiality of the defensive armament to the supposed strength of resistance of the enemy. What may be more than sufficient to-day under the assumed conditions, may be insufficient in less than a decade, or even before the armament is mounted. It is wiser to plan to make the defense in all cases overwhelming in character, with a very large margin to spare over the existing requirements.

These considerations point to the desirability of planning for an artillery force of not less than 100,000 men. Planning is easily done on paper, but such planning is a necessary preliminary to a realization of any kind.

In the details of the organization plan, Lieutenant Allen has not provided for very necessary grades of non-commissioned officers demanded by the advances of modern artillery. There should be special grades of artificer sergeants and electricians to operate and help to repair the steam and electrical plants that will now be so largely used.

RANGE AND POSITION FINDING.

By WILLIAM LASSITER, Second Lieutenant, First Artillery, U. S. A.

My subject may be divided for discussion as follows:

1. Necessity for the adoption of suitable range and position finders.

2. Essentials of a good range and a good position finder, with some account of the principles involved in the instruments now generally used.

3. Employment of a position finder in connection with a system of coast defence, involving direction and control of fire.

I. NECESSITY FOR RANGE AND POSITION FINDERS.

Range finding may be defined as the determination of the horizontal distance of one object from another; as, of the target from the instrument, or of one distant object from another.

Position finding may be defined as the determination of the horizontal distance and direction of one object from another; as, of the target from the instrument, the central station, or the gun.

The necessity for such instruments has arisen from the improvement in small arms and artillery; as the ranges possible with our improved weapons have steadily increased, the sharpshooter and the gunner can no longer rely upon his eye for the determination of distance. Further, with respect to the heavy artillery at least, the life of the gun is shorter, and the cost of each round of ammunition very much greater, than under the old conditions. Hence if we expect to utilize the full power of our weapons, and at the same time obtain a fair return from the outlay represented by each shot, all possible means must be taken to make each shot tell. To do this, one of the first considerations is to know accurately the distance to the target. This is a need which is felt to a greater or less extent, by all the fighting arms of the service. The cavalryman finds a light portable range finder of the greatest assistance on scouts and reconnoissances, especially for map making.

The infantryman is provided nowadays with a rifle sighted up to 2000 or even 2500 yards, but is taught to feel that there is little or no use for him until the enemy is within 800 or 1000 yards The tendency of infantry tactics just now, however, seems to be in the direction of a reaction from the every-man-for-himself method, and rather toward some closer formation which will allow officers to keep control of the men. To cross the danger zone, less reliance then must be placed upon the individual seeking of cover, and more upon a well directed preparatory fire of artillery and controlled infantry fire, with the idea of shaking the enemy. The enemy can only be thus shaken, however, by silencing his artillery and keeping an accurate fire directed upon his infantry; and it would seem that the side which could begin this accurate fire the soonest would win the advantage, other things being equal. If we are not able to give our men the correct ranges for this long distance fire, necessarily the fire will be thrown away, and the more so as the weapon is accurate and the men well trained to shoot at the ranges indicated to them.

The light artilleryman, now that his weapon is capable of ranges of over 5000 yards, must necessarily have some sure means of "finding" the target, if fire is to be attempted at all at these long ranges. He should not only be able to "find" it, but to do so quickly and with the least waste of ammunition. With the present accuracy of field guns and the great possibilities of shrapnel fire, the side which can open with accurate shrapnel fire first will certainly have a very great advantage. Nothing, it seems to me, in connection with field artillery should be more insisted upon than this. Whether we can rely upon the range finder and open this shrapnel fire at once, or whether we should begin with trial shells according to the bracket system, is a question that has been much discussed. It is claimed as against the range finder that what we want is not so much the actual range as the "relative" range; in other words, what we want to know is how to direct the gun, so that, for given conditions of wind, of atmosphere, of powder, etc., we will cause the mean trajectory to pass through the target. This is very true; still a range finder that did its work properly would be a most important adjunct to a battery.

1. As serving to reduce the number of trial shots to a minimum.

2. As giving us something to rely upon, when,—due to shots being lost, or confounded with shots from other batteries, or from other causes,—the bracket system fails.

I do not know that a position finding system, as such, has ever been suggested for field use; it seems to me, however, that as ranges increase, and indirect and high-angle fire are more extensively developed for field use, the need of some system of this kind will be more and more felt. This will be particularly the case in service over a rough and wooded terrain such as we may expect generally in our own country. Of course it is rather groping in the dark to attempt to write on such a subject without having had the least experience in field service; but after reading of, and listening to, descriptions of the great difficulty experienced during our late war owing to the inability to see the target on account of intervening obstacles, it does appear that a system which would enable our batteries under these circumstances to open an indirect or high angle fire of reasonable accuracy would be a great desideratum. Another factor, and one whose consideration leads to the same conclusion, is the introduction of smokeless powder; it would seem that at the very great ranges possible with the new weapons, a hostile battery may open and keep up a telling fire upon us from a position which we are utterly unable to locate. If its guns make no smoke, it might very readily be so disposed as to conceal its position from us entirely. In short, it appears that a system might be devised whose objects would be to overlook the whole terrain; to locate the position of batteries or of masses of infantry and cavalry concealed or held in reserve behind inequalities of the ground or other obstacles; to designate these positions to our artillery and perhaps infantry; and, finally, to aid in directing their fire upon these batteries and masses. If such a system be possible on the battle field, its adoption would surely give many advantages to the side making use of it.

In the case of siege artillery, the range finder has not heretofore been so indispensable as in the other cases mentioned, since, for the defensive, the terrain could be so thoroughly studied that the distance would be at once known to any position an enemy might occupy; while the offensive would, as a rule, have but one objective, and that a large one whose range could readily be found. With the substitution however of intrenched camps and detached forts for single elaborate fortresses, the conditions are considerably altered. As the defence gains in mobility, in the ability to move his guns quickly to any point of a large defensive position, so the conditions assimilate for both sides more toward those which obtain in the case of field artillery, and the more the need will be felt of some system for range or position finding.

It is with sea-coast artillery that range finders are of the greatest importance; and this not only on account of their use as such, but also on account of their development into position finders, which, as will be seen later, form such an important element in the system of fire control. There are three principal methods open to the sea-coast artilleryman for the determination of his range:

1. Ranging by means of trial shots.
2. By use of the range finder.
3. By using the position finder.

RANGING BY MEANS OF TRIAL SHOTS.

This method has the advantage of being simple and of not requiring calculations for corrections. It is conducted about as follows:

Some of the guns of a group of similar natures are detailed as "ranging" guns; the rest are "salvo" guns. The salvo guns are laid for a certain range at which it is desired to fire; the ranging guns are laid for a greater or less range than this, depending upon the direction in which the target is moving (assuming a movable target), and by an amount which depends upon the speed of the target's motion. The "ranging" guns are fired at intervals until the target appears to have reached the range for which these guns are laid. After a short pause the salvo guns are then fired. The difference in the elevation given the salvo and that given the ranging guns, is supposed to make allowances for the time taken up in observing the ranging shots, that required to fire the salvo guns and the time of flight of the projectile. In the case of a stationary target, all of the guns are used to find the range, or in other words the well-known "bracket system" is employed. The use of such a system as this would hardly suggest that we were getting the best work out of the costly weapons entrusted to us. Of course we can hardly expect, considering all the difficulties that now beset the gunner, to start in with hits from the first shot. Good shooting, it is believed, can only be obtained by ascertaining first the exact position of the target relatively to the gun; by making this the basis of a calculation of the corresponding angle of elevation to be given the gun, corrected for the conditions under which the firing is taking place; and, lastly, by carefully observing the fire, to make the needful corrections for subsequent rounds. All this may seem at first sight to entail complications that would be embarrassing on the day of battle, but systematized and aided by proper mechanical devices, surely more can be hoped from it than from a system which avowedly throws away a certain proportion of its shots, and which, in its application to the moving target at any rate, employs a loose and irresponsible mode of firing, which only by great good luck can be the cause of any damage to the enemy.

We must go at the matter more systematically; and the first step, as mentioned above, must be to find out exactly how the target is situated with respect to the gun. This brings us again to the need of a range or a position finder.

DETERMINATION BY USING THE RANGE OR POSITION FINDER.

Whether we are to rely solely upon a simple range finder for the service of coast defences, or whether we are to elaborate this into a position finder, is a question to be determined by the system we are to adopt for our sea-coast works. There is on the one side the system, which, if we may be said to have any at all, seems to be ours at present, viz., that while the ranges may be furnished from a central station, the gunner or an officer at the battery must do all the rest; must find the target, make the necessary corrections in range and deflection, aim the piece and fire it. The data as to the fall of shots relative to the target is supposed to be sent from the central station by telephone or otherwise, and corrections then made for the next round. Reliance is only to be placed according to this system in fire, conducted by actually sighting each piece upon the target. There are probably many advantages in connection with such a system, at any rate on the side of simplicity, if its details were properly worked out, and a general application of it as a whole insisted on. We have, however, no general method used of indicating to the gunner what particular target he is to aim at. I once saw an attempt made under our present so-called system to indicate by telephone, from the central station to the battery, the centre of a distant square at which it was desired to fire. The instructions were to aim at a certain building on an island in the distance, and to give an elevation suitable for the known range of the square. The result came so near being disastrous to the buildings on the island, in the opinion of all those watching the fire, that we were hurriedly told to try some other method. Of course the direction *might* have been indicated by suitable graduations on the traverse circle, but no such method had been prepared, and the bare possibility of its existence would not have helped matters much if we had wrecked one of the buildings on the island referred to. So much for this system, which only calls for a simple range finder.

Another system proposed is that which involves the control of fire by the officer directing the defences. These defences are so divided, and perhaps sub-divided, according to their extent, as to embrace a complete system of subordinate commands—the lowest being the group consisting of a number of guns of similar natures, so situated as to be capable of being directed by a single commander. The commander of all the defences capable of acting in the same vicinity, called the District Commander, indicates the objectives to the commanders of the larger units, the Fire Commanders; these in turn apportion the targets, or the particular portions of the targets to the Group Commanders. The Group Commander indicates on a dial at each gun the range and training desired, and may, when assured that the guns are properly aimed, fire them by electricity, singly or in salvoes. Such a system demands something more than a simple range finder; a position finder is evidently required.

Briefly, to emphasize the distinctions between the two systems, it may be said that the first relies finally upon the efforts of the individual gun detachments; the second relies first and last upon the strictest fire control and requires only mechanical duties of the gun detachments.

It is not within my province in this paper to discuss the relative merits of these two systems; but owing to the superior advantages offered for unity of directicn and for power of combined effort, as well as for the possibilities it opens up in the way of indirect and high angle fire, there is little room for doubt that if we are to adopt any system at all, some form of the system last outlined should be worked out and put into practice.

If this be done, we must, as said before, be provided with a position finder, and must moreover devote ourselves to perfecting the details of a complete system; such details, for instance, as a suitable means of communication, automatic indication of range and training to the guns, accurate laying of guns corresponding to these indications, and others—all of which must work harmoniously together in order to insure anything like satisfactory results from the system as a whole. The basis of such a system certainly appears to be the correct one; this being unity of control and the most perfect division of duties from the highest commander down to the lowest. This being assured, we may believe that with due effort the details of the most perfect system will gradually work themselves out.

II. ESSENTIALS OF RANGE AND POSITION FINDERS.

To begin with, the conditions of range and position finders and the demands made upon them in the field and in sea-coast works are so different, that it is hardly probable that we will be able to find one form of instrument that will fill the demand of both services. It is proper then to consider the character of the instruments, and the facilities to be provided for each of these distinctive conditions.

RANGE FINDING IN FIELD SERVICE.

As a rule, more will be expected of a range finder by the artillery than by the infantry and cavalry. The latter must have an instrument which is portable and quick in its operation. The former can afford to sacrifice these considerations somewhat to insure accuracy at the longer ranges. Still it is thought that these requirements are not so antagonistic as to prevent their being filled by a single instrument; while it would be a great advantage to have to provide but one instrument, which, either of itself or with suitable modifications, would be applicable to all the various mobile services.

Such an instrument should be

1. Light, portable, and rapid in its operation.
2. Simple in construction and easily worked under all sorts of conditions.
3. Not liable to breakage or any derangement due to rough field usage.
4. Not liable to fail in use during rainy and misty weather on account of loss of light due to a multiplicity of prisms, reflectors, etc.
5. Capable of determining ranges as great as those ever likely to be used with the gun, with an error of not more than 1% of the range.
6. Not necessitating the measurement of a base; thus using either a fixed base or determining its length automatically.
7. Capable of showing the range at once; thus dispensing with the need of calculating devices.

No instrument has as yet been devised, so far as I know, capable of filling all these requirements; but I think in adopting a range finder we should take one that embraces all of them to a greater or less extent.

As said in one of the papers prepared for the recent World's Fair Congress (that of William Oliver Smith): "If a telescope could be constructed so that the mere fact of focusing the objective was sufficient to record the range, we should have attained the ideal instrument. Such an instrument, however, is still in the ideal stage."

Without waiting for this ideal instrument, we should take the best instrument we can find and start some sort of instruction in range finding. As in many other departments of our profession, what we need is a start in the right direction; this once initiated some good results are very liable to follow.

The instruments that are principally devoted to field use now are those which operate by means of prisms or mirrors, employing a short base either fixed or variable in length.

Thus we have the Watkin and Weldon in England, the Goulier in France, the Souchier in Russia, the Unge in Sweden, and the Pratt and Gordon in our own country. All of these operate on the above principles. Germany does not employ range finders for field service, from all that I can gather. Italy has the "Braccialini 1886, pattern of Amici," and Austria an instrument invented by Captain Rocsaudre of the Austrian service. The Italian instrument is, I believe, similar to those above mentioned; of the Austrian, I have not been able to find any description.

POSITION FINDING IN THE FIELD.

Captive balloons, accurate maps of the country, telephonic or telegraphic communication, naturally suggest themselves as the essentials of such a system. Where an accurate and complete map of the terrain is available and the operators familiar with the natural landmarks of the country, the map would probably be sufficient for range and position finding purposes; the range would be given directly, having been taken off by a suitable scale, and direction indicated either by reference to natural and conspicuous landmarks, or by the use of compass readings.

A crude system such as this outlined, could hardly hope to direct an effective fire upon any but large targets, such as masses of the enemy on the march or held in reserve. But such a system becomes more and more necessary as armies increase in size, and as we depart from the days when a general could overlook the movements of the troops serving under his direction. A position finding service of the kind mentioned would adapt itself to supplying to the general in command valuable information as to the relative positions of the opposing forces, while as for its particular use of directing fire upon portions of the enemy concealed from view, it is believed that the conditions of actual service would quickly suggest refinements that would enable us to reap great advantages from this kind of fire.

RANGE AND POSITION FINDING IN SEA-COAST WORKS.

Range and position finding are so intimately connected with one another as generally applied to the purposes of coast defence, that I may describe at once the essentials of the required instrument or system. A position finder must first of all be a range finder, and differs from the latter in the objects aimed at only in this: that the position finder gives, besides the range, the azimuthal direction of the target. This latter property, as enabling us to fix accurately the location of the target with respect to guns, mine fields, etc., is so advantageous, that we should undoubtedly adopt a position finding system rather than a simple range finder.

The essentials of such a system would appear to be in the main as follows:

1. By the mere fact of keeping the instrument directed on the target, it should show continuously at a central station and at the guns, the range and direction of the target from the guns.

2. It should permit being shifted quickly from one objective to another, and with certainty of at once being directed upon the desired objective.

3. By observations on the points of fall of projectiles, it should be able to furnish data for subsequent corrections in range and training.

4. It should adapt itself to all sites and permit of being readily concealed.

5. It should be simple in construction and operation; a system embracing many delicate mechanisms, and requiring for its operation the cooperation of many persons, would be pretty sure to break down when most needed. Such a system would be worse than useless.

The best position finder will be a single instrument, fulfilling the foregoing conditions, and capable of being worked by a single man.

Many efforts have been made and are still being made, to provide a suitable position finder; these efforts have been directed along two particular lines, viz:—towards perfecting

1. A depression position finder.

2. A system employing a horizontal base, generally as long as possible, with electric communication between the two ends.

The depression offers the advantage of requiring but a single instrument; but the causes of possible error involved in its use are many, and to account for these in the working of the instrument itself, costly and elaborate contrivances are at present required. The errors referred to are those due to refraction, normal and abnormal, to the sphericity of the earth, to the rise and fall of the tide, and to the difficulty of reading on the water line of the ship owing to the roughness of the water. Moreover the instruments are applicable only to the service of the batteries in the vicinity of which sites more or less elevated can be found; the more elevated the site the more accurate are the results obtained in the use of the instrument. Taking this fact into consideration with reference to the applicability of the depression principle to our own coast-defence system, it would seem that the instruments embodying this principle would hardly adapt themselves to general use. On our Pacific coast, the desired elevations could, I think, be generally found, but on the Atlantic and Gulf coasts such an elevation would, from all I can gather, be the exception rather than the rule.

Taking fifty feet as a minimum elevation, at least as an elevation below which it would not be advantageous to employ depression instruments, I have asked the opinion of the Superintendent of the Coast Survey as to the probability of generally obtaining even such elevations. He writes "In reply to the general question as to the proximity of hills to the ocean which would furnish an elevation of not less than fifty feet, in locations where a wide view of the coast could be had, I would state that such is not generally the case along our Atlantic and Gulf coasts; lighthouses advantageously situated for your purpose are as numerous as the hills, if not more so."

What expedients, if any, the advocates of this class of position finders have in mind for adapting their instruments to all sites, I do not know. The instrument in use in England, the Watkin, has to be especially constructed with reference to the locality in which it is to be used, taking into consideration the height of the instrument, and the height of the batteries above the water and the nature of the channels to be defended. "The instruments are graduated to suit different heights, and are distinguished as Mark I, Mark IA, B, C, or D.

Mark I are graduated from 80 feet to 200 feet.
Mark IA are graduated from 50 feet to 125 feet
Mark IB are graduated from 100 feet to 250 feet.
Mark IC are graduated from 240 feet to 600 feet.
Mark ID are graduated from 25 feet to 50 feet.

Special are graduated for heights that do not come within the above."

Thus instruments are provided for sites having less than fifty feet elevation, but it is believed that with reference to English coast defence, such sites are considered exceptional. The Lewis position finder, invented by Lieutenant Lewis, 2nd Artillery, is another instrument of this class that has been spoken of very highly. I have not however been able to obtain any description of it, nor any account of the accuracy to be expected from it in use.

The other class of position finders, those employing a horizontal base line with operating stations at the two ends, connected generally by electricity, does not have to contend against the many natural sources of error involved in the use of instruments of the depression class. The principal obstacles to the development of a satisfactory instrument or system of this class, lie in the difficulty of indicating the desired objective to the two observers, and in the difficulty of combining instruments and means of communication at once quick and accurate in their operation, and not liable to break down on account of complicated mechanisms or lack of cooperation on the part of the personnel employed. The most carefully worked out systems of this class I have been able to discover are those prepared by Lieutenant Fiske of our navy and by Captain Weiss of the French army respectively (see for the latter, *Revue Maritime et Coloniale*, February, 1894). But judging only from descriptions of the two systems, it would seem that the Fiske system was open to the objection of involving delicate mechanisms, as seen in the difficulty of quickly balancing a Wheatstone Bridge or of quickly bringing a galvanometer needle to rest, while the Weiss system certainly offers many chances for magnifying errors due to the many instruments and operators employed.

After all, while waiting for something better, it is in our power to obtain very good results from the simple and unpretentious position finding apparatus, at present in our hands. We have at the Artillery School with comparative ease plotted the positions of a moving target at intervals of 20 seconds. Assuming that fear of torpedoes or the dangers of an unknown channel would force a hostile fleet, if not to anchor as quickly as possible for fighting, at least to keep down to a speed no greater than 10 miles an hour, readings every 20 seconds would correspond to positions about 100 yards apart in a vessel's course. With the system working methodically—necessary corrections in range and training quickly estimated and applied, and the resulting information quickly transmitted to the guns,—such data should enable us to keep up an accurately aimed fire on such a target. But unless the details of such a system are carefully worked out, appreciated and practiced, it would give rise to nothing but confusion, as those who have had any experience in these matters well know. There may be in somebody's mind systematized ideas as to what the Coast Artillery is going to do in case a hostile fleet comes sailing into view; undoubtedly every Coast Artilleryman, who has devoted any thought to the matter at all, has his ideas as to what ought to be done; but the fact remains that if the said fleet should come sailing into any of our harbors to-morrow, what would actually take place may be easily prophesied. Assuming that guns and ammunition are available and ready for use, and that the members of the garrison or garrisons are all at their proper posts, some attempt would probably be made by the officer in command to start the range finding system to working, to furnish the range to the guns, and to direct captains of batteries on what particular vessels to fire. But there has been no previous attempt to exercise the garrison as a whole in its duties; the batteries separately have had drills more or less perfunctory in the motions of moving the guns in and out of battery, loading and firing; the range finding apparatus has been used perhaps once a year to assist the individual batteries in their target practice. But no provision at all has been made for the time when all the batteries of a garrison are to be in action at once, when they are to be kept supplied with ammunition, when they are all to be informed of the range and the situatiou of their respective targets, when the commanding officer is to assume general control and direct the fire of the units under his command in the most advantageous way: in other words, for the time when all the component parts of the defence should be able to co-operate to inflict the greatest amount of injury upon the vessels of the hostile fleet. When the time for action comes, what is the result? There is no general plan of organization, there is no system. Can we hope for anything but misunderstandings and confusion? The commanding officer cannot communicate with his subordinates except by messengers; facilities are provided for sending ranges, etc., to but one battery at a time. The action opens. Captains of batteries get tired of waiting for information and instruction from the central station; they tell the gun detachment to go ahead, to commence firing. Soon all the guns that can find ammunition are firing; and only the gunner, the chief of detachment, or the subaltern in charge of each gun, knows at what vessel his gun is being fired, and even this person is lucky if he knows where its shots are striking. Thus all concert of action is lost.

This picture may be overdrawn, but I do not believe that it is; certainly we have no reason to expect that a better state of affairs should exist. Even at peace practice, where but one battery was firing, I have seen our supposed system pushed aside in much the same way. The captain thought that the data as to where his shots were striking came in too slowly from the central station, became irritated over the delay, and directed his lieutenants to go on with the firing, saying that all he wanted of the operators at the central station was that they should keep the record.

I have gone somewhat out of my way in this paper to refer to our complete lack of system with respect to coast defence, and to the half-hearted way in which even the means and apparatus under our control are made use of. But it seems to me that there is little use in adopting a range finder, a position finder, or any of the other generally recognized essentials of a modern artillery service, until we have some intelligent, generally understood and established scheme for combining all these essentials to effecting the common purpose. This scheme can only be so established by those in authority, but it is for artillery officers to study out its details, and to give some sign that the service they represent is ready and ripe to receive it.

III. EMPLOYMENT OF A POSITION FINDER.

As for the employment of the position finder in connection with a coast defence system, developed on the lines of fire control, it would seem that a position finder should be provided for the district commander, one for each of the fire commanders, and one for each group commander.

Let us take the case of the system perfectly developed according to the principles before outlined, where the fire is entirely controlled by the higher commanders. (The system is none the less supposed to be so flexible as to admit of the individual guns being aimed and fired on the target, should choice or necessity dictate).

The district commander, then, by the use of his position finder and a chart showing the zones of fire of the various forts, watches the approach of a hostile fleet—to take a general case—judges when fire should be opened and by what forts or groups of guns, and then gives his directions to the fire commander. The fire commander by the use of his position finder and some such chart as that referred to by Lieut. Zinn in his contribution to the *Journal* for April, 1894, locates the position of the vessel or vessels assigned him, sees what guns and groups of guns can fire upon it, and indicates the objectives,—a vessel or a particular portion of a vessel—to his group commanders. The group commander has his position finder turned upon the vessel assigned to him, and kept there until some new objective is indicated. He has already had his staff work out the corrections to be applied for existing conditions or reads them off directly from some suitable calculating mechanism. It should be possible to "set" the indicating device, so that these corrections would be at once applied to the range and training sent to the guns: this "setting" could then be changed from time to time, so as to bring the mean trajectory of the gun upon the target. We might account in this way for all the corrections necessary to be made on account of powder, wind, drift, hygrometric and barometric conditions. For a vessel in motion, the group commander can by reference to a chart determine its speed and direction of motion: an allowance must be made in range and training, which is a function of this speed and direction and of the time of flight of the projectile. When the vessel is moving, let us say, obliquely across the field of fire, this complicates the matter considerably, if this correction also is to be made at group commander's station before being sent to the gun.

If again, by the construction of our indicating device, we are enabled after a consideration of the duration of the time of flight and the changes shown on the dials in range and azimuth during that time, to "set" our indicators ahead or behind by the proper amount, we could always keep the guns so aimed with respect to the vessel as to allow for its changing position.

If an automatic indicating system can be devised capable of performing all these functions, the gun detachments, after loading the pieces, would only have to keep them elevated and trained so that indices, controlled by the mechanism of the carriage and superimposed on the dials showing range and training, would always coincide in position with the readings shown on the dials. Such a system would necessitate gun carriages very accurate in construction, and means of communication between the central station and the gun absolutely certain in their operation.

SUMMARY.

The conclusions reached through this study of the subject may be summed up as follows:

1. If we are to obtain the complete benefit of our modern weapons, we must have range finders.

2. If we are to make use of indirect and high angle fire, and

expect to establish a complete system having for its object the direction and control of fire, we must have position finders.

3. We are to rely upon range and position finders only to give us accurate information as to the situation of the target we expect to fire upon. On the data thus obtained we must base our calculations as how best to aim the gun to insure its projectile's trajectory passing through the target.

4. Perfect range and position finders are still only in the ideal stage. However, of the apparatus now obtainable some form of the prism or mirror instruments is probably the best for field use; while for the sea-coast service, a system involving a horizontal base with the best obtainable electric communications will probably prove the most suitable for us, as well as the most easily obtainable on account of its relative cheapness.

At any rate, even if we are not provided with the most improved apparatus, we should turn our attention to developing the means already in our hands—a motto, by the way, which if generally applied in our service might result in many changes for the better.

THE USES OF THE ARTILLERY-FIRE GAME.*

By First Lieutenant JOHN P. WISSER, First Artillery.

All instruction of officers and men in time of peace has for its object, of course, to prepare for war. Now there are several different modes of conducting the course of instruction for imparting the knowledge desired in any given case. The instruction may, in the first place, be purely theoretical, and given a semblance of reality by illustrating the principles established from the events of military history; in the second place the subject may be studied and made somewhat more real by means of Kriegsspiel, in which the movements are made and studied on a map, or better on a miniature representation of an actual field; in the third place, a still closer approach to reality is attained in the practical field instruction on the natural ground itself; and finally the conditions of actual war are almost reached in the practical field maneuvers, as conducted on a grand scale by the European armies. Each of these methods has its advantages, its disadvantages and its limitations; indeed, the most thorough system of instruction includes them all, and in the order given, each method depending more or less on a knowledge of and training in those which precede it.

The theoretical instruction, including the study of military history and campaigns (in addition to the principles of tactics and strategy), constitutes perhaps the most attractive branch, partly because it has been made interesting by the most able writers, but partly also because it is so easy of execution; nevertheless, the knowledge thus acquired is not generally sufficient for the subordinate officer. Kriegsspiel, properly conducted, is a very valuable aid in instruction, because it teaches an officer to

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* *The Artillery-Fire Game.* Rohne. Translated by John P. Wisser. Artillery School Press, Fort Monroe, Virginia.

apply the principles he has acquired to an actual case—to a particular kind of topography or other conditions. In practical field instruction, again, the officer has the field and its topography, all parts in their natural sizes and relations, moreover the conditions of weather and light are added and are actual conditions. In the maneuvers we have, besides all this, the troops, and at least in a degree the noise and stir of battle. Thus we see how closely the different methods are related, how interdependent they are, and yet how the conditions, objects aimed at, and results obtained in the instruction differ.

The theoretical instruction is a necessary preliminary to the intelligent use of the Kriegsspiel, for without it the time of the other players has to be taken to instruct him who is deficient in the principles of minor tactics, hence, tedious and unnecessary delays result; these principles may be made second nature (and much else that is useful may be learned) by means of Kriegsspiel, and the way may thus be prepared for practical instruction in the field, rides of instruction, etc., so that when the officers are out in the field with the instructor, it will not be necessary to refer to tactical rules or methods, but the simple statement of the case will be apparent to every one as sound tactics or strategy, requiring no explanation or comment, and only the relative values of different methods (all of which may be sound) will be the principal subjects of discussion; finally, when the officer takes his place in the field maneuvers, he can devote all his time to actually conducting his command,—he knows what ought to be done, he has only to *do* it.

The Artillery-Fire Game is a part of Kriegsspiel, a simple subdivision of it relating merely to the *fire* of the artillery. In its present form it is the invention of Colonel H. Rohne, of the German Artillery, for many years instructor at the Artillery Firing School, and has been used by him in his own regiment with great success. Firing is expensive and is therefore limited as a rule, to a certain number of shots for each gun or battery. Now a great many of the phenomena attending artillery practice may be learned by means of this game and Kriegsspiel proper, without any actual firing at all; therefore, when the officer after such instruction arrives on the firing ground, he can concentrate all his attention on the work there, especially that part which is the most difficult to study and learn, viz: the art of correct and rapid observation of the shots, as well as that other most important factor in conducting properly the fire of a battery, viz: the skillful application of the firing regulations (or, in our service, the principles of correct firing, since we have no published firing regulations). The phenomena above referred to can be learned very well by means of the Artillery-Fire Game.

The game as arranged is based theoretically on true principles as is shown in Section I of the book, but it is not deemed necessary to go into the discussion on that point in this connection. The tables (Appendix I of the text) may be used for our 3.2-inch field gun as they stand; for any other gun in service tables may readily be constructed after certain data have been obtained from actual firing.*

Now, to illustrate the simplest application of the game:

We will take the case of a captain of a light battery acting as director, the senior first lieutenant, *X*, as commander of the battery for the time being, the junior first lieutenant, *Y*, commanding the first platoon, the second lieutenant, *Z*, commanding the second platoon, and we will suppose these officers assembled in the lecture room.

The director decides privately (without communicating this to the others) that the observation conditions are poor, viz: 60 per cent. (1 to 60) correct, 32 per cent. (61 to 92) doubtful, and 8 per cent. (93 to 100) false. He then proceeds to draw for *deviation* one number from a bag containing a hundred little squares of pastboard numbered from one to one hundred, and records it in a table (see below); returning this number to the bag he draws another for *observation*, and so on; the entire result of thirty drawings for each of these objects is recorded in a table which the director holds for reference. He decides (privately also)

* We will construct such a table for the 8-inch rifle (converted) from such firing records as may be available, and append it to this paper, in order to illustrate the mode of procedure in any case. In testing our new guns it would be of great value to the artillery to have all shots *observed*, as more information can be obtained during the preliminary testing (2500 shots have been fired from a single gun at Sandy Hook) than in years of artillery target practice. The data required are the points of striking on a horizontal target, or the points of bursting in vertical side elevation.

that the deviations, on account of poor powder, strong wind, etc., are large, and from the first set of lottery numbers drawn (those for deviation) constructs, by means of the tables appended to the book, using percussion shell only, the third column of the following table. He then assumes (also privately) that the actual distance is 1920 m., and constructs the fourth column of the table; the rest of the table is explained below:

Shot.	Lottery number.	Deviation. m.	Actual target distance minus deviation. m.	Lottery number.	Observation.	Range ordered.	Position of shot with reference to target. m.	Information imparted by the director after each shot fired.
1	17	— 50	1970	98	f	1800	— 170	*Over**
2	18	— 50	1970	81	?	"	— 170	Doubtful
3	4	— 100	2020	11	c	"	— 220	Short
4	38	— 15	1935	74	?	"	— 135	Doubtful
5	59	+ 10	1910	43	c	"	— 110	Short
6	74	+ 30	1890	45	c	1900	+ 10	Over
7	68	+ 25	1895	95	f	"	+ 5	*Short*
8	50	± 0	1920	96	f	"	— 20	*Over*
9	35	— 20	1940	100	f	"	— 40	*Over*
10	49	± 0	1920	13	c	1850	— 70	Short
11	78	+ 40	1880	59	c	"	— 30	Short
12	36	— 20	1940	60	c	1950	+ 10	Over
13	62	+ 15	1905	68	?	"	+ 45	Doubtful
14	82	+ 45	1875	57	c	"	+ 75	Over
15	51	± 0	1920	14	c	1925	+ 5	Over
16	47	— 5	1925	81	?	"	± 0	Doubtful
17	48	— 5	1925	34	c	"	± 0	Target
18	58	+ 10	1910	24	c	"	+ 15	Over
19	48	— 5	1925	94	f	"	± 0	*Over*
20	38	— 15	1935	22	c	"	— 10	Short
21	54	+ 5	1915	98	f	"	+ 10	*Short*
22	45	— 5	1925	1	c	"	± 0	Target
23	24	— 35	1955	72	?	"	— 30	Doubtful
24	61	+ 15	1905	18	c	"	+ 20	Over
25	85	+ 55	1865	4	c	"	+ 60	Over
26	6	— 85	2005	11	c	"	— 80	Short
27	98	+ 100	1815	79	?	"	+ 110	Doubtful
28	41	— 15	1935	66	?	"	— 10	Doubtful
29	100	+ 140	1780	72	?	"	+ 145	Doubtful
30	27	— 30	1950	40	c	"	— 25	Short

* Those in italics are false, having been so observed.

The director then informs Lieutenant *X* that he is to fire on a battery which has already opened fire on him, and is standing directly in front of him at a distance estimated at 1850 m.

Lieutenant *X* commands: "Percussion shell, on firing battery directly in front, third piece, 1800, from the right flank, commence firing!" Lieutenants *Y* and *Z* command "*Range 1800 m., with shell*, LOAD!" And when ready Lieutenant *Y* commands, "*Number one*, FIRE!" and so on to the left of the battery. After each shot the director announces (after consulting his prepared table, subtracting algebraically the numbers in the fourth column from the ranges ordered) whether it is "*short!*" or "*over!*" or states that the observation of it left it "*doubtful*" as to which it was; of course, if it be actually *over*, while the observation of it happened to be *false*, he calls it "*short!*" (see ninth column).

At the ninth shot Lieutenant *X* orders the range (elevation) 1900 m., and as the observation of this shot was *over* and the next *short* he keeps it up for two more shots, after which he orders 1850 m. for the tenth shot, 1950 m. for the twelfth shot, continues at that to include the fourteenth shot and then comes down to 1925 m., the correct range, and keeps that to the end.

The ranges ordered are given in the seventh column of our table, the actual deviation of each shot from the target (numbers of seventh column minus numbers of fourth column) is given in the eighth column, and what the director calls out in each case is given in the ninth column. Of course the lieutenants know only what is given in the seventh and ninth columns.

After the game is over it is discussed. The interesting points are brought out by the director, violations of the firing regulations are noted and approved or disapproved, according to the circumstances, improvements are suggested, and so on. In the firing before us it is seen that the false observation of the first shot, and the fact that the observation of the second and fourth left it doubtful as to whether it was short or over, prevented Lieutenant *X* from seeing that his range was too short for five shots; and again, the three consecutive false observations in the next four led him to lower the elevation when it should have been raised; his next two shots (10 and 11) showed him, however, that he was too low, and he therefore goes at once to 1950 to establish the short fork (the limits between which the true range lies); shots 12 and 14 decide him to come down to 1925, which he keeps to the end.

Such a firing record does not differ essentially from those resulting from actual firing, and therefore its study will give quite as much information. From the discussions given in the text it is evident that much may be learned in this way, and after a number of games of this kind under various conditions have been played, the officer can take up the actual firing with a much more intelligent idea as to what is liable to happen, and a much more definite idea as to his proper action in any given case, and of course, to teach that is one of the main objects of the game. The firing with shrapnel furnishes a much more interesting game, and the study of the record is even richer in lessons than that with percussion shell; in the case of torpedo-shell we have still other conditions entering into the problem. In all cases of shell with time fuses (shrapnel, etc.) the director assumes (besides the previous assumptions) whether the fuses burn normally, or so much (in metres or yards) too long or too short a time. Finally in firing against a moving target, such, for example as infantry advancing, we must also assume a certain rate of advance. All these applications of the game are fully explained and illustrated in the text.

Now to illustrate another application of the game, we will take the case of a practice firing with the 8-inch rifle, converted, m.l., using the tables appended to this paper. We will suppose each shot located by means of the observation stations at the ends of the permanent base-line; of course, in this case the *observation* is practically perfect. If the shots are observed merely from the battery, of course observation conditions have to be assumed. At permanent forts the actual target distance is readily determined and with considerable accuracy, but as the target often drifts (when anchored at sea) we will assume that its distance is only approximately known, about 3000 yards, let us say.

From an actual drawing of lottery numbers the following table results, the fifth column giving the range ordered. For comparison we have placed alongside the record of thirty consecutive shots as given in the firing record of this post. The actual target distance in our assumed firing was 3000 yards, that of the actual firing was 3059 yards. We have omitted the elevations ordered on the actual firing, because they are given in degrees and cannot be compared directly with those of our assumed practice, which are given in yards of range. The similarity in the two cases is very striking, and it must be evident to any one that one conveys quite as much information as the other.

Supposed Target Practice. Target Distance, 3000 yds.						Actual Target Firing. Target Distance, 3059 yds.	
Shot.	Lottery number.	Deviation. yds.	Actual target distance minus deviation. yds.	Range ordered. yds.	Position of shot with reference to target. yds.	Plotted range of shot. yards.	Position of shot with reference to target. yds.
1	63	+ 60	2940	2900	− 40	2905	−154
2	71	+ 120	2880	"	+ 20	2872	−187
3	61	+ 60	2940	"	− 40	3450	+391
4	26	− 140	2860	"	+ 40	2722	−337
5	91	+ 280	2720	"	+180	2978	− 81
6	35	− 80	3080	"	−180	2968	+ 9
7	37	− 80	3080	"	−180	2730	−329
8	99	+ 500	2500	"	+400	3040	− 19
9	85	+ 220	2780	"	+120	2858	−201
10	88	+ 260	2740	"	+160	2887	−172
11	48	− 20	3020	3100	+ 80	2869	−190
12	23	− 160	3160	"	− 60	2969	− 90
13	58	+ 40	2960	"	+140	2948	−111
14	50	± 0	3000	"	+100	2864	−195
15	17	− 220	3220	3000	−220	3083	+ 24
16	1	− 580	3580	"	−580	2744	−315
17	45	− 20	3020	"	− 20	2815	−224
18	79	+ 180	2820	"	+180	2962	− 97
19	97	+ 400	2600	"	+400	2950	−109
20	35	+ 80	3080	"	− 80	3090	+ 31
21	51	± 0	3000	"	± 0 *(target)*	3059	± 0 *(target)*
22	16	− 220	3220	"	−220	3025	− 34
23	40	− 60	3060	"	− 60	3220	+161
24	3	− 440	3440	"	−440	3293	+234
25	3	− 440	3440	"	−440	3277	+218
26	40	− 60	3060	"	− 60	3110	+ 51
27	27	− 140	3140	"	−140	3130	+ 71
28	83	+ 200	2800	"	+ 200	2869	−190
29	41	− 60	3060	"	− 60	3040	− 19
30	13	− 260	3260	"	−260	3293	+234

The uses of the Artillery-Fire Game may then be summed up as follows :

1. To make the officer thoroughly familiar with the principles of correct firing (or with the firing regulations).

2. To illustrate graphically the law of deviation of projectiles.

3. To enable the officer to become acquainted with the deviations to be expected with any particular gun in service.

4. To show what effect special deviations may have in leading to wrong conclusions as to the actual target distance, and the proper elevation to be given.

5. To impress upon the officer the great value of correct observations, at the same time teaching the mistakes liable to arise when false or doubtful observations are made.

6. To economize the time and work required for the actual firing, thus enabling the officer to devote all his time to cultivating his powers to *observe* well.

It would, therefore, seem to commend itself to our army, as well as to the armies of Europe; indeed, with us it is even more necessary to have all the time at actual target firing available for observation, because such a small number of shots with any one piece is allowed. The game appears quite complicated, but is in reality very simple after the tables fcr the gun in question are once constructed, and they, when once obtained, are good for all time. It may be added that this game will be much more valuable for the new heavy guns now being built than for the old ones still in service, because these new guns will respond (in range) much more accurately to all changes in elevation, and that is quite a necessary condition for accurate firing.

The game is herewith submitted to my brother officers, trusting that it may be found useful and interesting.

Table showing for each lottery number the amount of deviation of the shots for the centre of impact, 8-in. rifle (converted) m. l.

The data for the calculation of this table* were the record of the firing of sixty-seven solid shot (Eureka projectile) at this post (Fort Hamilton, N. Y. H.) between 1891 and 1894. Weight of projectile, 180 lbs.; charge, 35 lbs. hexagonal E. V. H. powder of sp. gr. 1.75 and granulation 92; range, 3059 yards.

The ranges of the shots as plotted are taken from the firing record: the position of each shot is then referred to the one of

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* *See Handbook of Problems in Direct Fire—Ingalls.* Problem XXI. The shots should all have been fired at the same elevation to make the table exact, but the elevation differed so little that for practical use it will be sufficiently accurate.

shortest range as an origin, and the average $\left(\frac{\Sigma\ x}{n}\right)$ is the position of the centre of impact (X_0), or, $\frac{29027}{67} = 434$ yards.

Now taking the sum of all the numbers greater than X_0 (in our table) which is $\Sigma x_s = 20960$, and their number (m) which is 35, we have for the mean deviation in range,

$$e_x = \frac{20960 - 35 \times 434}{33.5} = 171 \text{ yards.}$$

$$1.691 \times 171 = 289 = Z_x.$$

$P = \frac{289}{2} = 144.5$ yards, as the probable deviation, let us take it at 145 yards. This may be regarded as the probable deviation under ordinary circumstances; under specially favorable circumstances it may fall to 90 yards, under unfavorable it may rise to 200 yards.

Let us suppose the horizontal target divided into zones each 20 yards wide. The probability of hits (p. 6 of text) is found thus:

For the zone 10 yards either side of the centre of impact $\frac{20}{2 \times 145} = \frac{20}{290} = 0.07 = 4$ per cent. ∴ four shots out of a hundred are $\pm$ 0 (since we reckon to tens of yards only), so we make 49, 50, 51 and 52 correspond to $\pm$0 in the following table:

The probability of striking 20 yards from the centre of impact (short or beyond) is:—$30 \times 2 : 290 = 0.21 = 11.5\%$

$$10 \times 2 : 290 = 0.07 \qquad 4\ \%$$

$$\overline{7.5}$$

$\frac{7.5}{2} = 4\%$, so we make 45, 46, 47, 48 correspond to —20, and 53, 54, 55, 56 to + 20.

40 yards:—$2 \times 50 : 290 = 0.34 = 18\ \%$

$$2 \times 30 : 290 = 0.21 = 11.5\%$$

$$\overline{6.5}$$

$\frac{6.5}{2} = 3\%$, so we make 42, 43, 44 correspond to —40 and 57, 58, 59 to + 40, etc., etc., etc.

Lottery number.	Deviation.	Lottery number.	Deviation.	Lottery number.	Deviation.	Lottery number.	Deviation.
1	— 580	26	— 140	51	± 0	76	+ 160
2	— 500	27	— 140	52	± 0	77	+ 160
3	— 440	28	— 140	53	+ 20	78	+ 160
4	— 400	29	— 120	54	+ 20	79	+ 180
5	— 380	30	— 120	55	+ 20	80	+ 180
6	— 360	31	— 120	56	+ 20	81	+ 180
7	— 340	32	— 100	57	+ 40	82	+ 200
8	— 320	33	— 100	58	+ 40	83	+ 200
9	— 300	34	— 100	59	+ 40	84	+ 220
10	— 280	35	— 80	60	+ 60	85	+ 220
11	— 280	36	— 80	61	+ 60	86	+ 240
12	— 260	37	— 80	62	+ 60	87	+ 240
13	— 260	38	— 60	63	+ 60	88	+ 260
14	— 240	39	— 60	64	+ 80	89	+ 260
15	— 240	40	— 60	65	+ 80	90	+ 280
16	— 220	41	— 60	66	+ 80	91	+ 280
17	— 220	42	— 40	67	+ 100	92	+ 300
18	— 200	43	— 40	68	+ 100	93	+ 320
19	— 200	44	— 40	69	+ 100	94	+ 340
20	— 180	45	— 20	70	+ 120	95	+ 360
21	— 180	46	— 20	71	+ 120	96	+ 380
22	— 180	47	— 20	72	+ 120	97	+ 400
23	— 160	48	— 20	73	+ 140	98	+ 440
24	— 160	49	± 0	74	+ 140	99	+ 500
25	— 160	50	± 0	75	+ 140	100	+ 580

In a similar way tables may be calculated for small deviations ($P = 90$), or for large deviations ($P = 200$).

COAST ARTILLERY FIRE INSTRUCTION.

First Lieutenant E. M. Weaver, R. Q. M., 2nd Artillery.

Account of experimental firing at Fort Monroe, Virginia, September 21st to October 4th, 1894, in testing a system of plotting and means of directing the fire of coast batteries on moving targets.*

The system consists, in general terms, of a chart of the water area in front of a fort or a group of guns so plotted into range zones and into azimuth sectors, that the elevating apparatus and traverse circle at the gun may be arranged to duplicate these range zones and azimuth sectors, respectively.

By thus establishing a direct connection between the means employed at the gun to give elevation and direction to the gun, and the plotting of the chart of the water area in front of the battery, it is possible to dispense with tables giving the angle of elevation and the azimuth angle corresponding to any block; much time is thereby saved and accurate shooting may be made at moving targets with indirect fire.

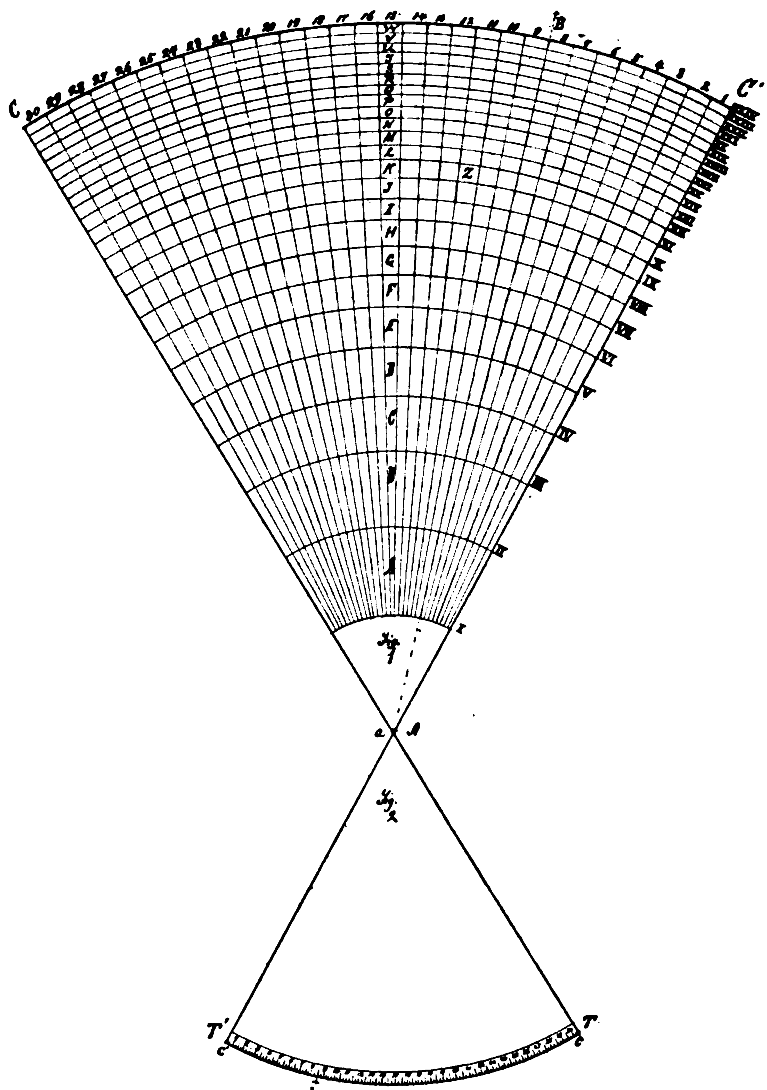
The details of the system are as follows:

In Fig. 1, let *A* represent on the chart of the water area in front of a coast fort the plotted position of the gun to be used. Draw the lines *A C* and *AC'* marking off the limits of the field of fire within which the gun can be used. Let *B* represent the plotted position of some small, distinct, distant object, as, for example, the chimney of a light house or a flag-staff. Draw the line *B A*; this is the datum line of the plotting for the azimuth divisions. From *A* as a center, with a radius equal to the extreme range of the gun for aimed fire, draw the arc XXIV. From the point at which this arc cuts the datum line *BA*, divide the arc both ways into equal parts, making each division equal to the length of an average battleship, say, 300 feet. Number these divisions from right to left and join the extremities of each division with *A* by radial lines. From this description it is apparent that the field of fire is now divided into a number of azimuth sectors, 300 feet wide at the extreme limit, and decreasing in width to the gun, and that the azimuth of any point in the field of fire can be given to within the limits of these sectors, by merely giving the number of the azimuth sector within which it is found.

An average battleship may be assumed to present thirty feet of vertical target to the attack of coast artillery projectiles. Assuming the gun to be placed near the water's edge, such a target would be within a danger zone for all of our guns under 0° elevation, up to a certain range, say up to I., on the line *A C*, Fig. 1. Starting at the range *A-I*, Fig. 1, compute the angle of fall of the projectile for this range; from this angle of fall determine the

* Read before the Officers' Lyceum, Fort Adams, R. I., February 26th, 1895.

depth of a second danger zone, within which the target would be hit for a further distance out, say, to the point marked II. on the line AC'. At II.,



again compute the angle of fall and the depth of the corresponding danger zone; this takes us out to III.; and so on we may lay off, in succession, the depths of danger zones out to the extreme limit of fire of the gun, and points IV., V., VI., &c., may be determined. With A as a centre, and with radii equal to A-*I.*, A-*II.*, A-*III.*, &c., describe, successively, arcs of circles terminating in the lines CA and $C'A$ which mark off the field of fire. It is evident that these arcs will divide the field of fire into a series of concentric "danger zones" having A as the common centre. A battleship occupying any position on the water area included within the field of fire, will fall within one of these danger zones, and a projectile entering the zone, with proper azimuth, will hit the ship some place between its gunwale and a point below the water line.

Marking the range zones by the letters A, B, C, &c., as indicated in Fig. 1, it is evident that any block within which a ship might be plotted, could be accurately designated by *combining the numeral designation of the azimuth sector with the letter designation of the range zone.* Thus: a ship plotted at Z, Fig. 1, would have the block within which it is plotted completely designated by the symbols "11-K."

On Fig. 2 let a represent the position of the pintle of the gun. Let TT' represent the traverse circle on which the gun and carriage are moved in azimuth about the pintle. A pointer is attached to the fork of the left chassis traverse wheel, so that its point nearly reaches the upper surface of the traverse circle. Aim the gun carefully at the distant object B, Fig. 1, and mark the point b on the traverse circle, immediately under the point of the traverse circle pointer. It is evident, now, that when the gun points out over the water along the line ab, it will be directed on the object B, Fig. 1. Divide the traverse circle from b towards c' and c' into equal divisions according to the following proportion:

$$\frac{AC'}{ac'} = \frac{\text{Length of division at XXIV}}{\text{Length of division on traverse circle}}$$

(Figs. 1 and 2), or length of division on traverse circle

$$= \frac{\text{Length of division at XXIV}}{ac'}.$$

For example, suppose $AC' = 4000$ yards and ac' 10 feet, then one division on traverse circle = 3 inches.

Number the divisions on the traverse circle from left to right.

From the manner in which the chart and traverse circle have been oriented with respect to each other, it is evident that if the traverse pointer be brought to the middle of any one of the divisions on the traverse circle, the gun will point out over the water along the middle of the sector bearing the same number on the chart (Fig. 1).

A piece of mechanism called a *range dial* is employed to give elevation to the gun. The range dial (Fig. 3) consists of a steel arm A, 20 inches long by 2 inches wide by ½-inch thick, which carries a rack at its outer end, this, in turn, gears into a small brass pinion B, having a radius of 2 inches; this pinion carries a steel pointer C, 11 inches long, which sweeps over the brass

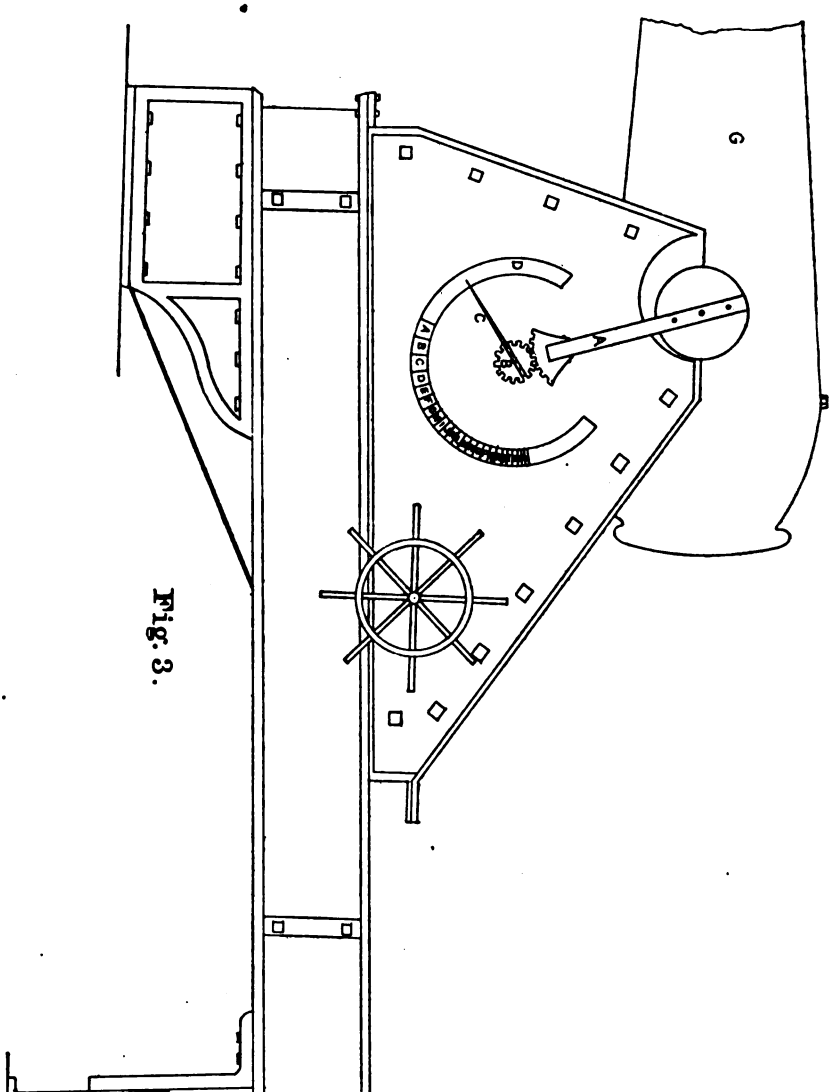


Fig. 3.

arc *D*, 10 inches in diameter on the inside, 2 inches wide and ¼-inch thick. These parts are placed on the left side of the gun and top carriage as indicated in Fig. 3. The ratio of radii between *A* and *B* serves to multiply any angular change in elevation of the gun ten times on the arc *D*. The diameter of *D* is such as to give a linear swing of four inches on the outside circle of *D* for an angular change in elevation of one degree; for one minute change this would give $\frac{1}{15}$ of an inch on *D*. *That is, the range dial makes it possible to read directly angular changes of one minute with perfect ease ana distinctness.*

The range dial is carefully graduated by the quadrant to degrees and minutes. Its reading being smaller than the smallest reading of the gunner's quadrant, the minute divisions are laid off by dividers.

It is assumed that the muzzle velocity of the powder to be used in firing the series of shots is known, and is practically constant for the series; this enables the ranges and the times of flight to be entered at once on the outer edge of the arc *D*. The marks on the arc *D* may be made in ink which gives clear divisions, is permanent enough for all uses during the series, and yet may be erased when it is desired to change the muzzle velocity, or if it be desired to apply the range dial to another gun.

Having determined the muzzle velocity of the powder to be used, and having graduated the arc *D* into quadrant angles along its outer edge, the pointer *C* is moved until it stands at the angle which will give the range *A-I*. (Fig. 1); a line is then drawn at this point across the arc *D* (Fig. 3). In the same way other lines are marked across the arc *D* dividing it into bands which correspond with the range zones *A*, *B*, *C*, *D*, &c (Fig. 1). Let these bands be lettered to correspond with the range zones on the chart. From this it is evident *that when the pointer C points to any band, as, for example, the band K on the arc D, the projectile will fall in and be plotted in the range zone K on the chart.*

To direct the gun therefore on any block, we have only to bring the pointer of the traverse circle to the proper number, and the pointer *C* (Fig. 3) to the proper letter. Thus, suppose the signal "*K*-25" were given; the pointer *C* would be brought to "*K*" and the traverse circle pointer to 25, the projectile would then fall in block *K*-25.

All guns of the same kind in the fort may be oriented in the same manner with respect to the same chart: they could be arranged for either converging fire, or for parallel fire, or both.

The plotting on the chart of the position of a target, or the trace of a moving object having been made by means of observers at the end of the base line, or by a position finder of any kind, the system enables the gun to be directed to the block within which the point is plotted with little delay. It has been found that these blocks need not be larger than 25 yards, in azimuth dimension at 4000 yards, and that a gun may be aimed on any point in the field of fire and fired within 15 seconds. The system comes into use between the position finding service and the gun, and operates in firing the gun to expedite the use made of the position finder information.

TEST OF SYSTEM AT FORT MONROE.

The details of the test made at Fort Monroe, are as follows:

The range-dial was fitted to an 8-inch M. L. converted rifle (No. 74), and graduated to degrees and minutes as described above. A stiff steel pointer was fitted to the fork of the left traverse wheel.

Bug-Light was taken as the datum point for azimuth graduations on the traverse circle and on the chart. The gun was carefully directed on the light and the point under the traverse pointer carefully marked, giving the datum line for graduations on the traverse circle (see *b*, Fig. 2).

Four thousand yards was taken as the extreme range. The distance from the pintle to the traverse circle was ten feet, therefore the length of a division on the traverse circle corresponding to 300 feet on the 4000-yard range was three inches; this was laid off in succession from the datum line both ways to the limits of the field of fire, and the division lines cut into the iron traverse circle with a cold chisel. These 3-inch divisions were then subdivided into 1.5-inch, and these into 0.75-inch divisions, corresponding to 50 yards and 25 yards respectively, at 4000 yards (see Fig. 2), and the 3-inch divisions were numbered from left to right running from 1 to 55.

A piece of strong drawing paper was laid on the plotting board, and the positions of the gun and the observing stations plotted thereon. The observers at the ends of the base line made many very careful readings of the Bug-Light angles, and finally signaled to the plotting house the angles of the light and its position was then plotted on paper. A line was drawn connecting the position of the light with the plotted position of the gun, and this formed the datum line on the chart. A circle was then drawn on the paper with the position of the gun as a center and a radius equivalent to 4000 yards, and on this circle divisions equivalent to 100 yards were laid off, in both directions, from the datum line to the limits of the field of fire. These divisions were then numbered from right to left, and radial lines drawn from the extremeties of each division to the plotted position of the gun.

The muzzle velocity of the powder to be used was then tested. In order to do this ten shots were fired under the same conditions of laying. A trial angle of elevation corresponding to a muzzle velocity of 1400 f.s. was given, as previous firings with this gun and powder had indicated that this velocity could be expected. The shots however fell short and grouped as shown at I–1, I–3, I–4, I–5, I–6, I–7, I–8, I–9, I–10. Shot I–2 was abnormal and was not considered in subsequent computations. The cartridge bags used in this series of shots were somewhat larger than the usual cartridge bags, and it was thought best to make a further test for muzzle velocity using the ordinary bag. This was done next day. Four shots were fired under the same conditions as the first ten; these will be found plotted at II–1, II–2, II–3, II–4. These four shots, taken in connection with the first ten, showed by computation that the muzzle velocity of the powder was about 1330 f. s., under the conditions of loading to be followed, viz: weight of powder, 35 lbs.; length of cartridge bags, 21 inches. The surplus cloth of the cartridge bag was cut off, and a disc of thick pasteboard was inserted to close the mouth, the cloth of the cartridge bag being stitched on to the cloth covering the pasteboard disc. The shots plotted at II–6 and II–7 were then fired, with angles of elevation corresponding to a muzzle velocity of 1330 f.s., at the targets II–b and II–c, respectively; the close plotting of these two shots showed that the muzzle velocity had been obtained quite accurately.

In firing the shots referred to above, the reading of the range dial had been verified each time by the reading of the gunner's quadrant placed on the face of the piece. The *exact* agreement found in each case made it unnecessary to resort to this verification in the subsequent firing. The grouping of the shots I–1 to I–10, II–1 to II–4, and the close plotting of II–6 and II–7, incidentally, fully tested the accuracy of the range-dial,* and the accuracy of the orientation of the graduations of the traverse circle with respect to the azimuth divisions on the plotting chart. It was, after this, accepted that both these features were successful, and this was confirmed by the subsequent firing.

As the extreme range of 4000 yards to be used in the firing carried the elevation beyond the mooted "cusp-point" in Whistler's jump curve, shots II–8, II–9 and II–10 were fired at the targets II–d, II–e and II–f to test this point. A number of shots had been fired at long ranges (3500 to 3900 yards) from this gun and carriage during the month of June, and this series seemed to indicate that there was no cusp in the jump curve for this particular gun and carriage. Acting on this view, and in the light of the firings referred to, a new curve was drawn on Whistler's chart for jump, from the point at which Whistler's curve cuts the 6° ordinate line to the upper extremity of the 10° ordinate line, and jump was taken according to this new curve. The subsequent firing indicated that we had not allowed enough for jump at the longer ranges, and that it would have been better if the curve had been drawn to the upper extremity of the 9° ordinate line instead of to the upper extremity of the 10° ordinate.

The angles of elevation, angles of fall and widths of danger zones were then computed, making use of Whistler's graphic tables. The results are embodied in the accompanying table.

The circles marking off the danger zones were then drawn on the chart with the radii given in the last column, and the range-dial graduated as explained above. The zones between the circles were lettered outward from the gun from *A* to *Dd*, and then the system was fully installed and ready for testing.

The following problems were proposed for the test of the system:

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* A range-dial on this principle had been previously successfully tested at Fort Adams, R. I., in October, 1893.

Table.

Range circles.	Angle of departure.	Jump.	Angle of elevation.	Angle of fall.	Radii of circles for danger zone.
I	1° 45′	10′	1° 35′	1° 55′	1000 yards.
II	2 25	11	2 14	2 42	1331 "
III	2 55	12	2 43	3 17	1564 "
IV	3 19	13	3 06	3 47	1754 "
V	3 40	14	3 25	4 17	1917 "
VI	4 00	15	3 45	4 45	2062 "
VII	4 18	16	4 02	5 05	2193 "
VIII	4 35	17	4 18	5 30	2314 "
IX	4 52	18	4 34	5 52	2426 "
X	5 08	19	4 49	6 12	2531 "
XI	5 23	19	5 04	6 32	2630 "
XII	5 37	20	5 17	6 50	2724 "
XIII	5 50	21	5 29	7 08	2813 "
XIV	6 02	21	5 41	7 24	2898 "
XV	6 14	22	5 52	7 40	2980 "
XVI	6 26	22	6 04	7 57	3058 "
XVII	6 39	23	6 16	8 10	3133 "
XVIII	6 51	23	6 28	8 33	3205 "
XIX	7 02	24	6 39	8 45	3274 "
XX	7 14	24	6 50	8 57	3340 "
XXI	7 24	24	7 00	9 15	3403 "
XXII	7 34	25	7 09	9 32	3463 "
XXIII	7 44	25	7 19	9 45	3223 "
XXIV	7 54	25	7 29	9 53	3583 "
XXV	8 04	26	7 38	10 11	3643 "
XXVI	8 14	26	7 48	10 20	3703 "
XXVII	8 24	26	7 58	10 38	3763 "
XXVIII	8 34	27	8 07	10 55	3823 "
XXIX	8 44	27	8 17	11 10	3883 "
XXX	8 54	28	8 27	11 25	3943 "
XXXI	9 04	28	8 36	11 40	4003 "

1. The attack of an imaginary battleship entering Hampton Roads from the direction of the sea.
2. The attack of an imaginary ship passing out to sea.
3. The attack of an imaginary ship approaching the gun on a zigzag course.
4. The attack of an imaginary ship running away from the gun.
5. The attack of an imaginary ship moving in an elliptical course in front of the gun.
6. The attack of a visible moving target.

This programme was carried out fully. Each course will be found plotted on the chart and the result of each shot indicated thereon.

In firing at the imaginary targets three minutes were allowed for loading the gun, one minute for prediction work on the plotting board and one minute for aiming, firing and time of flight, making five minutes between shot splashes. This allotment of time was found to be ample for each division of work. The angles of the splashes were sent in to the plotting board and were plotted during the three minutes allowed to the gun for loading.

In firing at the visible target, the observers sent in the angles of the target at the call for target angles from the plotting board. The shots were four minutes apart. In starting a course, two positions were plotted two minutes apart, and after this, the angles of the target were sent in by the observers at each splash without calling for them. The predictions were made by the plotting officer four minutes ahead, allowing thus, two minutes to receive and plot the target angles, one minute to predict, and one minute for aiming, firing and time of flight. The gun was allowed three minutes for loading, as before, and this was done during the plotting of the target angles (two minutes) and prediction (one minute). After beginning a series of shots the angles of splashes were not sent in and plotted until the entire series was finished. Two instruments were used at each observing station, and the angle of target and angle of splash were taken, both at each station, at the same instant.

In the firing at visible targets much annoyance, delay and inaccuracies resulted from the use of the ordinary telegraph instruments for transmission of information between the observing stations and the plotting house. Some of the operators were not sufficiently expert, either in sending or receiving messages, and these served to neutralize the best efforts of other good operators. It was only with the greatest difficulty that the path of a drifting target could, at times, be plotted upon the chart with two minute intervals between target angles, and the angles were sometimes so slow in coming in, and so evidently wrong, that the tracking had to be begun anew. It was evident to all concerned that the ordinary telegraph instrument, and its system of signals, are too slow and too unreliable for ship tracking. Unless the angles be repeated, no confidence in the messages can be had, and if the angles be repeated, the time required is too great. The troubles experienced are well illustrated in shot No. 8, series VII. The angles had come in locating the target (drifting) at △ VII-8, the shot was fired and plotted at ○ VII-8, and would have hit the standard ship target in that position, but a telegraphic mistake had occurred, either in sending or receiving the target angles, and the target was, as a matter of fact, between VII-7 and VII-9, and a miss was scored, due entirely to telegraphic errors. This is a very important matter, and should receive the attention of artillerymen without delay. The telephone would be much better than the telegraph in this work, and perhaps the telautograph would be better than either. By means of this instrument it is understood the observer could reproduce in writing, instantly, at the plotting board, the angles of the target. If possible a test of this instrument for this purpose should be made. With a quick and reliable means of transmitting information between the observing stations and the plotting board, continuous good practice may be made at moving targets by this system, *regardless, almost, of the rate or direction of movement* of the target. A position finder which will trace accurately on the chart the course of a moving object, would of course give still better results. With such an instrument and with the new guns and carriages, it is believed a very high percentage of hits could be made on the ship target.

Twenty-one shots were fired for purposes of information, viz:

I–1 to II–10 }
II–1 to II–7 } To determine muzzle velocity of powder.

II–8 to II–10 }
VII–12 } For information in regard to jump.

Fifty-one shots were fired in testing the merits of the system. The data connected with these shots are given in Table I.

The columns headed "Deviations" and "Error in Range" give the deviation right or left, and the excess or shortage of range with respect to the precise point at which the target was located. The column headed "Hit" or "Miss" gives the result of the shot with respect to a target having the dimensions of a battleship of average size; the dimensions assumed were, length of ship, 300 feet; beam, 60 feet; height of hull exposed to attack, 30 feet. It will be observed that 34 hits are recorded with 13 misses, or 74 per cent. of hits. Four shots were lost by errors of telegraph operators and interposition of shipping between observers and the splash. The mean deviation of 49 shots was 14 yards. Leaving out of consideration the seventh series, in which the error of range is believed to be due largely to defects of the supports of the traverse circle, as noted in the column of remarks of table, and leaving out the first shot of the eighth series, the excessive range of which is believed to be due to a personal mistake in giving elevation, as noted in the table, there remain 37 shots fairly indicative of the working of the system in regard to range; these 37 shots give a mean error of range of 45 yards. With practice, with a firm, solid emplacement, a true level traverse circle, and with better means of communication between the plotting house and observing stations, both of these errors could be reduced, especially the error of range. As it is, the results compare favorably with the usual practice with this gun at a fixed target, using the greatest care, taking time without limit, and after instrumental corrections for thermometer, barometer and wind have been made. In this firing at Fort Monroe no allowance was made for barometer or thermometer, and only such allowance for wind as could be made by the officer at the gun by personal observation.

The weather conditions throughout the greater part of the time were decidedly unfavorable to good firing. During the firing in the first and second courses a X-o'clock wind of between twenty and twenty-five miles per hour was blowing; in the third, fourth and fifth courses the wind had increased to over thirty miles per hour and blew fishtail across the field of fire.

The experiments brought out some defects of the carriage on which the gun was mounted. The following facts were noted:

1. The play of the left front guide was sufficient to allow the front part of the carriage to rise about one-half inch when the gun was fired.
2. The gun bounded out of the trunnion bed when fired, far enough to completely disengage the cogs of rack and pinion of the range dial.
3. Owing to the eccentric position of the centre of gravity of the gun with respect to the centre of motion in giving elevation to the gun, a turning moment is produced for all positions except 0° elevation. For angles of elevation this moment acts to rotate the muzzle downward; for angles of depression it acts to rotate the muzzle upward.
4. The quadrant angle was taken before and after firing for a number of shots. The following data bearing on this point was taken by Lieutenant C. D. Parkhurst, 4th Artillery, who supervised the loading of the gun during the firing:

No. of shot.	Before firing.	After firing, before running in.	After firing, after running in.	Rotation of trunnions measured on outer circle of trunnion bed.
	° ′	° ′	° ′	
1	6 41	9 15	10 05	$\frac{7}{16}$ inch
2	"	9 07	10 35	$\frac{11}{16}$ inch
3	"	9 07	11 00	$\frac{8}{16}$ inch
4	"	9 15	10 22	not taken.
5	"	9 02	10 17	$\frac{7}{16}$ inch
6	"	8 45	9 45	$\frac{6}{16}$ inch
7	"	8 40	9 50	$\frac{6}{16}$ inch

The questions arise, whether any of this motion was produced before the projectile left the gun, what caused the rotation, and how far, if at all, it affected the jump of the gun.

5. The lateral play of the guide clips was considerable, and permitted the top carriage to ballot laterally in moving to the rear. The shocks from this, carried to the traverse wheels, displaced the chocks put to hold the traverse wheels in place.
6. The traverse circle was not horizontal, had some play, and its wooden supports were old, and decayed to some extent; there was a difference of about 30′ in the reading of the quadrant when the gun was placed at one extremity, and when it was at the opposite extremity of the circle.

7. The jump of the gun was different for different positions in azimuth; this seemed to be due, in part at least, to the condition of the wooden supports under the iron traverse circles, which, as already stated, were not sound.

The projectiles varied greatly in weight and were much lighter than those usually fired from this gun. The heaviest projectile weighed 180 lbs., and from this the weight fell off to 174 lbs.

The record of the officer making predictions and giving block signals to the gun is as follows:

Courses.	Block signaled to gun.	Block in which splash plotted	Courses.	Block signaled to gun.	Block in which splash plotted
1st Course.			5th Course.		
1	48—U	48—U	1	51—Z	51—Aa
2	28—J	28—J	2	55—N	55—56-O
3	1—2—J	1—2—J	3	46—F	46—F
3rd Course.			4	26—E	lost
1	45-Dd	45—Dd	5	17—M	17—L
2	36—W	36—W	6	24—25-W	24—W-X
3	32—L—M	32—L—M	7	35—Bb	35—Aa
4	25—26—F	25—F	8	45—Dd	45—Cc
5	11—12-D	11—C	6th Course.		
4th Course.			1	46—M	46—M
1	7—B	7—B	2	66—W	66—X
2	13—14-K	13—14-K	3	84—Aa	84—Aa
3	16—Dd	16—Ee	4	89—L—M	89—N
			5	75-76-D-E	76—E
			6	31—B	31—B
			7	16—F	16—F
			8	42—43-L	42—43-M

Where a dash is drawn between two numbers or between two capital letters the pointer on the traverse wheel or range-dial was to be placed to correspond, between the numbers or letters so signaled. It will be observed that without exception the projectile passed out from the gun over the water within the azimuth division signaled, and that when it did not fall in the signaled range-zone it fell in the adjacent one.

Throughout the firing the error of lateral deviation was very small and it is believed fully proves the advantage to be derived by taking lateral deviations from the traverse circle. The advantage of the range-dial over other forms of apparatus for giving the proper elevation is believed to be unquestioned. The great advantages claimed for it are, that, by means of it, the elevation may be given accurately and rapidly to within one minute, and that there is little or no chance for misreading, or for variations due to differences of eyesight; that ranges, times of flight and other data may be entered in connection with the range graduations on the arc of the range-dial.

The possibilities of this means of laying a gun for firing at a fixed target is well shown in the group of shots I–1 to I–10. They give a mean lateral deviation of 6.7 yards, and for nine shots a mean longitudinal deviation of 17.5 yards. These ten shots were fired in about fifty minutes. The thermometer and barometer corrections were not made and no corrections were made for wind except such as resulted from personal observation and judgment trained by experience.

With modern guns and mortars and modern carriages the results obtained in this test could be much improved. The system may be used in connection with the instruments and methods now employed at our forts in target practice, and by using the telephone or telautograph for communicating information from the observing stations to the plotting house, practice at real or imaginary moving targets may be tried at once.

These Fort Monroe experiments show, that, if the 8-in M. L. rifle be loaded, it may be aimed and fired at any point within the limits of the field of fire in fifteen seconds, with a mean deviation for 49 shots of 14 yards, and at the rate of one shot from each gun every four minutes.

In applying the system to several groups of guns located at different points about a harbor, or other defined water area, the fire of which is to be controlled and directed by a single officer, there is a simplification of details at the guns. The commanding officer would be at the position-finder, and would have before him at all times the trace of the target across the squares of the standard harbor chart.* He would be in electrical communication with each group commander, and, when he wished to direct the fire of any group, or all the groups, on the target, he would signal simply the numerical designation of the square of the harbor chart on which the target happened to be. Each group commander would have, on a plotting board, a copy of the same harbor chart, properly oriented with respect to the position of his group of guns. On this chart would be drawn the *outer* range circle (Fig. 1) only, and, pivoted at the position of the guns, a *transparent* ruler would be fixed to sweep over the chart. This ruler would have *marked and lettered distinctly on it the range-zones* (Fig. 1) so that the *group range-zones* would be read *on* the ruler while the *harbor-squares* would be visible *through* the ruler. There would be no other connection between the guns and the position-finder. Only one position-finder and one set of observers would be required for all guns of the several groups or forts.

For example, let Fig. 4 represent the harbor chart with squares numbered serially along the north and west sides, and suppose the officer in command of the forts located at X, X′, X″ and X‴ should desire to concentrate the fire of all the forts on a ship in square N. 15—W. 12 (given by the trace of the position finder). He would signal to all the groups: "Fire on ship in N. 15—

* A clear distinction is made between the *harbor* chart and the *group* chart; the former is the chart now in use at our forts, divided into uniform squares of 100 yards on a side and arranged on north-south and east-west lines; the latter is the chart represented in Fig. 1.

W. 12." Each group commander would move the transparent ruler until it passed directly over block N. 15—W. 12, and then signal to his group *at once* the designation of the *group block*, taken from the *outer range circle on the chart* and *range-zone on the ruler*. Figure 4 shows the chart as it would appear at the group at X. The group commander has placed the transparent ruler directly oyer the harbor square N. 15—W. 12, notes at once *on* his ruler the range-zone "H," and on the outer range circle the azimuth sector "12." He signals immediately to the guns "H—12," and in ten to fifteen seconds the guns are aimed and fired without further command. It is evident that all group commanders may be directed to report "ready" to the general commander and, after all reports are in, the latter may fire all the guns of the entire circuit by simply pressing the firing key placed near his plotting board. Assuming the guns to be loaded, and all officers and men at their proper stations, the entire process here described may be completed within one minute; this allows the liberal time of 20 seconds to transmit and receive the designation of the harbor square, 20 seconds to arrange ruler at the group station and to signal the guns, and 20 seconds to give elevation and direction, and to fire the gun. The officer at the position-finder would, therefore, only have to predict *one minute* ahead of the last point of the tracing, and no ship could materially change either her rate of movement or direction in such a brief interval; that is, as stated above, the accuracy of the system is practically independent of the rate or direction of movement of the target fired at.

In order to secure if possible a real moving target an attempt was made to build a sailing target. It was thought that one might be constructed on the principle of the catamaran, and if provided with a keel, rudder and sail it might be made to sail across the field of fire by fixing the rudder and sail in proper positions. The attempt was a failure however. The keel was not deep enough, the rudder was too light and the sail not large enough. It is believed that with proper dimensions, adjusted to the strength of wind and tide to be encountered, a sailing target can be constructed on this principle so as to sail a course across the field of fire.

It was found that the traversing of the gun by maneuvering bars working in holes of the traverse wheels, was too slow for rapid changes of the target in azimuth, and to remedy this an iron telegraph pole, such as is used by the signal service of the army, was lashed to the chassis, projecting about twelve feet to the rear of the chassis. In aiming the gun, the cannoneers not otherwise engaged applied themselves to this long lever-arm and moved the gun and carriage in azimuth with ease and with all the rapidity required. The simplicity and efficiency of this means of obtaining rapid angular movement, suggests that the principle might be applied at all times as a substitute for the present method. By making the lever work through proper gearing, even the largest guns might be moved on the same principle.

The advantages claimed for this system over the square system now in use, are that the size of each block is adjusted to the danger space at all ranges; the

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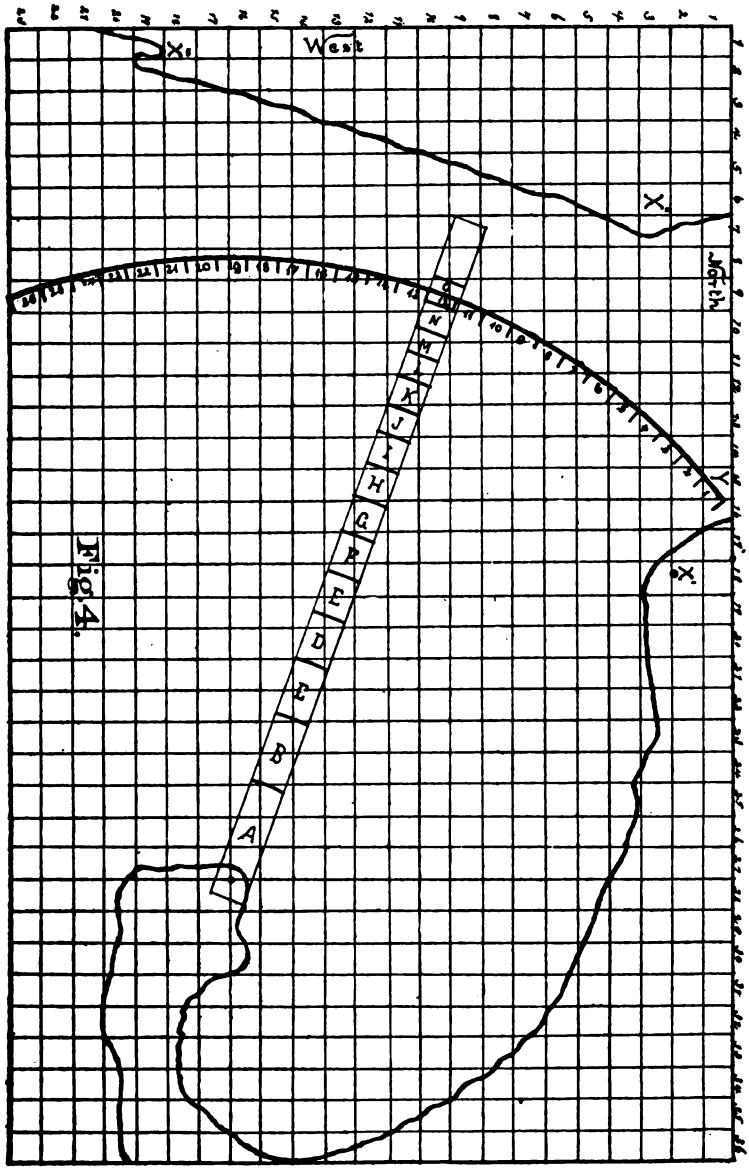


Fig. 4.

blocks are much deeper in range for the mid ranges and short ranges than those of the square system at these ranges; that for the same water area to be covered, fewer blocks are required by this system than by the square system; that the direct connection between the plotting and the aiming apparatus at the gun makes it unnecessary to resort to converting tables for azimuth and elevation in order to direct the gun on a block; that it has the advantage of simplicity and quickness of operation over other systems; that the range dial is an improvement on other means heretofore used to give elevation; that direction in azimuth can be best given by traverse circle graduations; and finally, the system may be put into operation at once in firing at moving targets in connection with the apparatus and methods now employed in target practice at our coast forts, and with no expense except for making the range dials.

The experiments were conducted and carried out in all their details by officers and enlisted men of the garrison of Fort Monroe, detailed for the purpose by Lieutenant-Colonel Royal T. Frank, 2nd Artillery, Commanding Officer of Fort Monroe.

1st Lieutenant *J. W. Ruckman*, 1st Artillery.—Having aided in the firing test described in the preceding pages and being deeply interested in the work and the object to be attained, the following observations are offered for the benefit of those who, from the nature of the case, must be unfamiliar with many of the minor details.

At first sight the importance of the above test and its results may not impress the reader, and for this reason it is proposed to bring out in relief its main features. This piece of work is important, *first* from the fact that it is the first practical test by the artillery of any plan looking to the development of a system of tactical command and fire control; *second*, from the lessons it teaches with respect to the defects of present apparatus and needed improvements, and *third*, from the clear deductions which may be drawn in connection with future target and artillery exercises, and the efficiency of artillery fire when so executed as to obtain maximum results.

In regard to the first consideration it marks an epoch in our development. A definite scheme for directing the fire of sea-coast guns was presented and tested, and the service thus given the opportunity to study it in action; to ascertain advantages and disadvantages, and in fact to consider a *system* and obtain facts which may lead to some tangible result. The experiments carried out, should and probably will lead to others in the same direction. In future work it will be an easy matter to trim where necessary, to modify parts to suit service conditions and gradually to construct the foundation for the much needed *Firing Regulations*.

Now looking at the practical lessons taught by this test in reference to existing and needed apparatus, the following comments may be presented. To those engaged in the execution of the test, two facts seemed clearly proved. (1) We possess no satisfactory, not even a reliable method of transmitting information, and (2) we have no serviceable system of range and position finding. If any proof were necessary, it was here proved beyond doubt that the ordinary telegraphic means was not only very slow but frequently unreliable. The many progressive steps through hands and minds, which a message must undergo in this system to reach its destination, introduces too many chances of error for satisfactory work, and depends too much for accuracy upon the concerted action of many minds to be quick and certain. In efficient service of guns continued verification of messages is quite out of the question. It is not here the intention to depreciate the value or discourage the use of telegraphy in our present methods of practice, but it is submitted that the time is at hand when we must look about for more suitable means of information transmission, that we may be enabled to enter wider spheres of action in our treatment of our tactical artillery problems.

Present range finding methods, so far as any are in operation, are subject to essentially the same criticisms as just mentioned in connection with telegraphy. The plotting by observation, transmission of angles and use of protractors is so slow and cumbersome, that in practice at moving targets all prediction is liable to be nullified by the delay involved.

These two elements, forming the basis of any system of fire concentration and control, must be fully developed before a system of firing regulations can be constructed. Thus as in the design and construction of a complicated machine, the elementary parts must be finished before it can be assembled and put into operation; so with the question of *Firing Regulations*, must the fundamental parts be created and combined for use. When this can be accomplished the details can be filled in with comparative ease. It therefore seems clear that the first questions in our tactical evolution,'are the selection and installation of suitable apparatus for transmission of information and range and position finding: they require immediate attention.

It does not follow that either of these methods must be the best or even the ones finally adopted in the service, but that in the beginning some means must be assumed.

While the experiments now considered force us to the above discouraging conclusions on the one hand, they draw forth many satisfactory facts on the other.

Passing to the actual results obtained as shown in the tabular sheet, several instructive points are discovered. The firing shows what a high efficiency can be obtained when carried out with intelligence and skill with the present poor material,—guns, platforms and ammunition in spite of the other difficult circumstances of communication, and the want of systematic preparation for the highest grade of work. It is safe to say that in another series of tests the efficiency could be greatly increased. When the difficulties of unknown jump, initial velocity and other unknown deviating factors inherent in the gun carriage and platform, which have since been unearthed, are considered, there is no doubt that in another trial a greater number of hits could be obtained. This conclusion coupled with the satisfactory results recorded in the present paper, may give the reader at least a general idea of the effect of modern guns served with suitable ammunition and according to the principles of scientific gunnery.

The question of rapidity of fire was somewhat elucidated, especially in the firing at the drifting targets. Taking the gun as it was used, loaded from a fixed loading platform in front, from which and to which it had to be traversed before and after each shot, it was found that the gun could, as a rule, be run to the loading position, loaded and run to the firing position in two minutes, frequently in less time and never exceeding two and a half minutes. The gun was fired regularly at five minute intervals; but for the occasional delays in the plotting and prediction could have been fired at four or even three and a half minute intervals. The delays incident to the system were considerable, and it seems reasonable to say that under the most favorable conditions a very rapid and well aimed fire could be delivered with the proposed method, even with the old muzzle loading guns.

Experience during the trial showed that atmospheric deviating causes could not be neglected as was at first proposed. The wind and other deviating causes will have to be corrected in aiming either through the personal skill of the gunner or by means of suitable devices. Important corrections, it appears, must be considered in this system as in all other systems. It is not probable that gunners will be able to make the necessary allowances from judgment alone, but it is believed that the necessary data could be placed on the dial and that the pointer could be made adjustable to admit of simple but quick changes to correspond to the needs of the case.

Table I shows deviations of shots from center of target at the instant of firing. The map shows all the courses of assumed ships, the drifting target courses and the plots of preliminary firing. The shots are plotted where they fell and when they would have hit a ship 30 feet high, 300 feet long and 60 feet wide, the point so struck is indicated by a star. In pointing the gun, the dial pointer was invariably placed above the zero center by about 25 yards for the long and medium ranges and about 50 for the short ones. This was purposely done to eliminate as far as possible misses caused by shots falling short, as some in the general distribution inevitably will. In other words the leading idea was to place the center of impact high upon the ship's side, and thus secure the advantage of the general grouping of shots both above and below this point upon the vertical side of the target. In fact it simply becomes a question of placing the ends of the vertical rectangle of the group at such a point as to include the maximum number of impacts (out of a given number of shots) upon the vulnerable side of the vessel, between a line, say five feet below the water and the upper line of the vertical equivalent of the deck. The point to be aimed at would therefore lie not far from the center of the vertical side. A study of Table II accompanying these remarks and the cut of a ship similar to the *Centurion* type will make this clear.

In the construction of Table II the point of reference is that part of the ship's side nearest the gun; and where the shots missed through deviation to right or left, the reference is that end of the ship nearest the line of fire. This selection was made with the idea that the supposition more accurately represents the conditions of the problem than would be obtained by referring points of impact to the center of the ship as was done in making up Table I.

Other alterations of a more serious character also distinguished the second table from the first. By referring to the general map of the harbor and the courses, it will without difficulty be noticed that the shots on the left hand side of the field have greater errors in range than on the other, and that there is an almost regular increase in the range error in passing from right to left. The cause of this increasing error was not definitely determined, but up to the completion of the firing was generally attributed to an insufficient allowance for jump which was not accurately known for the gun and platform used. In the first drifting target series of shots it will be noticed that the range errors are excessive; they are in fact so great that it was scarcely reasonable to account for them by irregularity of jump, and the apparent anomaly in the series remained, to the writer at least, a veiled mystery.

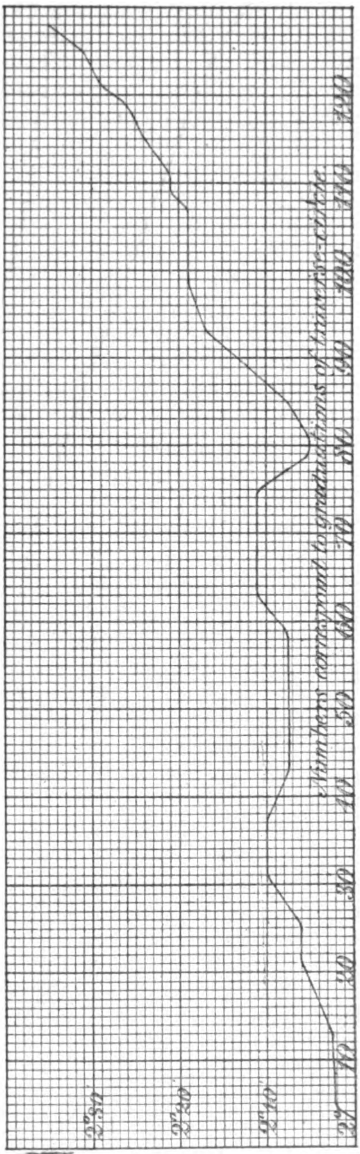
On reading a few days ago in the preceding account of the trial that paragraph which mentions the unevenness of the traverse circle and meditating upon the effect such inclination would have on the fire, the idea at once arose that this probably had something to do with the above mentioned errors.

As at this time it was still possible to investigate the subject and measure the inclination, it was done without delay. The gun was accurately elevated to 2° and firmly clamped in the position with the azimuth pointer pointing to mark 1 on the circle The gun was then traversed from left to right, number by number, measuring the elevation in each case before passing to the next. This was done over the complete circle. After having taken these measurements, at the suggestion of Lieut. David Gaillard, Corps of Engineers, who assisted in taking the readings, the gun was run back to mark 1 and the elevation again read. This time it was 2° 4′ instead of 2°. The platform had settled four minutes due to the gun's passage over it. The quadrant was used for elevation and thus the errors shown are the integral of all errors which are a function of the position of the gun upon the traverse circle.

The calibration of the range dial was made by use of the quadrant, the gun standing in one position throughout the operation. Therefore any inequalities in the circle would be combined with the indicated elevation of the dial pointer. Thus if the dial was calibrated at zero it is clear that for other positions around to the right the real elevations would equal that of the dial plus the errors, as shown in the accompanying curve.

The exact point on the circle at which the dial calibration took place is a matter of some uncertainty, but from the remembrance of all connected with the operation and other confirmative circumstances, it must have been near the mark 17. This was assumed, as the point in the construction of Table II and the resulting changes in range from the errors found applied. The errors as found are shown graphically in the figure.

A peculiarity of this curve is the wavy form which indicates a periodic or



recurring cause. Taking as maximum and minimum points those at which the curve runs parallel to the axis, such points lie at intervals of about from 33 to 35 divisions apart, the maxima and minima occurring at about equal intervals from each other. This irregularity may possibly have been due to eccentricity of the traverse wheels, but later inspection of the wheels for eccentricity failed to discover a sufficient variation to account for that in the curve.

As a solid granite and concrete platform is now in construction on which will be laid a perfectly smooth level circle, this question can be further investigated when the carriage and gun are mounted upon the new platform.

The principal importance of what has just been said may be summed up in the proposition that in future *all traverse circles be accurately calibrated and a record kept of their inequalities.* It also appears important when firing with quadrant elevation that the gun should be directed upon the object and the elevation given as the last operation.

Taking the different series of shots we have from Table II:

1.	Mean	longitudinal	deviation,	31.3	yds.
3.	"	"	"	19.2	"
4.	"	"	"	89.3	"
5.	"	"	"	47.	"
6.	"	"	"	40.75	"
7.	"	"	"	119.73	"
8.	"	"	"	42.5	"

Taking these results in regular order the following facts are interesting:

First Series.—Center of impact 19 yards beyond nearest side of target, while the minimum value of this distance (that is at the greatest range) should have been from 35 to 45 yards beyond the target.

Third Series.—Omitting the first shot which missed through lateral deviation the center of impact falls 14 yards short of the target. In consequence of the position of this point being too low on the target, half the shots are misses.

Fourth Series.—Ship assumed as moving away from the gun. Center of impact 89.3 yards beyond target should have been about 80 yards beyond; all shots are hits.

Fifth Series.—Center of impact 14.2 yards short. All shots short of this point are misses, all beyond it hits.

Sixth Series.—Center of impact 36.5 yards beyond; should have been from 35 to 50 yards beyond. All are hits, showing that the center of impact is near the correct position.

Seventh Series.—Center of impact 119.7 yards beyond: should have been from 90 to 100 yards beyond. All are hits but one which also missed laterally.

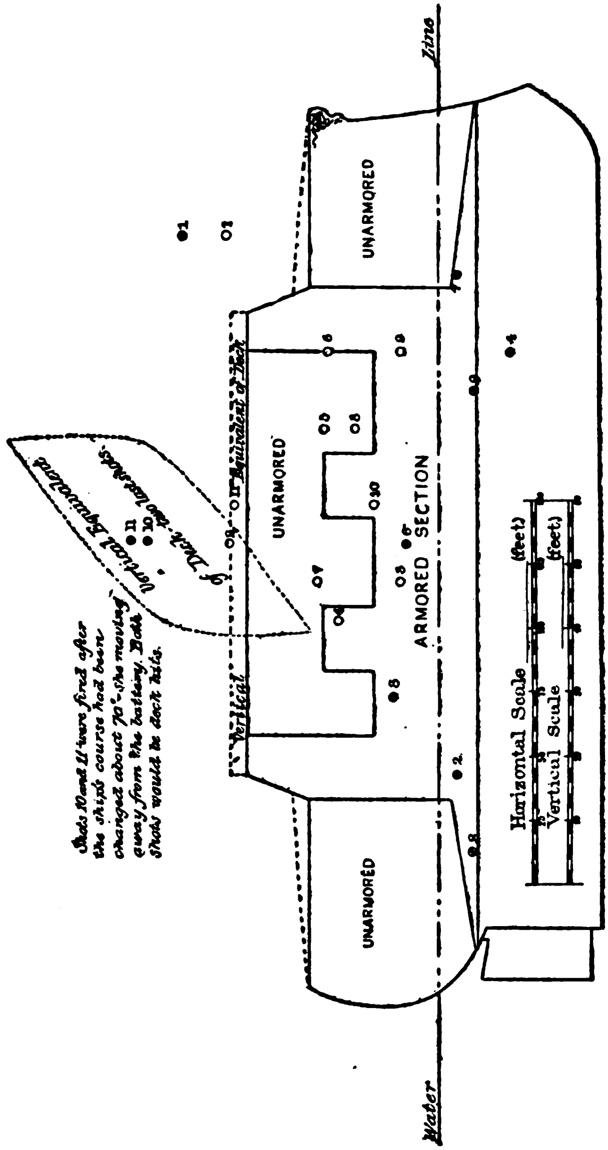
Eighth Series.—Center of impact beyond target 10.7 yards, should have been from 40 to 50 yards beyond. The first shot missed laterally. All shots short of the center of impact are misses, all those falling beyond it are hits. Excepting in the 7th and 8th series, on account of the great differences in range for the different shots, it is difficult to state briefly and accurately the proper distance beyond the target for the center of impact. It would change for each shot and the minimum only is indicated. For the 7th and 8th courses the ranges were nearly constant and the numbers given are approximately correct.

The reader can apply the general idea here indicated to any group of shots fired at a given object. A consideration of the foregoing groups and the large percentage of misses found amongst the *short* shots (see Table II) is a conclusive proof of the great danger of shooting too low.

The reference of each shot to the side of a ship as a target brings into relief certain points of interest relative to Coast Artillery fire. The efficiency of the whole trial if measured by the mean deviation is rather low, but when measured by the number of hits upon the target which would be presented in battle, the efficiency is remarkably high.

Taking this piece of work as a whole, the results tell more loudly than any words how very erroneous are our present methods of firing, plotting and estimating the value of practice. The first series at the visible drifting target, where all shots fell from 70 to 250 yards beyond the target, records 10 hits out of 11 shots. In this case, the value of the practice, estimated by the mean deviation, would be exceedingly low, in fact the shooting might be considered too bad to speak of. But, as a matter of fact, the efficiency is 90%. Again, taking the second series, we have 11 shots (including the 8th, which fell where aimed, and entitles the gunner to a hit), eight of which are hits. This gives 73% efficiency.

The positions of hits of the two drifting target courses are plotted upon the vertical side of the ship, such as was assumed to be the target during the test. The points of impact of the first short range series of shots are indicated by the circle. All but the first are hits. In the second or long range series,


Shots 10 and 11 were fired after the ship's course had been changed about 70°–she moving away from the battery. Both shots would be deck hits.
Vertical Equivalent of Deck–two last shots.
Vertical Equivalent of Deck
UNARMORED
UNARMORED
UNARMORED
ARMORED SECTION
Water Line
Horizontal Scale (feet)
Vertical Scale (feet)

there were three misses, the first probably due to a defective letter on the dial, through which the pointer was placed on the *Y* zone instead of the *V*. The fourth was 24 yards short, and the fifth unaccountably 122 yards short. In studying column 8, Table II, a question of considerable importance arises. Shots falling short will be valuable or worthless, depending on the distance short. A shot falling 5 yards short will evidently be an effective shot; one falling 50 yards short will certainly be of no value whatever. What then is the limit in range, short of the target, at which shots cease to be effective? In counting hits in these remarks, shots 18 yards short are counted effective—22 yards short are counted misses. There are no experimental data to serve as a guide to discrimination between effective and non-effective shots. Until this question is experimentally settled, the value of shots falling short at varying distances can scarcely be anything but a matter of individual judgement. The question has an important bearing on our target practice and should, if possible, be definitely settled.

OKEHAMPTON EXPERIENCES, 1894.

By A. J. HUGHES, Major, R. A.

A lecture delivered at the Royal Artillery Institution, October 11th, 1894.
COLONEL E. D. D. LOCKHART, R. A., IN THE CHAIR.

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The Chairman—Gentlemen, the subject to-night and the lecturer are both well known to you. I only ask you to take note of anything that occurs to you in the lecture that you may disagree with, or which you may think specially worthy of notice, or which you do not quite understand.

Gentlemen—It is with great diffidence that I accepted the kind invitation to deliver a lecture on this year's Okehampton Experiences, for now that the system of practice is so well-defined and known, the changes from year to year are very small, and consequently, I am afraid you will find the lecture in a great measure a repetition of those of former years.

The system of issuing schemes, giving orders, &c., was very similar to that of the two previous years.

The chief alterations in the practice were:—

First, there were more changes of fire when in action, and therefore fewer changes of position.

Secondly, the targets were more diverse.

BRIGADE PRACTICE.

The interest in the brigade practice centered rather in the fire tactics, transmission of orders, &c., than in the actual shooting, for owing to the necessity of using up the common, nothing else was employed. No results were therefore taken, and when the effect is certain to be unknown, not much interest can be shown in the actual shooting.

Orders were generally written and sent by dismounted orderlies. One brigade-division had a system of mounted orderlies, which appeared to work well. When in action the orderlies of the officer commanding the brigade-division remained mounted, some little distance in rear of, but within sight of the officer commanding; one of them always keeps a watch on the adjutant. When an order had to be sent, the adjutant having written it, started off with it toward the orderlies, seeing him coming, one of them at once galloped up, took the order, and returned to await his turn again.

Owing to the varieties of carriages, sights and clamps now in use, great care had to be taken in sending orders for range and fuze from one battery to another, and mistakes arose on several occasions; in fact, with batteries coming from different stations, it is very hard to avoid them.

Take the following cases of three batteries, A, B, C, equipped as follows:

A.	having	Mark	II. carriage	and	Mark	I. sight.	
B.	"	"	"		"	"	with altered clasp.
C.	"	"	I. "		"	"	

Say the range is 2100 yards.

If using **T** scale and yards, B and C would have the same elevation, *i. e.*, 2100 yards and **A** a greater one (2200); whilst if using Scott's sights and degrees, A and B would have the same elevation (3° 3′) and C the lesser one (2° 48′). Thus, not only has the adjutant to know what carriages and sights the batteries have, but even their clamps.

The question raised at this lecture two years ago by Colonel Ollivant, as to whether it is necessary for a battery commander to verify, before adopting a range and fuze passed to him, still remains unsettled. The balance of opinion certainly is in favor of acceptance at once, because:

First, verification is generally impossible, on account of the number of shells falling on the target.

Second, concentration should be sudden, and if each battery has to verify, it cannot be so.

It is however difficult to tell whether such a fire would be effective. I think it should, for there is rarely more than 50 yards between the elevations fired at by batteries when practicing on the same day over the same ground: unless, of course, through bad observation any battery has not found the range. It would, I think, be interesting to arrange a brigade-day, so as to have range reports and test the question thoroughly. Targets to be placed so that each battery had a separate one to start with, and as soon as each had reported range and fuze, the officer commanding could (in place of concentrating) change the targets amongst the batteries, who should open at once with the given range and fuze.

OCCUPATION OF POSITIONS.

The two methods, as usual, give rise to a good deal of talk.

With regard to the deliberate, it struck one that it was a mistake for the section commander and gun-layers to make a race of it when doubling out to the battery commander. The latter could not start his instructions till all had arrived; further, the rush looks bad, and has the disadvantage that the layers arrive breathless, and shaking so much, that many are quite unable to set their sights. A slow, steady double appears quite sufficient.

The chief cause of failure of the deliberate was, that the gun layers did not pay sufficient attention to choosing positions for their guns from which the target could be seen over the sights; consequently, after the guns were in action they often had to be shifted. In order to avoid this, in some batteries the section commanders, before returning to the battery, placed their layers, and gave them orders not to move. This generally worked well, and is quite worth the extra time it takes.

Section commanders before leaving the layers should look to the dressing, and if one section cannot see the target without advancing far to the front, it appears desirable that the section commander should report it. This seems trivial, but neglect in reporting it often had bad results, as the following case, which occurred more than once, shows. The layers of a battery coming into action by the deliberate method, having had the target pointed out to them, extended from the right and took up positions for their guns; now in consequence of the ground, the layers of the left section, in order to see the target, had to advance further to the front than those of the center and right, generally ended in one of two ways, both rather disastrous; either—as the battery was coming up the left section layers, getting nervous about their dressing and seeing the commanding officer on the right, dressed back in line with the remainder, and consequently, the guns could not see the target; or else, if they stood fast, the guns when in action were so far in advance that it was dangerous for the others to fire.

When however the battery commander was on the left flank, *i. e.*, the advanced one, the other layers dressed up and no evil resulted. This seems to point to the necessity for a battery commander, after the layers are placed, but before the battery arrives, dressing them up on to the most advanced layer, rather than to the flank on which he happens to be. Sometimes the battery commander, when pointing out the target, appeared to go further forward than was necessary, and it was suggested that better concealment would be obtained if he only went sufficiently forward to be able just to see the target, and that the layers, after they had extended, should advance far enough to be able to see it over the sights. A few tried showing the target to the section commanders first, and then they showed it to their layers.

With reference to this, one must remember that the ground at Okehampton, a bare hillside with no bushes, &c., makes it very hard to avoid exposure; further the exposure always appears more to an onlooker with the battery than from the target. The group of layers, when seen from a flank, or from behind at a distance of a few yards, appears very different to what it does from the point at 3000 yards.

On several occasions, together with officers of the courses, I stood looking out from a bomb-proof close to the target. Although the range was only 2000 yards, very little could be seen, and had we not known exactly where to look for the battery, it could easily have escaped notice until the first gun.

I think more criticism from the target end of the range, especially during brigade practice, would be valuable; but of course, it must be from a bomb-proof close to the target, and not from the usual position of the range-party on a flank.

One of the causes of the direct method coming to grief was that of not advancing sufficiently to the front for all the layers to see the target over the sights; although done in the hope of not exposing the battery, it appears a fatal error, for on all occasions and most certainly when the direct method is employed (*i. e.*, range short and great rapidity desirable), the first desideratum is to be able to see the target over the sights without any running up.

With both methods it sometimes happened that a flank section, even if run up to the safe limit, was still unable to see the target. When this is the case, and there is room on the other flank, the easiest way out of the difficulty appeared to be for the section to be limbered up and moved round, fire in the meantime being continued with the other guns. Should this be impossible, clinometer elevation must be given to the section, the angle of sight being obtained from one of the guns that can see the target. This method with our present clinometer is very complicated, as it entails two different elevations in the battery, and under such conditions it is very easy for the battery commander to make a slip. With a clinometer having an adjustable zero, such as the German or Scott's sight, fitted as recommended last year, it is comparatively simple. All the section commander would have to do would be to set it at the **T** elevation, place it on one of the guns that could see the target after it was laid, and automatically register the angle of sight by working the small screw until the bubble is in the centre of its run. The battery commander, thus relieved of all trouble, could begin with four guns, and the other two would be ready to open fire by the time he had ranged.

Failing such a clinometer, the best way appears to be to ignore the angle of sight and use clinometer elevation for all the guns, only planting pickets for those that cannot see the target, the remainder laying for direction over the vent and muzzle.

The method of one section using quadrant and the remainder **T** elevation was successfully employed by one battery commander; on all the other occasions, so far as I know, the guns simply remained out of action. Seeing this happen with a single brigade division on positions so well known, it seems probable that with a long line, sections or even perhaps batteries, could easily find themselves so situated that they must either have recourse to pickets or remain silent.

At brigade practice, when employing the direct method, the intervals between batteries sometimes suffered, and appeared to be best kept when the final advance was done in short echelon; this was especially noticeable in those cases in which, owing to the lie of the ground, the line of advance was not quite at right angles to the position to be occupied.

The system, mentioned last year, of the battery commander pointing out the target to the nearest section commander, and leaving the others to pick it up for him, again answered well. In pointing it out to the nearest section commander, the best and quickest was generally for the battery commander to lay the first gun.

Misunderstandings of right and left were very rare; in fact, I only heard of one, due, I believe, to the words "enemy's left" being mistaken. There was more doubt when numbers were employed, and one heard such questions as, "His own number two, or do you mean number two from the right?" It would tend to obviate these if all numbers were to be as read, *i. e.*, left to right, or else that the numbers were always to begin from the firer's right.

SIGNALS AND ORDERS.

A few batteries used a number of extra signals. It appeared, however, that those at present in use are quite sufficient, and that more are only confusing. Repetition of, and extra orders, were still sometimes heard. A repetition called necessary by some battery commanders was that of repeating the range after a doubtful observation. This seems unnecessary, because having been given once, the guns were really laid; further, it causes delay, because of the many repetitions which it necessitates (four for each doubtful round), and also because the layer, hearing an elevation given, forgets that his gun is already laid, and is apt to put his sight in the gun and start re-laying. During slow fire, time was sometimes lost by the battery commander, intent on the target, not noticing when a gun was ready. To obviate this some commanding officers allowed their section commanders to draw their attention verbally; others trained their recorders to always look in the battery, and then when the section commander signaled, to say "gun ready, sir."

APPEARING TARGETS.

Petards were always fired at any new target, both as it appeared and also a few seconds after. The moving targets, both cavalry and infantry, also fired them just previous to, and when they began to move; and orders were issued that, whenever any petards were noticed, fire was to be at once turned on to that target. The system worked well, and even when the petards had to be supplemented by orders, they were of great use in enabling the battery commander to quickly find the new target.

In one series a target of kneeling dummies appeated on the left flank as the battery was on the move. When it appeared, some batteries were in column of sections, most of them wheeled towards the target and came into action front, others wheeled away and came into action rear. This latter was generally considered best; it was quicker, and had the further advantage that, should any of the horses be struck, the limbers would not prevent fire being opened; to do it, however, requires practice, because undoubtedly, one's natural inclination is to wheel up.

A few batteries even preferred coming into action rear on ordinary occasions. This preference is partly due, I think, to the time limit. For with action rear the first gun is, as a rule, got off slightly quicker, because Nos. 1, 2 and 3 can go on with the laying while 4 and 5 are struggling with the magazines; but with action front they can do little until 4 and 5, having got rid of the magazines, have come to the wheels.

On the other hand, the great essentials of dressing and intervals, with action rear, are rarely so good, and this difficulty, in the judgment of most, more than over-balanced the slight advantage of a quicker first gun.

ECHELON AND MOVING TARGETS.

An echelon series, very similar to the trial two fired last year, formed part of the battery service. The target consisted of three sets of 15 standing dummies (each in line), and three sets of 15 kneeling dummies. They were supposed to represent advancing infantry, and were placed in echelon at different intervals, the farthest at about 2200, and the nearest 700 yards. The battery fired for four minutes at the farthest, and three minutes at each of the others.

The average result in the 19 minutes were:—Rounds fired, 60.2; hits, 81; dummies disabled, 32.3; but the chief interest lies in the various methods adopted for attacking such a target. Although, perhaps, hardly a service target, it was generally considered a good one, since it required quickness, and showed if a battery could adapt itself to novel conditions.

The following three methods were employed:

1. Telling off a ranging section and keeping the other four guns for time shrapnel, in a very similar manner to that laid down for an advancing target.
2. Ranging on the farthest, in the usual manner, and then keeping up ordinary fire, when the change of target was ordered, simply giving "change target. Range——, fuze——," and if these were not correct, changing either without interrupting "ordinary fire."
3. Very similar to the second, but using "rapid fire, by sections," in place of ordinary fire.

The first system appeared to answer well provided there was no hitch, but if anything went wrong, such as a ranging gun being out of action for a short time, the whole battery was liable to be upset.

The second method was, by almost universal opinion, considered the best. It seemed to run smoothest, and casualties hardly affected it; as many rounds were fired as with the others, and better results were obtained.

The third system resulted in uncontrolled, and consequently, unaimed fire, and great waste of ammunition.

A slow-moving target, advancing from about 2000 to 1000 yards, was tried for the first time at Okehampton. Although the ground had previously been considered too rough, it worked well, and only two runs were spoiled by the rope being cut. Next year there will be a better target, running on rails down hill. The series was to range on a column, distant about 2100 yards, and then, as soon as ordinary fire was reached, the moving target, placed about 50 yards to the flank of the column, started off, firing petards as it began to move, in order to draw attention to it. It advanced at a walk for about 900 yards, the average time it was moving being about 10 minutes. The number of rounds fired at in the time varied from 6 to 41, the average being 23.

Some battery commanders adopted the system of a ranging section, while others tried ordinary fire round the battery, dropping range and fuze as the target advanced.

Failure in the ranging section system was generally due to the delays caused by:

1. Not giving the order for the time sections soon enough.
2. Changing the fuzes of the second and third rounds after they were already set.
3. Not setting the second and third fuzes at the limber.
4. Ranging section not giving sufficient deflection to ensure the rounds being to windward.

The result of the first was that the order for "rapid fire" came before the sections were ready, consequently, after the order had been given, there was a long pause before a gun was fired. This pause led to the second error, for the battery commander, seeing the target advancing all this time, and thinking it was getting ahead of the battery, would alter the range and fuze for the second and third rounds, and the re-setting of the fuzes caused a yet greater delay.

The necessity, when firing at a moving target, of not giving orders too quickly one after the other, or altering those once given, was very evident. Perhaps an actual example will explain better. Say the ranging section is at 1800 yards, giving a minus, and the remainder loaded and laid at 1650 yards, fuze 8, and two shell ready at fuze 7¾, 7½: the battery commander fires another round and obtains a plus, and at once orders "Three rounds, rapid fire." The first four rounds all burst on graze, shewing 8 to be too long. One's inclination is to cause the other fuzes to be shortened, and should one do so the delay caused by altering them will probably allow the target to get inside the range; further, the torrent of new orders upsets the battery. In such a case it appears better not to attempt to alter the fuzes, but let them be fired, they will act on graze and do some damage, and the next batch can be ordered shorter.

The third reason, *i. e.*, limber numbers not setting fuzes, was perhaps the most frequent. When fuzes were set at the limber the system worked well; thus, one battery took only fifty seconds to fire its first set of rapid fire (two rounds a gun), and 1 minute 30 seconds (this time three rounds a gun).

The fourth cause led to many ranging rounds being lost, and was liable to throw out the battery commander.

The other system, a kind of ordinary fire through the battery, was very similar to that described for the echelon target. The following modification appeared to give the best results: On the change to moving target being ordered, the battery commander gave "Range—— slow fire," and fired until he had roughly fixed its position, and then started ordinary fire. The fire was from the right. After No. 4 had fired, the commanding officer gave new length of fuze to right section, and after No. 6 had fired, gave final elevation. You will see that it is not exactly ordinary fire, for the right section waited to load until they received a new fuze. Also the centre and left section commanders made a drop in range and fuze, on their own account, from that ordered for the right section. The centre giving 25 yards less elevation and ¼ fuze; the left 50 yards and ½ fuze. It was considerably simpler than it appears from the explanation, and it certainly worked well, and at ranges when observation is easy, say under 1800 yards, would probably give a more effective fire than with a ranging section. At longer ranges the latter is probably better, as it fixes the position of the target with greater accuracy.

A great deal of time was often taken up changing from the standing to the moving target. The latter, although it fired petards both before and after starting, was certainly hard to see; but even after the layers had made it out, there was often a further delay, generally caused by indecision as to what was to be done with shell in the guns at the time the change was made, and many batteries did not get fairly started at the target until it had completed almost half its run. The quickest change was made in 30 seconds, and was by a battery employing the ordinary fire method, and it certainly is one of the advantages of that method, that the change is easier and quicker.

RANGING.

The system of ranging by echelon, or ladder of distances, again cropped up and was tried on several occasions. with almost invariably bad results. Thus, on one occasion the commanding officer misjudged the range, about 2100 yards, by over 400 yards, and used eight ranging rounds before obtaining a plus, whereas with the ordinary method he would probably only have needed half as many. It appears to me that quickness in ranging for elevation at short ranges should be gained more by quickness on the part of the battery commander in making up his mind and giving orders for the next round at once, than by an elaborate special system that is liable to collapse should anything unforseen occur. Almost always, at short ranges, glasses can be dispensed with; this alone will save 10 or 20 seconds a round. Again, ranging to 25 yards is not required before going to fuze, at so short a range there is little difficulty in working both together. Some battery commanders gave three lengths of fuze as suggested last year, and it again appeared to work well; some even attempted it at long ranges, but at these I hardly think it succeeded.

Thd judgment of distances was often at fault, and how difficult it is to estimate even a short range, 700 to 1200 yards, was conclusively shown by the three series fired at those ranges. It was rarely that the first elevation was within 300 yards, on some occasions not within 700. Another thing noticed at short ranges was that the fuzes almost invariably were very short, this was especially the case when firing down hill, most batteries having them from 150 to 200 yards short.

FIRE FROM UNDER COVER.

The fire from under cover was hardly so successful as that of last year. The position was certainly a more difficult one, for it required very careful reconnoitring to get the battery well covered from the enemy's view. Insufficient reconnoitring and moving the layers out too soon generally ended in extra delay; it saved time in the end to thoroughly reconnoitre the whole front to be occupied *before* calling out the layers, for when once the latter are out any change is sure to lead to confusion.

The actual time taken planting pickets varied from 2 to nearly 14 minutes, and was quickest in those batteries whose layers planted their pickets as at drill. The commanding officer pointing out the position of a front flank picket and the other layers simply extending from it. Done this way, from two to three minutes is ample time in which to plant them. It also saves time if section commanders remain out and superintend the planting of the pickets, only returning to the battery when the layers are in position.

Another difficulty of the position was, that the guns were often on considerably different levels, and this not being noticed led to difficulty in ranging. Even when noticed it is hard to correct, especially with our present clinometer. The correction for each section has practically to be guessed, some idea of it may, perhaps, be ascertained from the range-finder's range in combination with the rule of one minute giving an inch in each 100 yards; or roughly, 10 minutes will give the correction for the same number of feet that there are 100 of yards in the range. The difficulty, however, of remembering such rules and figures would, I think, induce one to evade rather than overcome the trouble. Thus, if the slope is from a flank, one could range with the center section, and then on opening ordinary fire the section on one flank would shoot long and that on the other short, the mean trajectory being correct. Or again, as actually happened, a cross-fire may attain the desired object if the target is inclined to the line of fire. Another difficulty that cropped up was that of deflection. It being some times forgotten that after the first general deflection for wind the battery commander must order it for *individual* guns according to the result of the fire, since the pickets may be wrong and section commanders cannot see the target. He can either order the actual deflection himself, thus "No. 2 gun 10 minutes more deflection right," or else can call out "last round 20 feet to left," and leave the section commander to give the necessary correction.

RESULTS.

The results are arranged in as nearly as possible the same form as those of last year, but even so, afford small basis for comparison on account of the different nature and positions of the targets used.

As to the artillery target, it is the first time for some years that so short a range, 2000 yards, has been used. The results are rather disappointing, for the difference seems to have led to no increased effect. The guns were placed just short of rather a flat crest, the background was dark and made the target difficult to see, only about three guns on one flank being at all clear. They were first placed so that the ground line of Holstock, where the batteries come into action, could just be seen, but when placed thus, it was found they could not be seen from Holstock except with glasses, and then only with difficulty, they were therefore run forward until about the upper half could be seen. It would be rather interesting to let them fire petards every 30 seconds and try a series at them as at first placed.

Two series were fired under conditions suggested by officers of the other arms. Both were arranged with a view to seeing the depth covered by shrapnel bullets.

In the first series the targets consisted of four lines covering one another at 300 yards distance. The first line contained 50 kneeling dummies, the second and third 50 standing, and the fourth 20 Hessians. The battery began on the third, then changed to the second and then the front, firing for five minutes at each. The average effect of two batteries was fourth line, 40.5 hits 19 Hessians; third line, 157 hits on 36.5 dummies; second line, 107 hits on 37 dummies; first line, 38.5 hits on 19.5 dummies. In this series the effect due to the depth is only shown by the results being greater than the average results at single targets. The other series showed them better, for the batteries only fired at the front line. The target consisted of three lines, first, 90 kneeling dummies; second, 70 standing dummies; third, 24 Hessians. The distance between the first and second was 200, and between the second and third nearly 300 yards. The time taken was 9 minutes 40 seconds, during which 56 rounds were fired.

The effects, first line, 327 on 84; second line, 82 on 44; third line, 22 on 13 were good, and the results on the second and third lines are all fairly due to the depth of the shrapnel and not to exceptional rounds, because in the whole series no time shell and only two percussion burst beyond the front line.

COMPETITIVE.

The change from the column to a 4-gun battery for the first series seemed popular. From the results it appears as though four marks per dummy was hardly sufficient to put the series as regards marks on an equality with the second and third. Taking Okehampton, Glenbeigh and Shoebury (37 batteries), the average marks obtained were in the first series 38.6; in the second, 63.1; and in the third, 60; from which it seems as though six for each dummy disabled in the first series would be a better proportion.

Only 12 batteries out of 45 fired the whole of the rounds, so that the time seems about correct. Perhaps a better distribution would be to give eight minutes for the first, seven for the second, and six for the third, so as to lay more stress on accuracy at the long range, and rapidity at the short. Almost everyone was unanimous in wanting the fire discipline marks kept up. If anyone still had any doubt on this point, the result of dropping them in India should convince him.

For instance, Colonel Ward in his report states that he found batteries "holding up the trails and lowering them together;" similarly, Colonel Tyler after giving examples, states: "No check is placed on plans and devices which may be introduced at the will of the commander. Opinions were much more divided as to the necessity of keeping up the qualifying marks for firing, and it certainly seems hard that batteries at Okehampton and Lydd should have to obtain the same number as those at Glenbeigh, Shoebury and Morecambe, which are admittedly easier ranges for effect. It appears as though each station should have its qualifying minimum, or else it might be done away with and batteries take places 1, 2, 3, &c., at each camp.

There seemed also a desire to have the competitive extend over the whole service practice. It would of course tend to eliminate the luck, still I think one would have too much competitive. Perhaps the most feasible suggestion in this direction was, to have the competitive, much as it is at present, and to add the effects only, of one or two days' service practice, settled on by each camp commandant. Its chief objection is that, when there is only a time limit and no fire discipline marks as a check, hurried fire and great waste of ammunition often spring up, the fire being conducted on the principle that if you only get off enough something must hit.

EQUIPMENT.

The sight graduations and clamps were as usual the cause of many errors. A sight marked in hundreds and fifties, from 1400 to 2000; and in twenty-five yards at longer ranges was tried; the fifties being represented by a short line and the twenty-fives by a dot; although the figures are rather crowded owing to the short radius, they appeared better liked than the old one.

The greater number of errors in the laying examination were caused by the sight slipping when putting it into the gun. Perhaps a ratchet sight, somewhat similar to that on the quick-firer might be tried; or if this is considered too complicated, a better clamp. A plain nut that screwed up the sight in a somewhat similar manner to the nut on a hammer-vice might answer.

It also seems desirable that the sight should be strong enough to stand being left in the gun when fired; for even with the greatest care such a thing may happen, and a bent sight seems a heavy penalty.

Some batteries had the clamp altered so as to use a Mark I sight a in Mark II carriage. This rather complicates matters, for although it makes the sight correct for the yard scale, it throws out the degree scale and makes the tangent sight and Scott's sight disagree. Thus, a battery commander using the tangent scale employs a Mark I range-table, whereas when he uses a Scott sight he must employ a Mark II table. It would obviate all these difficulties if all sights were made like those for heavy guns, the yard scale being on a slip that can be changed should the carriage or charge be altered.

The mekometer was again liked; one battery commander considered it more reliable to accept the mekometer range than to determine it by T scale laying, and said he would have no hesitation in accepting its range when under 2000 yards and

opening with time shrapnel at once, at longer ranges only using a very few ranging shots. Personally, I disagree with this, and think the results hardly justify it. Several series were spoilt owing to battery commanders distrusting their own observations and believing the range finders. On service also the range finders would probably be oftener wrong, even the mild excitement of the competitive apparently upset them. In the first series there were six out of 15 cases in which the range finder was not within 50 yards of the true gun range. In the second series eight out of 15, and in the third four out of 11, a total of 18 out of 41, equal to 43.9 per cent.; applying the same test to the elevation fired at (*i. e.* range as found by observation) the figures are first series, three; second, two; third, one; or only 13.3 per cent. These figures so astonished me that I thought they must be wrong, and I therefore went through all the service practice 1894 and competitive 1893, the latter gave 37.5 for range finder and 5.7 for observation, whilst the service practice, excluding competitive, gave 32.7 for range finder and 24 for observation. Although of course these figures are by no means conclusive, they all point the same way.

The results of observation would, I think, show up even better if one could get over the dislike of calling rounds doubtful. In looking through almost any practice report, one finds more wrong than doubtful observations. In some ranging series I have seen four wrong out of six rounds and yet no doubtful; with such a large proportion wrong, some must have been doubtful, and it would have been better to have classed them as such and repeated. A doubtful round entails only the loss of one round, whereas a wrong observation generally leads to several being lost. The same difficulty occurs in India, thus Colonel Murdoch in his report on Muridki says: "Wrong observation was the most frequent fault; it must at the same time, be admitted that the observation at Muridki is particularly difficult. A fault in observation that was noticed frequently was declaring a round plus or minus when it was doubtful. Of course such a round should be recorded as 'not observed' and be repeated even more than once if necessary."

EXPERIMENTS.

The ordnance committee have kindly allowed me to give the following notes of the experiments carried out at Okehampton this season.

The Q/2-guns and equipment were again used by "P" Battery, and were much liked by all who saw them, and it has, I believe, been definitely decided on for the horse artillery. The twist of rifling is to be further tested. Experiments so far appear to show that the lesser twist, 1/35, gives a closer pattern (the 1/28 covering about ten feet more at 75 yards burst), but the shell is not so well centered, and it is doubtful if the accuracy is sufficient to ensure good ranging. The tubes were of a different pattern to those tried last year, and gave no trouble.

Much interest was also taken in the trial of the 15-℔. shell carried out by the 75th battery.

The charge was 15¾ oz. cordite, and gave a muzzle velocity of 1550 f. s.

A radial vent was employed, and the tubes were almost identical to those used with the Q/2, and appeared very satisfactory.

The shell was a base burster 1½ oz., and contains 216 bullets.

Mark I. carriages were used, they were fitted with steel pockets, one on each side, to carry two fuzed shells and two cartridges, the two weighing 1 qr. 16 ℔s.

The service limbers were employed, the boxes being altered to carry fuzed 15-lb. shell and cordite. The number of rounds carried being as at present. I am unable to give the exact weight behind the team, but it is approximately the same as with 12-℔. shells. The weight gained by the use of cordite being about equal to the extra weight of shell, tubes and steel pockets. Two of the guns were fitted with wheels similar to those on the Q/2 equipment, and they seemed to answer well. Should they be adopted there would be a gain of about 1 cwt.

Two experiments were carried out to test the smoke-giving properties of shrapnel and ring shell. In the first, service shrapnel, shrapnel with special fuze, and ring were tried. In the second, shrapnel and ring; these latter were 15-℔. shell, the shrapnel had a base burster of 1½ oz., and the ring one of 4¼ oz. compressed powder down the centre.

In both experiments the shrapnel came out best. It is hard to say why 1½ oz. gave more smoke than 4½ oz., but it certainly was so, and I can only imagine that the latter was not thoroughly consumed.

Three clinometers, namely, the Watkin with double drum, the German, and a modified Austrian, made in the arsenal, were tried, the latter appeared most liked. However, I believe that before a final decision is made, a Scott's sight, fitted with an adjustable bubble, is to be tested, in the hope that, if successful, it will obviate carrying an extra clinometer.

Average Results of Competitive Practice.

Station practiced at.	No. of batteries.	Rounds.			Hits.			Marks.				
		I.	II.	III.	I.	II.	III.	I.	II.	III.		
Okehampton—												
4-gun average.	4	22.5	23.22	24	12.5	49.25	53.75	36	49.5	43	90.5	221.5
6 " "	11	19.63	23.36	23.81	19.09	49.54	45.9	23.09	40.9	44.45	91.54	200.27
General "	15	20.4	23.33	23.36	17.33	49.46	48	26.6	43.2	44.06	91.26	205.93
Glenbeigh—												
4-gun average.	5	20.6	23.8	24	31.2	157	137.6	51.2	82.2	73.4	93.8	296.3
6 " "	3	16.3	24	24	18.6	194.3	132.3	46.6	80	72.3	94.6	293.6
General "	8	19	23.8	24	26.5	171	136.5	49.5	81.3	71.3	94.1	295.4
Shoeburyness—												
4-gun average.	4	19	23	24	21.2	169.2	102.7	42	82.5	62	83	269.5
6 " "	12	19.6	22.5	22.6	31.83	122.58	130.36	47.3	73	72.66	89.58	282.59
General "	16	19.5	22.6	23	29.1	134.2	123.4	46	75.37	70.0	87.93	279.31
Morecambe—												
4-gun average.	1	24	22	24	29	144	93	64	82	78	96	320
6 " "	2	23.5	23.5	24	24.5	124	130	38	64	71	94	267
General "	3	23.6	23	24	26	131	117.6	46.6	70	73.3	94.6	284.6
Lydd—												
4-gun average.	3	17.3	20.3	21.3	13	39.6	32.6	24	38.66	58.66	89.66	195.0

PROFESSIONAL NOTES.

A. ORGANIZATION.

(a). Airship Company—Switzerland.

In the draft of a new organization of the troops, special attention is invited to the equipment of an airship company, as lately introduced into the armies of the countries surrounding us. (Compare page 51 of the *Botschaft* and § 60 of the draft of laws, table XXVII). As in this case it treats of an entirely new institution in our army, it appears desirable to throw a little more light on this new war-medium, its organization, use, service and financial bearing in a special report.

In the *Botschaft* of May 29, 1893, in regard to the credit for the purchase of war materials, an item of 69,500 Fr. is proposed for the first outfit of a military airship-park to be taken up by the Material Budget for 1894. The great importance of the new war-medium is set forth on this occasion. It is specially emphasized that the captive balloon allows the officer in command to recognize throughout the battle the whole of the lines of fire of the enemy, the number and position of his reserves, and the preparations made for insuring the result. From the height of the balloon he can also overlook the positions of his own army and is continually informed of the successive firing-positions of its parts. The commander-in-chief, who, through the general staff-officer in the balloon, is every moment informed by telephone of the condition of the enemy and of the situation of his own troops, gives orders therefore during the battle by means of an information service which can scarcely be more perfect. He is in a position to be able to give his orders in good time for defence against any threatening danger, which without this medium of information would often be given too late.

The commission of the National Council did not undervalue the great importance of this suggestion, but was of opinion that a special message should be brought in relative to the airship park, and suggested therefore the preliminary reduction of the items under consideration in the Material Budget for 1894. This was accepted by the National Council and the *Staenderat* agreed to it.

In consequence of this resolution the equipment of an airship company was taken up in the draft of laws concerning the organization of the army of the confederacy, and we have the honor to annex the following explanation.

The progress which has been made of late years by the use of captive balloons for military purposes is of such importance that this formerly rather awkward war appliance does not at the present day stand behind any of the wagons of a mobile division in its capability of being easily moved, and consequently can be inserted in any marching column. The necessary time for inflating the balloon is reduced to a minimum and consequently its tactical use is perfectly assured at all times.

The advances in military ballooning are of two kinds: the one belongs to the domain of the technique of balloon building, with the aim of raising the power of resistance, in order that it can be used in a strong wind; the other concerns the generation of hydrogen and the inflation of the balloons. In the earlier military balloon-parks the hydrogen was generated in special wagons (generators), which together with several transport wagons for the raw material of the gas generation, followed the mobile balloon-column. Further, the generation of the hydrogen necessitated the neighborhood of a pond or brook on account of the large quantity of water required. Therefore the inflation of the balloon was dependent on the accessibility of such reservoirs, and its tactical use in the field was in consequence very limited. The inflation required from 3 to 4 hours, so that often by the time the balloon was ready for use, the conditions had quite changed and the tactical object to be gained through balloon observation was impossible.

In the new balloon-parks the hydrogen will be generated in a strongly built station behind the immediate theatre of war and there compressed, by means of compression pumps of from 120 to 150 atmospheric pressure, into steel cylinders, which are then sent to the mobile park and forwarded as required. The carriage of the requisite hydrogen cylinders for one balloon inflation requires three light wagons. The inflation, therefore, of the balloons, in a very short time (about 20 minutes), and in every place, is now possible, without regard to whether water is at hand or not. Besides which the inflation of the balloons from cylinders considerably reduces the special fighting-column of the airship-park, while the number of wagons for the cylinders at present requisite, is considerably below the number of transport wagons which were formerly required for the raw material of iron and sulphuric acid.

For battles of the present day the balloon has become quite an indispensible means of information. The battle, which formerly was fought in relatively limited space, and, so to speak, under the eyes of the general in command, is now divided into numerous separate combats of the divisions and army corps, which must seek the shelter of the terrain if they are not to be carried off, before the battle is decided, by the devastating fire of the enemy. The fight consists, therefore, in a long tough struggle to obtain possession of the enemy's position or maintain our own, during which ensue the decisive movements of the reserves on the center or on one of the enemy's wings, against the flank, or even in the rear, and often at a wide circuit covered by the terrain. As a consequence of the large space occupied, the result of the battle at the present day lies as much in the superiority of the strategic conception as in the local tactical issue, which is often only a partial issue and is balanced or outweighed by more important strategic issues in other parts of the battle field. By this state of things it is clear, that that party has an enormous advantage which recognises his enemy's equipments and intentions, earliest. For those acting on the defensive it is of decided importance to discover as soon as possible against which point in his lines of defence the opponent places his reserves, that he may be able in good time to direct his own reserves to the threatened point. For those attacking, it is equally of importance to know the position, strength and division of his opponent's forces, because they form the scheme and fundamental plan of his attack. Up to this time armies had only one means of obtaining such information, namely, their cavalry. As, however, the effectiveness of the firearms of the present day is such that no cavalry dare venture to reconnoiter on the direct line of the enemy's front or position, they are sent to the flank for information and they can get there only by making a wide circuit and with great loss of time.

By the time the general receives the announcement of the result of the reconnaissance, the enemy's situation may have materially changed, or the time have already passed for effective measures for counteraction. Further, it is to be considered that the opposing cavalry will work in every way against this reconnoitering, and whenever possible prevent it. The stronger the enemy's cavalry is in comparison to yours, the better they will be able to gain their object and so much the worse will be the knowledge of the general in command in regard to the position and intentions of the opponent. Finally comes the consideration that the reconnoitering cavalry-patrols can generally only see a small vanishing portion of the hostile army as it is spread out under shelter behind terrain coverings, making a breadth and depth of several kilometers and that a nearer approach to the enemy is precluded by the rapid long range and precise shooting of the muskets or guns. We can therefore say, that with the present conditions of battle, the cavalry is a means of information much less to be depended upon than formerly, and the Swiss army have a right to expect less of it as it may be foreseen that our opponents will always command a cavalry numerically very superior to ours.

For this source of information service, the captive balloon is now of almost ideal efficiency.

The general's staff-officer in his car, from a height of 500 m., overlooks the whole surrounding district for a distance of 15 kilometers. In good weather and with the sun at the back or side, the different kinds of troops and even their uniforms can be distinguished. He looks into all parts of the terrain and is in direct telephonic communication with the commander-in-chief. He sees the positions and movements of the enemy and the exact position of his own army and the commander-in-chief receives continuous information upon the conditions of the battle and the intentions of the enemy, as they manifest themselves.

This observation is still quite sufficient when the balloon is kept beyond reach of the enemy's fire, for this height of 500 m. and at the same time a lateral distance of 5 kilometers from the enemy's lines of fire suffices. Then, as already mentioned, the details can still be observed for a distance of 10 kilometers. The balloon reconnaissance is therefore considerably less liable to be obstructed by the enemy than that of the reconnoitering cavalry. The communication of the result of observation does not require a space of time in which the conditions could have changed, besides, it is not influenced by the efficiency of the horses or the condition of the road. It works spontaneously and without any interruption or loss of time.. Finally it is not limited to single parts of the battle field but always takes in the whole field. Therefore, the commander-in-chief is able to take advantage at once of the weakness of his opponent or the mistakes of his position; for example, by making the decisive advance before the expected reinforcements of the enemy have arrived, or before he can remedy a mistake. Under other circumstances, the commander-in-chief can retire before all is lost. Victory or defeat may therefore depend upon the possession of a balloon park. It is certainly true that the captive balloon has difficulties to fight, such as high wind and fog. However, only under these peculiar circumstances, which cannot be considered as normal, can its efficiency be limited or nullified.

It has been questioned, if the use of the balloon in time of war in our terrain is possible on account of its being rather cut up. In the Jura and the Alps one can only use them in a limited measure, but there no great battle would take place. In the table lands, however, between Lake Constance, the Rhine and Lake Genoa on one side, between the Alps and Jura on the other, there where the decisive battles must be fought, the balloon would be of very great use on account of the height it reaches, and the disadvantages of the small irregularities of the terrain of this neighborhood would for the most part disappear. The adversary who undertakes an invasion of our country will not leave his airship park at home, he will bring it with him to use against us. This necessitates our employing the same means against him.

It is not possible to replace the balloon by posts of observation placed on the terrain heights of the table land. These heights do not reach, by a long way, the altitude from which the observations from the airships can be made. Also the means of communication from those posts of observation to the general in command are generally difficult and slow. An exact study of the topographical conditions of our table lands shows, that in the neighborhood of the defensive positions to which our army would be preferably directed, there is no mountain where an observation post could render anything like the service that the use of balloons would give for the direction of an army.

If, however, our balloon gets loose while the enemy possesses his, our army finds itself deprived of means of information, the significance of which instinctively communicates itself to the farthest soldier. He sees before and over him the enemy's balloon, which like an all-seeing eye, recognises in all their details our forces and positions, while our general is in absolute uncertainty regarding the like conditions of the enemy. Will not our army be demoralized by this feeling, that it may be fighting under the most disadvantageous circumstances, that the enemy may have a great advantage? Will not this feeling make leader and troops uncertain, cripple their activity, create the idea that the enemy will get the upper hand and that the army is lost—before a decision can be arrived at? This depressing influence on the morale and confidence of victory of the troops, may be almost rated as high as the material advantage of the balloon itself. Both together make this new accessory of war appear indispensable for our army.

We consider the formation of an airship park as one of the most important and pressing questions for our army.

For the balloon service a special troop must be set aside and educated, namely, the airship company, which in the field is to be placed directly under the commander's staff, and is to receive its directions and orders from the general-staff officer who is charged with this service.

The men and wagons of this company fall into two divisions, of which the stronger is the mobile division, the weaker the machine division.

The mobile division looks after the proper airship service with the field army. The machine division on the contrary remains in a central position inland, generates there the hydrogen, compresses the latter into the cylinders and sends it to the mobile division.

To the mobile division will be assigned the balloon carriage, the cable carriage and the wagons for the hydrogen cylinders, with a requisition carriage.

The balloon carriage carries the balloon and all its appurtenances, a reserve balloon cover and a reserve net; these latter are necessary on account of the numerous injuries to which the balloon is readily exposed.

The cable carriage carries a steam windlass with a cable 500 m. long.

For one inflation of the balloon three cylinder carriages (a *garniture*) are necessary, so that with nine such carriages three inflations can be made. They are generally divided in the following manner: one *garniture* at the central station with the magazine division for filling the empty cylinders, the other two *garnitures* with the field army. Consequently it is possible, in case the balloon shall have suffered very much, to restore it by means of the reserve covering and net even during the battle, and accomplish immediately a second inflation.

To the machine division belong the hydrogen generator, the compression pump with the steam engine belonging to it, and a requisition carriage. This division has also, besides this, a small balloon which served as gasometer for the gas manufacture. With these machines and apparatus the necessary gas for a balloon inflation can be made and pressed into the cylinders in one day.

The effective working condition of an airship company consists in France of 3 officers, 90 airship men, 30 train soldiers; in Russia of 15 officers and 215 men; in Italy of 2 officers, 52 airship men, 21 train soldiers.

For the setting up of the Swiss balloon park are required:

Three to four officers.

Thirty-seven airship men, non-commissioned officers and soldiers.

Thirty-three train men, non-commissioned officers and soldiers.

Of the three to four officers, one has to undertake the direction of the machine division in the character of machine engineer. The two to three others will be appointed to the mobile division; one of them in command of the whole company.

In the field the airship company serves preferably the staff, and relatively the general-staff officers entrusted with the information service. The organization of this troop therefore interests primarily the general staff. It may therefore be recommended that the airships with the troops serving them be placed, at least for the beginning, under the general-staff bureau, with the proviso of being attached later to the engineers.

The uniform and equipment of the airship men can be that of the engineers, (for the train soldiers, that of artillery) with some distinctive mark added.

Concerning the instruction we propose to select the airship men similarly to the wheel drivers, *i. e.*, from men who have already gone through a recruit school, and indeed an engineer-recruit's school. They have then to pass through an airship school of 35 days, and afterwards they have a review of the course of 18 days every two years. For the first instruction of the officers and non-commissioned officers a special course of about three weeks is necessary. In the years in which no review of the course takes place, the company must undergo a company course of 12 days in order to keep in practice with the materials.

This branch of instruction consists, for the men in a knowledge of the materials and practices with the balloon as a preparation for further use in the field; for the officers and non-commissioned officers, besides knowledge of the sciences necessary for this service, practice and observation are needed. Therefore it is necessary for the officers to have practice in air journeys, that they may have opportunity to become quickly acquainted with all the conditions and contingencies of the balloon.

The expense for the material of an airship park is as follows:

A.—Cable carriage, hydrogen generator, balloon carriage with tackle, double balloon cover and net	43,000 Fr.
B.—Boiler	6,000 Fr.
C.—Compression pump with steam engine	11,000 Fr.
D.—Three *garnitures* of cylinders at 18,000 Fr. per *garniture*	54,000 Fr.
E.—Nine carriages for transport of the cylinders with appurtenances at 1800 Fr.	16,200 Fr.
F.—Cost of transport and unforeseen expenses, about 5% . . .	6,800 Fr.
Total	137,000 Fr.

The different items are reckoned according to the prices given us by the factories in England, France and Switzerland. The total certainly exceeds our memorial in the Material Budget for 1894 by 17,500 Fr. (69,000 was given there as immediate outlay and further 50,000 Fr. was devised for the supplimentary successive completion of the material). The reason of this difference was that we at first believed we could manage with two cylinder *garnitures*, but since then we have been convinced that a third is indispensable if the balloon is to suffice for all emergencies.

From the requisite sum total of 137,000 Fr., we would, for the first year,—say 1895—have to lay out a sum of 85,000 Fr. to 90,000 Fr.; the remainder would be claimed for the following or two following years.

As for buildings, the organization of the airship company requires three sheds which must be newly erected at some suitable place. As military establishments, they must be placed to the account of the department of the interior; they are not included in the above account of 137,000 Fr. for providing materials.

These sheds to serve the following purposes:

In the first place a covered-in space is required in which the inflated balloon can be placed over night. According to an estimate made in Paris, the cost of such a shed 15 m. in length, 15 m. high and 12 m. wide would be 6,300 Fr. As in this estimate the desirable arrangement of a trap-door was not included, we place the cost of this shed at 8,000 Fr.

Of the two other sheds, one must be 12 m. long by 11 m. wide and a height of 5 m; the other, 12 m. long by 4 m. wide and a lesser height. The first is for the hydrogen generator, the compression pump, the gasometer balloon and the carriages; the latter is destined for the boiler, the coal and acid stores. On account of the insignificant height of these sheds the price of both together should not exceed a total of 6,000 Fr.

Concerning the cost of instruction, we must consider one course of an airship school for about 40 men. During one part of this school about 15 train soldiers with a corresponding number of horses must be added to the reckoning. With regard to the proportionally large number of officers and horses, the price individually per man must be set down at 5 Fr., which for a school of 35 days makes a total of about 9,000 Fr. Besides which we must take into consideration a sum of 6,500 Fr. for providing raw material for making gas, whereby we presuppose that for the purpose of practice the balloon must be inflated several times during a course.

The cost of the repetition courses, which are shorter by one-half than the first school, will be correspondingly less, therefore about 4,500 Fr. to which must be added for raw material, about 3,500 Fr.

—*Allgemeine Schweizerische Militär-Zeitung.*

(b). Italy.

Just before the opening of Parliament on December 1st, 1894, five Royal Decrees appeared in the Official Gazette, making decisive changes in the army organization. They represent the results of the recommendations of a private commission which met in June with Lieutenant-General Cosenz as President, and in the beginning of October reported on the possibility of economizing.

By these measures the Army Budget is reduced about 7,500,000 lires, which sum the ministry had represented as necessary, in connection with retrenchments in other branches, to make the receipts equal the expenditures.

The form of Royal Decrees, which still need the sanction of Parliament to become law, is an unusual one, and is even termed unconstitutional by some extreme papers. This method has, however, been chosen in order to introduce the reforms as quickly as possible, and to cut short the tedious budget debates.

There are five decrees in all, of which one relates to changes in the army organization, one to territorial jurisdiction, one to allowances, and two relate to the new arrangement of the war ministry.

The most important innovations, which represent by far the greater part of the retrenchment, are the following:

(*a*) Abolishment of the Inspection of the *Bersaglieri*.

(*b*) Considerable reduction in the Personnel of the District Commands and doing away with the twelve upper District Commands. This measure is adopted in order that the business part of the district be limited hereafter to compensation for men and horses, while the entire administration in peace as in war, which till the present time was incumbent upon them, now goes over to the military. As a consequence of this, the title they have hitherto borne of *distretti militari* is changed to *distretti di reclutamento*.

The large number of men and horses which become available by this means are to increase the infantry, so that for each regiment of the mobile militia in peace there will be eight captains and twelve lieutenants.

(*c*) Discontinuance of ordnance officers with commanding generals.

(*d*) Reduction of the number of depots for securing horses from six to four.

(*e*) Abolishment of the general inspections of the artillery and of the engineers, as well as of a field artillery inspection.

Hereafter there will be the following inspections of the artillery directly from the War Department:

1 inspection of the field artillery.
1 inspection of the fortification artillery.
1 inspection of artillery construction.
1 inspection of arms and equipment of the troops,
and likewise of the engineers.
1 inspection of engineer troops.
1 inspection of engineer works.

(*f*) Changing of six field batteries into six mountain batteries. This applies to the batteries hitherto double equipped (the so called *batterie trasformabili*). The number of field batteries is reduced by this to 186, so that some brigades have three instead of four batteries. On this account the number of batteries of the mobile militia is to be raised from 56 to 62. The mountain artillery will consist hereafter of five brigades of three batteries each.

(*g*) Disbanding of the five foot artillery regiments as well as of the 14 territorial bureaus of artillery, and establishment of 12 artillery local commands in place of these, to which there will be added a bureau for material, and two or more of the present unattached fortification coast artillery brigades that are forming. By this step the number of the fortification artillery companies is at once increased by eight, that is to say to 72 in 22 brigades.

(*h*) Reduction of the total number of manufacturing plants pertaining to the artillery from 15 to 10, still keeping the same number of workmen and the same variety of material produced.

There will now be:

1 small arm factory.
1 construction arsenal.
2 pyrotechnic laboratories.
2 powder factories.
1 artillery construction workshop.
1 engineer construction workshop.
3 central military magazines.
1 military pharmacy.

Formation of five engineer regiments out of the troops now constituting four. The classification will be as follows:

First and Second Regiments (sappers) consisting of four brigades of three companies, two train companies and one depot.

Third Regiment (signalmen) consisting of four brigades of sapper-telegraphers of three companies, two expert companies, two train companies and one depot.

Fourth Regiment (pontonneers) consisting of three brigades of pontonneers with eight companies in all, one Brigade *Lagunari* of two companies, two train companies and one depot.

Fifth Regiment (pioneers) consisting of four brigades of three companies, one train company and one depot.

(*k*) Establishment of two new companies in the railroad brigade, whereby this brigade is brought up to six companies.

(*l*) Reduction of the number of engineer territorial bureaus from 19 to 15, three of which have likewise to provide for the coast defence in connection with the Navy Department.

(*m*) Extinction of all the *Collegi Militari* (cadet academies) and union of the School of Caserta for preparing non-commissioned officers for officers, with the Military School of Modena.

(*n*) Reduction of the invalid companies from four to two.

(*o*) Considerable reduction in the number of surgeons attached to troops, partially set off by an increase in the number attached to hospitals.

(*p*) Total transformation in the administrative department.

The duties of our *Intendantur* are performed in Italy by civil officers (with official titles), the *contabili* for the money accounts and the *commissari* for victualing the troops. In regard to the functions of the first, there exists now a certain confusion, since these accounting officers were assigned in greater numbers, to troops as well as to subsistence companies.

This service was under the direction of a supervising bureau. This last is now abolished, the "general-commands" and above these the War Department doing this work, being furnished with the necessary powers. The supernumerary *contabili* officers are dismissed, and service with the subsistence companies is limited exclusively to the commissariat.

(*q*) Reduction of the number of military tribunals from 19 to 14.

(*r*) Reduction in the ration and some other allowances.

(*s*) Simplification in the arrangement of the War Department, with reduction in the number of officers and clerks. The details of this new arrangement are not yet published.

The most sweeping measure is by all odds this great reduction of officers and military clerks which the Minister of War will put in effect gradually, in the course of three years.

This reduction embraces the following, according to the "*Esercito Italiano*:"

203 officers of the army, including eight generals.
107 officers of the medical corps.
26 officers of the commissariat.
615 *contabili* officers.
8 veterinary surgeons.
10 officers of the invalid corps.

On account of the sudden adjournment of the council, these decrees will no longer be discussed, and meantime the Minister of War is pushing forward their execution energetically.

For example, the general inspection of the 1st of January of the artillery and of the engineers, as well as of the *Bersaglieri* have already been abandoned. On the same date the new budget went into effect, and the remodeling of the six field into six mountain batteries was ordered.

It is taken for granted that the decrees, which represent great economizing, will be accepted unconditionally. The form in which they are brought before the council allows only acceptance or rejection, but not alteration.

—*Militär Wochenblatt.*

(c). The Reorganization of the Royal Engineers.

Our readers will remember that from March to August of last year there was a lively discussion in our columns under the heading of "Military Engineers and Civil Appointments." This had its origin in an article on "The Employment of Royal Engineer Officers in time of Peace," by a "Quondam Officer of R.E.," which was published in the *United Service Magazine*, March, 1894. There has now appeared a pamphlet entitled "The Reorganization of the Royal Engineers." This latter begins with a short preface; it then reprints an article by Colonel the Hon. Arthur Parnell, late R.E., which appeared in August-September, 1894, in Colbourn's *United Service Magazine*, on "The Reorganization of the Royal Engineers," and then follows the latter article to which we have already referred. From page 45 to page 156 is occupied with the letters which appeared in our columns, while the remaining five pages are extracts from other sources. The issue of this publication is evidence that the subject is not to be allowed to drop. If the dissatisfaction existing with regard to the present position of the Royal Engineers were confined entirely to the civil branch of the profession, which suffers severely from the undue preference shown to military men in the distribution of public appointments, it would be serious enough. But it has a far more extended range than this. Those officers who have made a comprehensive study of the condition of our Army, declare that the Royal Engineers, as a body, are bad soldiers, that they are unfitted to command men in the field, and to perform the duties that would devolve upon them in campaign. This is a very grave charge, but the evidence in support of it seems difficult to refute. It is notorious that the Royal Engineer officers are most anxious to acquire civil and semi-civil berths, and that when they do so they cease to concern themselves with drill and tactics. They build barracks the designs of which are got out by civilian contractors, under the supervision of civilian surveyors. This duty spoils them as soldiers, and makes them neither architects nor engineers. Or they act as inspectors to the Local Government Board or the Board of Trade, advising as to the acceptance or refusal of designs and works for which civil engineers are responsible. But it is possible to be a fair critic, and yet to be absolutely devoid of the constructive faculty. Many of them obtain positions in the Public Works Department of India, which is a better field for acquiring experience than can be found at home. But here, again, they chiefly seek after office berths, where they are concerned with administration and routine, and have but little to do with practical work. They grow rusty as soldiers, and learn but little as engineers. The object of their desires seems to be to shake themselves free from all regimental duties and responsibilities, or, in other words, to drop their military character.

The strength of the Royal Engineer Corps for 1894–95, including 385 officers and 3 sergeants on the Indian establishment, is 7576. The British establishment includes 553 officers, 117 warrant officers, and 993 sergeants, 112 trumpeters and buglers, and 5413 rank and file. There are thus, in all, 938 officers to 5525 men, or 1 to 5.9 men. Reckoning officers, warrant officers, and sergeants, the proportion is 1 to 2.7; surely the rank and file should be well looked after. The number of officers suggested by Colonel Parnell is 270, while the proportion assumed in the German Army would give 288, so that there are now three-and-a-half times as many officers as are required. The reason is that a large number of them are engaged in civil pursuits. If they were available for service in time of war, the state of affairs would have something to recommend it, but the consensus of military opinion is, as we have shown, that these half-retired officers have lost their knowledge of, and taste for, military matters, and would prove but amateurs if they were suddenly called upon for active service. At the same time they are an expense to the country, and lead to a delusive sense of security, as they figure as efficient officers, when they really are incapable of performing the duties that pertain to their rank and station.

The success of the Royal Engineers in obtaining civil appointments is largely due to the way in which they stick together, and exert their combined influence in favour of individual members. They are still more united in repelling all attempts at reformation, and in crushing any officer whose love of military efficiency leads him to criticise their methods. The effect of this feeling is shown in the pamphlet before us. We search in vain for the names of author, editor, publisher, or printer. No clue is afforded to its origin, because —so we imagine—the originator is not prepared to face the contumely that he thinks would be poured upon him if his identity were discovered. We have had inquiries as to where copies can be obtained, but have not been able to answer them. We should be glad to know, since it is a pity that such an important subject should suffer for want of due publicity.

—*Engineering*, March 22, 1895.

(d). Engineer Troops—Russia.

The *Prikas*, number 200, establishes the reorganization and increase of engineer troops in the Russian Army. In this manner, observes the *Russkii Invalid*, each one of the army corps will have its battalion of engineers of four companies, the first three sappers and the fourth telegraphers. In addition there will remain troops of the same class assigned to the bridge, fortress, and torpedo services, etc., not assigned to any particular army corps. The material of the corps battalions has been increased also, each one possessing a light bridge train and telegraph material for the erection of 85 versts and 6 stations.

Finally, in order to improve as much as possible the technical services, a school of electricity was created (*Prikas*, July 13/25) for the purpose of instructing the engineer personnel in all that pertains to the management of the various apparatus which have recently been introduced into the military service, based upon the different applications of electricity.

All these dispositions corroborate, as has already been mentioned in this *Review*, the thorough transformation which is being made in Russia, where all that relates to preparation for war is started to the extreme limit.

—*Revista Cientifico Militar.*

(e). Technical Artillery—Austria-Hungary.

The "*Revue*" gave in 1894* a few notes on the subject of the organization of technical artillery into a corps apart and distinct from the rest of the artillery. As a result of various contingencies, this reform only went into complete operation to date from February 1st, 1895. Henceforward the personnel of the technical artillery will constitute a distinct corps or arm having its own special hierarchy and promotion.

The bases of this new organization are as follows:

In a general way, the functions of the technical artillery consist in the study and manufacture of the material, arms and munitions necessary for the army and strongholds, in the preservation and repair of all supplies of which the care does not pertain to the line, and finally in the management of the establishments. The most important of these establishments are:

* See *Revue d'Artillerie* vol. 44, May 1894, page 173 and September 1894, page 576.

1. The arsenal of Vienna, which comprises the manufactory and depot of material, the receiving board (*Commission de Reception*), &c.
2. The manufactory of munitions and the depot of Wiener-Neustadt.
3. The powder mills of Blumau and Stein.
4. Nineteen* depots and 18 sub-depots (*Zeugsfilial depots*).

The personnel of the new corps comprises

1. The engineers (*Artillerie Ingenieure*) charged with the general administration and management of the technical establishments (construction shops, arms factories, powder mills, inspection and proving boards (*Commission de Reception*, &c.).
2. The employees (*Artillerie-Zeugsbeamte*) charged with the current business and administration of the establishments of every description.
3. The non-commissioned officers and cannoneers (*Zeugsmannschaft*) fulfilling the functions of overseers or secretaries, or merely utilized as workmen.

The effective of the engineers is as follows:

2 engineer generals (*General-Ingenieure*).
4 chief engineers (*Ober Ingenieure*) 1st class.
4 " " " " 2d class.
7 " " " " 3d class.
25 engineers.
10 assistant engineers (*Ingenieur Assistenten*).

These engineers have respectively the rank of brigadiers general, colonels, lieutenant-colonels, majors, captains and 1st lieutenants. They are taken from the artillery officers and also from the technical employees who have followed successively special courses. All of the candidates are obliged to take a six months' course (stage) in a state establishment; when they are, if satisfactory, either immediately appointed to, or else merely rated for the grades of engineer or assistant engineer†.

The effective of the employees is as follows:

3 chief overseers (*Oberzeugs-Verwalter*) 1st class.
3 chief " " " 2nd class.
6 overseers.
157 employees (*Zeugs-Offizialen*), of whom 53 are *first class*, 27 *second class* and 77 *third class*.
51 assistants (*Zeugsaccessisten*).

The overseers have the rank of field officers (colonel, lieutenant-colonel and major); the employees and assistants the rank of captain and lieutenant. The employees are recruited from the non-commissioned officers and masters (Meister) of the artillery and establishments, and from the officers and

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* These depots correspond nearly with the French *Directions d'Artillerie*.

† In the transition period, special rules were obtained for the formation of the new corps, which absorbs, by the way, the greater part of the personnel pertaining to the special staff and special services of the artillery.

non-commissioned officers of the reserve artillery*. But one-third, only, of the vacancies are allotted to the reserve candidates.

The non-commissioned officers and masters of artillery must fulfil certain conditions as to conduct and physical aptitude, must be unmarried and less than forty years of age. The non-commissioned officers must, in addition, have completed ten years of active service. All are compelled to attend a special school and to pass an examination†. The reserve officers and non-commissioned officers must submit satisfactory guarantees as to their general education; they are, besides, obliged to go through a six months' course (stage) in an establishment (depot, workshop or manufactory).

They next undergo the examination to which reserve officers are subjected who apply for admission to the active list of the garrison artillery (*artillerie de forteresse*).

The soldiers form a group (*Zeugsabtheilung*) commanded by a 1st captain and three lieutenants belonging to the garrison artillery, but additional to the effective of their corps.

This group has an effective of 668 men as follows: 1 accountant, 66 masters, 96 artificers, 31 sergeants, 47 corporals, 427 cannoneers or employees of various sorts.

In time of peace the personnel of the group is scattered through the establishments. In reality, it is more especially assigned to the various duties of the arsenal and establishments of Weiner-Neustadt.

For field service (*a*) field companies (*Feldzeugscompagnien*) are formed by details from the reserve. These are assigned to the army parks, field depots and siege parks. Also (*b*) field detachments (*Feldzeugsabtheilungen*), equally from the reserve, which are assigned to the mobilized groups of siege batteries, to the parks of mountain divisions and to certain field depots. The men are recruited, for the greater part, from the artillery of the line, in which they must have served at least two months; the personnel necessary for the establishments is made up of civilian workmen (skilled mechanics and laborers) whose number is decided by the importance of the work foreseen.

The uniform of the engineers and employees is of the same color as that of the artillery, but differs in cut and headdress. The engineers have as insignia, stars; the employees, rosettes. The uniform of the soldiers is that of the artillery, the sabre being similar to that of the pioneers, except in the case of the artificers who wear the cavalry sabre. In the field the cannoneers carry a musket without the bayonet, and thirty cartridges.

—*Revue d'Artillerie.*

(f). Armies.

H.R.H. the Duke of Connaught presided on Tuesday at a lecture delivered at the Prince Consort's Library, before the members of the Aldershot Military

* The corps of technical-artillery can receive, besides, students who are judged unfitted for service with the line from the artillery schools, or from the cadet schools; and, exceptionally, officers of artillery with the approval of the superior.

† This school is to be organized at the Vienna Arsenal. The conditions of admission and arrangement of details are not yet promulgated.

Society, by Col. J. F. Maurice, Commanding the Royal Artillery in the Eastern District. The subject upon wnich Col. Maurice was invited to lecture was, "How far the lessons of the Franco-German War are now out of date," but, as was explained in his opening remarks, the lecturer entered very largely upon the tactics adopted by the Japanese in the war in which they are at present engaged with the Chinese.

Col. Maurice said that since he was asked to lecture before the society they had found themselves in the presence of a new war, which, to say the least, presented certain remarkable features, and it became interesting to inquire how far from the information they yet possessed of the Chino-Japanese War they were able to confirm the lessons of the past, or to add to them new deductions in order to judge how far what was new in the experiences of the Franco-German War was likely to be met with again in future wars. The changes since 1870 had been very numerous, and they could best estimate their probable effect in modifying the lessons they learned from the Franco-German War by considering how far the peculiarities of that campaign were the result of the changes which had been introduced before that time, and how far the more recent changes tended only to accentuate the difference from former wars or introduced altogether new conditions. The most remarkable feature of the war of 1870 was "organization," and during that war and in the preparations therefore, it acquired an importance such as it never had before. It was hardly too much to say, as marking the contrast, that during the period when France was conquering Europe Napoleon triumphed; but that during the war of 1870, not Von Moltke but the organization which Von Moltke had created before the war and guided during it triumphed. Actual experience since 1870 had fully confirmed that great lesson, and that afternoon he proposed to inquire whether they did not already know enough of the present war between China and Japan at least to still further confirm the same lesson. What, he asked, was it that had manifestly been the cause of the startling success of Japan? No doubt they could put it in many ways, but he found that almost everyone instinctively summarised the facts by saying, "What an extraordinary power of organization Japan has shown." A few of his friends had also pressed on him the inquiry, to which as yet they had no answer, "Who is the man?" They said that a development and employment of resources so thought out, so consistent, so complete, so uniform, must imply that it was the work of some one man inspiring and setting to work all the rest. Whoever he was, at all events they had the consolation that if such a one there be, he was a man like Von Moltke, so loyal, so patriotic, that his identity was lost in his work, and that it was only among nations where Crown and people were one that the breed was produced. Proceeding to discuss the Chino-Japanese War, he said they had as yet no such description as would enable them to judge how far the practical working at Ping-Yang or elsewhere was carried out in detail in accordance with the deductions which the Germans themselves had drawn from their own experiences in 1870, but in the main, and so far as the circumstances demanded it, the Japanese began by intending to apply those deductions, he thought they could safely assume. They knew they had made a most careful study of them, and that they were taught by the best instructors they could get from Germany. How far the experiences of their own war had induced them to modify those deductions they did not know, for here the inferior fighting power, the inferior organization, the inferior skill, and the inferior weapons of the Chinese would altogether confuse the conclusions they might draw. The Germans had only to consider how, with equal if not superior numbers, they should meet men supplied with the best weapons that modern science could supply them with. There might, however, be other points, even as regards the tactical conduct of an action, as to which they might pick up useful hints. The general arrangements of two of the great fights—Ping-Yang and that at the passage of the Yalu—both of which presented similar characteristics. In the case of Ping-Yang the form of the attack followed the nature of the march. The column which came from the right carried out a pure outflanking movement directed from its original line of advance, and there could be no doubt that during the battle its co-operation with the remainder of the army was regulated by the field telegraph. In their selection of their position on the Yalu the Chinese made a good old-fashioned blunder. They had divided their army into two parts, separated by the river Ai, which flows into the Yalu. The whole Japanese force was, therefore, able to throw itself on a body said to have been about 7,000 strong on the east side of the Ai, without the remainder of the Chinese Army being able to render it the least assistance. When, subsequently, the victorious army crossed the Ai to move against that portion of the Chinese forces which had not been engaged, they found the place it had occupied abandoned. So far as these general conditions of attack and defence were concerned, there was nothing remarkable about the action. The same blunder would have led to the same result in almost any other period of war, and there was nothing in it to assist in the solution of the main question. So far as the meagre reports to hand enabled them to judge of the later operations, they gathered that their characteristics were very similar to those of the earlier ones. Separated bodies had been worked, both doing long marches and for battle purposes, by means of the field telegraph with a freedom that would have been impossible without it, and its employment, despite occasions on which the wire was cut, had been fully justified. When they spoke of the "lessons of the Franco-German War," it was obvious that different people might have derived different lessons from it. To some it seemed that the one lesson of those campaigns was never to miss an opportunity for attacking, to others that the breechloader had conferred an enormous advantage on the defence; to some, again, it seemed that the one great change was that from fighting in close order to fighting in dispersed order. Others, especially of late years, since the actual remembrance of the battlefield had become somewhat dimmed by time, had come to the conclusion that all that was a mistake, and that they could not fight too closely shoulder to shoulder; and to others it seemed that the losses inflicted at a given spot at a given moment were so tremendous that the only solution was that at which the Americans arrived at the end of their Civil War—the use of the spade and pickaxe. For each of the deductions, various and conflicting as they were, there was much to be said. In military matters, as in others, there was a time for every purpose. The question was, how and when to do these things? How were they to learn them? But at all events, as a lesson from the war, all were agreed that the essential condition of success was a unity of action due to previous training, a trained knowledge how to tackle difficulties, and a trained capacity to co-operate for an assigned end without many orders. Proceeding, he said that by 1813 Wellington had created in the Peninsula a splendidly organised and equipped army, but it was an army that had been formed almost entirely by long years of war. The army, by the help of which Prussia developed into Germany, overthrew Austria, and conquered France, was essentially a peace creation. He invited them to follow him and to look back a little into our own history. That glorious army made in war, "which could go anywhere and do anything," did not continue in a state of suspended animation. It became stone dead. It was done to death by England. Nothing but exuviæ and ashes remained of it. That was the most vital point he wanted them to consider. During the second yeai of the Crimean War, and during the Indian Mutinies, it was as true of England as it is now true of Japan, that "the whole land, from Her Majesty to the lowest crofter, was consolidated by one great heart-beat of national effort," but in the 30 years which followed Waterloo, England in one of her cold fits strangled the Army which Wellington had created, while he, anxious to save such *débris* as he could, had allowed them to be so scattered and hidden from view that all life had gone out of them. One man at least thought he saw clearly the direction in which we had to move, in order that we should be able to fight at all as an army, not as a mere mere congress of braves. He did much else; but two or three notable things that he did concerned him at the moment. By his influence the Army was provided with the very best and newest of weapons. He formed the camp at Chobham, and he founded that library. The experiences of 1870 and 1894 had absolutely confirmed his judgment, and like Germany and Japan they took a great step in peace-time which led to their perfection in war. It had been by bringing their armies, not specimens of their armies, together on ground where it was possible for all arms to be trained in large bodies, and for all to become accustomed to the combined working of all arms, that they had alike attained the second great step in their organic efficiency. Lastly, it had been by reversing the idea that the more ignorant a soldier was of the past the better he would be in the future; it had been by cultivating knowledge and judgment in all ranks that beyond all dispute they had attained the third most important step. Continuing, he said that every attempt to carry out the principle which underlaid the formation of the camp at Chobham, by either withdrawing troops from small stations where they had no chance or even purchasing ground that would make at least the practice of small bodies somewhat better than it is, was resisted by local greed. Parliamentary pressure was brought to bear to resist the one; the hope of fleecing the Government sent up the price at once to resist the other.

—*Army and Navy Gazette*, January 26, 1895.

B. PERSONNEL.

(a). Army—England.

Annexed are two tables, the first showing the actual numbers of the various grades of officers of the British Army on January 1, 1894 and 1895 respectively, The second shows the actual number of promotions which have taken place in the various ranks, subalterns being for this purpose left out of the calculation. It will be observed that there is throughout the army a net gain of sixty-nine officers, of which 104 occur in the subaltern ranks. The only other grade

TABLE I.—SHOWING ACTUAL ESTABLISHMENTS ON JANUARY 1, 1894 AND 1895, RESPECTIVELY.

Rank.		Cavalry and Infantry.	Royal Artillery.	Royal Engineers.	Total.	Increase or decrease.
Field-Marshals	1894	vari'us	vari'us	vari'us	5	+ 2
	1895	"	"	"	7	
Generals	1894	*9	‖3	¶2	14	
	1895	†10	2	¶2	14	
Lieutenant-Generals	1894	‡23	7	4	34	— 1
	1895	‡22	7	4	33	
Major-Generals	1894	§49	14	7	70	— 1
	1895	§48	14	7	69	
Colonels	1894	278	73	63	414	+28
	1895	291	80	71	442	
Lieutenant-Colonels	1894	252	117	86	455	—42
	1895	232	103	78	413	
Majors	1894	699	272	165	1,136	—14
	1895	701	267	154	1,122	
Captains	1894	1,917	499	221	2,637	— 7
	1895	1,924	481	225	2,630	
Lieutenants	1894	1,866	524	272	2,662	+51
	1895	1,849	586	278	2,713	
2d Lieutenants	1894	1,034	258	117	1,409	+53
	1895	1,138	207	117	1,462	

* 2 ex. † 2 ex., 1 sup. ‡ 1 ex. § 1 sup., 1 ex. ‖ 1 sup. ¶ 1 late Indian.

TABLE II.—SHOWING ACTUAL PROMOTIONS.

Rank.	1893.	1894.	Increase or decrease.
Field-Marshals	—	1	+ 1
Generals	7	9	+ 2
Lieutenant-Generals	9	10	+ 1
Major-Generals	14	14	—
Colonels	33	67	+34
Lieutenant-Colonels	74	78	+ 4
Majors	143	157	+14
Captains	271	230	—41

which shows a decided increase is that of colonel, the difference being twenty-eight. As a set-off to this we find forty-two fewer lieutenant-colonels, fourteen fewer majors, and seven fewer captains. The establishment of general officers has shrunk by two, as against which there is one more field-marshal. Coming to the actual promotions which have taken place during the year, there are thirty-four more colonels, and fourteen more majors promoted than in 1893; but against this forty-one fewer subalterns attained captain's rank, not a great falling off, it is true, and representing only about 2 per cent. of the totals, but still showing that in this step, which many officers look upon as the most important of their career, the flow of promotion is not quite so rapid as it was. This is only what was to be expected in view of recent legislation, which has been all against voluntary :etirement, and still more against compulsory retirement in the younger stages of a man's life, two things which tend to swell the non-effective votes, and are therefore *anathema maranatha* to the official mind. The Indian Army, Army Service Corps, and Marines are not included in the tables.

—*Army and Navy Gazette*, March 2, 1895.

(b). Continental Powers.

Streffleur's Review for last October published the following data upon the organized units of the powers:

	Inhabitants.	Battalions.	Squadrons.	Batteries.
Germany,	46 millions	1305	508	504
Austria,	34 "	934	435	268
Italy,	32 "	567	145	265
France,	38 "	1133	500	696
Russia,	90 "	1555	1253	473

—*Revista Cientifico Militar.*

C. INSTRUCTION.

(a). Facing Odds.

Must we despair of success in future wars because of the smallness of our Army? Our voluntary system of military service obviously tends to keep the total of our fighting force at a minimum as compared with the enormous armies of other countries where conscription prevails. Since the Crimea the standing armies of Europe have been enormously increased, and now there are millions where there were but tens of thousands. Our Army, however, not reckoning the Volunteer Force because of its restriction to the purpose of defense, is little, if at all, more numerous than it was then. Yet we believe with Colonel P. Neville, 14th Bengal Lancers, that, as he declared some little time back in the course of a lecture delivered before the United Service Institution of India, our cause being just, we may confidently look for victories in the future such as were achieved by our fathers in the past against fearful odds in the famous battles of Crécy, Poictiers, Agincourt, Assaye, and others of glorious memory.

Considerations of space forbid us to follow, as we otherwise willingly would, Colonel Neville in his spirited review of some of the battles in which, though outnumbered, our troops were victorious, but we may usefully consider the suggestions they offer for the present and the future. We must indeed look well to it, as the gallant Colonel rightly declares, if we would continue to hold our own against any of the great Powers; and it behooves us to calmly consider in what direction our strength lies and how we may increase it, for numbers, as history teaches us, do not always give victory. The first great point is, beyond all reasonable doubt, discipline, and we are not surprised to find that General Sir Henry Brackenbury and Colonel G. Young strongly supported the lecturer's view in this respect.

Sir Henry pertinently referred to the passage from Carlyle's "History of the French Revolution" giving a brilliant description of one man facing odds, the passage wherein he tells of Bonillé standing alone on the steps at Metz, and keeping back a whole mutinous regiment. Every now and then a musket is leveled at him, while he looks on as a bronze general would; the musket, however, is always struck up by some corporal or other. It is the effect of discipline still telling upon the men. For two hours he stands thus keeping that regiment at bay. It is in connection with this episode, Sir Henry reminds us, that Carlyle uses that wonderful expression, "Discipline is a kind of miracle; it works by faith."

In order that the soldier may face great odds calmly and with confidence, such faith must have a firmy founded basis; and it seems to us that Sir H. Brackenbury is right in holding that it must be threefold—that a soldier must have faith in his weapon, and he must have faith in the officer who leads him. We would add that he must also have faith in his comrades—a thorough confidence in their standing by him to their last breath.

A still stronger position is taken up by Colonel G. Young. He is inclined to hold that the power of a small force to face odds lies in the one item of discipline, and in this alone; that the importance of discipline is not merely one of the main lessons, but emphatically *the* lesson, to be drawn from every occasion where a small force has been defeated by a large one. The gallant Colonel also shrewdly remarks that the multiplication of power (it being nothing less) which is given by discipline is only obtained, like all other things worth having, by much thought and constant practice. We fear that he is only too justified in thinking that at present it receives in our Army neither the one nor the other—at all events, to a sufficient extent and in the way necessary.

Hardly too strong an assertion is it that discipline cannot be learned in war. Certainly, whatever of it is so learned for the first time must be at a fearful cost. It must, as Col. Young contends, be learned in the barrack-room, in the orderly-room, on the range, and on the training-parade. The soldier has absolutely to acquire a habit, one which is strange to every feeling of all his previous existence—a habit of absolute unquestioning, instant subordination of his will to the, perhaps apparently erroneous, will of another. It must be acquired, just like other things, by practice in the very smallest details, and even in many little things in which (except in order to gain the habit) such implicit obedience would be quite unessential.

We fear that the temper of our age is against the enforcement of such a discipline. But unless it can be done—and we agree with Colonel Young in maintaining that it can—it is clearly impossible to attempt the only *rôle* by which odds can be successfully faced, the *rôle* of feint, of manœuvre, of pretending to strike here but really attacking there, of pretending to be beaten back and then suddenly turning on the enemy and beating him in detail, and suchlike stratagems. It is of no use for the commanding officer to have in his hand a weapon if he cannot launch it just exactly at the spot and just exactly at the instant that his brain and eye tell him will achieve success; the moment passes and the opportunity is gone. When we have acquired the full power of discipline, then, as the gallant Colonel clearly perceives, we need have no fear of facing odds, and an English soldier will once again be equal to three of any other nation, for he will be one of a force which has within it the power to adopt that *rôle* which can alone win when facing odds.

As regards our Cavalry, Colonel Neville boldly advocates our completely freeing ourselves from the trammels of foreign systems; and it must be admitted there is much in his argument that if the odds are against us no extension of our front line will prevent us from being out-flanked; while, on the other hand, no system of *échelons*, howeyer well calculated, will give us victory when opposed to an enemy who also fights in *échelons*, and who is our superior in strength; that, therefore, we should cultivate a system of rapid manœuvre, and not fear to manœuvre, feint, and even retire when in close proximity to the enemy.

Avoiding a crushing front attack, we should, the gallant Colonel considers, approach it as closely as possible, so as to prevent the enemy from foreseeing our object, then by a rapid spring gain his flank and attack by successive *échelons*; and we should not hesitate to engage by single squadrons if time does not permit of our forming larger bodies, for surprise will be a great factor in our favor. Our aim should be to defeat and put to flight each successive unit of the enemy's force, pursuing with small units to prevent him from rallying, and rapidly rally our victorious squadrons for the prompt support of the nearest body engaged, thus continually bringing up fresh bodies of troops into the fight. It is, we think, sufficiently obvious that such manœuvres would require the most careful and skillful training in time of peace; but it is essential that we should do something to compensate for our weakness in Cavalry, and, as we fear it is useless to hope for any appreciable augmentation of its strength, it would be well, we think, if Colonel Neville's very reasonable contention, that in the direction of rapid manœuvre there lie great potentialities of success, were to receive the most serious consideration.

One useful lesson more is pressed by Colonel Neville upon the notice of officers. He rightly reminds them that personal courage in these days is not sufficient to ensure victory. We want knowledge, skill in handling troops, an eye for country, quickness in seizing on points of vantage, and most of all, perhaps, an intimate acquaintance with the military history of the past, in order that we may profit to-day by the lessons it contains; none of which things can be achieved without study.

This is enforced by Sir Henry Brackenbury. Too often even now, he observes, is it said by those who dislike study, "All these examinations and this training are useless. We all know that when real fighting comes the one thing that is wanted is pluck; if you have that, the men will follow you anywhere." All practical soldiers will agree with Sir Henry that there never was a greater mistake; that while skill without courage is of no avail, courage without skill may lead to disaster. No more forcible words could be quoted than those of Napier. "An ignorant officer," he says, "is a murderer. All brave men confide in the knowledge he pretends to possess, and when the death trial comes their generous blood flows in vain. Merciful God! How can an ignorant man charge himself with so much bloodshed?"

Too often, however, it is not sufficiently realized by the thoughtless that battles cannot be won without losing men. Some of those present at the lecture we have been referring to have seen in fights against odds comrades and friends fall by their side. Others have had to weep at home over loved ones killed. These Sir Henry does well to assure that every true soldier envies such a death—death with no lingering pains, no backward looks of longing and regret, but death swift and sudden in the full flush and vigor of manhood; in fine, that the thought of every true soldier is summed up in the two well-known lines of Macaulay—

"How can man die better
Than in facing fearful odds?"

—*United Service Gazette*, February 16, 1895.

(b). Wei-Hai-Wei—China.

Although full details are yet wanting of the operations at Wei-Hai-Wei, the general course of events is known. After a gallant defense Admiral Ting has surrendered the surviving ships of his fleet, and the hostilities at the port are at an end. The brave old seaman has won the praise both of friends and foes, and his surrender brings him no dishonor, though it is an irreparable blow to the Chinese. On the Japanese side the attack has been conducted under glacial conditions, which have demanded the utmost hardihood on the part of the men, and the officers and crews of the torpedo-boats have won golden opinions. The assault upon the Liu-Kung forts was not so fully successful as was at first supposed. The Chinese garrison made a desperate defense, and the bombardment was resumed with the result that a shell penetrated the magazine in the Whihtan fort and completely wrecked it. Formidable obstacles, in the way of mines and torpedoes, had been laid in the channels to the harbor, and Admiral Ito did not venture a torpedo-boat attack until the shore forts had been captured. The flotilla, however, made an attempt to enter the harbor on the night of January 30, but was unable to force the passage. The weather then grew worse, the ships were covered with ice, and the cases of frostbite became frequent. But on February 2, the gale having abated, and the connecting wires of many of the mines having been cut, the flotilla made another attempt. The Chinese again succeeded in repulsing their assailants, and it was not until the night of Monday the 4th, that the torpedo men gained their object.

Fifteen boats seem to have penetrated the harbor by the eastern passage and to have crept up to the Chinese vessels which lay under the island forts, protected by a screen of torpedo-boats. One boat succeeded in discharging two torpedoes at the *Ting Yuen*, which immediately began to settle down. A wild fire was then opened, and the attacking boat was destroyed, but another boat succeeded in torpedoing the cruiser *Ching-Yuen*. She appears, however, to have kept afloat, for a later Japanese official despatch states that she was sunk last Saturday by two shells from Fort Luchiatsoi. Seeing the desperate situation, the Chinese torpedo-boats made a rush through the western entrance of the harbor during the bombardment of Liu-Kung, and many of them succeeded in getting to sea, but the Japanese cruisers gave chase, and one by one they were sunk or driven ashore. Two are believed to have escaped and twelve to have been destroyed. On the night of the 5th the Japanese flotilla renewed its attack, and appears to have sunk the *Lai-Yuen* and the *Wei-Yuen*. These, at least, are stated to have been sunk in a despatch from Yokahama on Wednesday, in addition to the *Ting-Yuen*, *Ching-Yuen*, and thirteen torpedo-boats. Last Tuesday, while Admiral Ito was vigorously prosecuting his attack, the Chinese vessels hoisted the white flag, and an order was given to cease firing. A gunboat then came out from the harbor and sent a boat to Admiral Ito with a despatch from Admiral Ting, in which the latter offered to surrender his remaining ships afloat, with all arms and ammunition, and the island forts still holding out, upon the sole condition that the lives of the Chinese seamen and soldiers, and of the European officers serving under the Chinese flag, should be guaranteed. These terms were granted by the Japanese admiral, and the surrender was forthwith proceeded with. When full details are received of the capture of Wei-Hai-Wei we may expect to learn much concerning the conditions of torpedo warfare, and especially of the employment of torpedo-boats in such operations.

—*Army and Navy Gazette*, February 16th, 1895.

(c). Despatch Bearers—Germany.

The German military authorities have decided to apply to Parliament for a special grant for the training of despatch-bearers in the army. During the Franco-German War the want of reliable despatch-bearers was much felt, and since then it has been the aim of the War Department to improve this part of the service. The men who are to be employed in this capacity must possess certain qualifications fitting them for the duties; they must be naturally intelligent, good riders, capable of guiding themselves by aid of a map either by night or day. They must be able to use the telephone, to judge distances, and also estimate the strength of the enemy; to grasp orders quickly and repeat them accurately. The men, in addition to all this, must be self-reliant, and practised in riding long distances without tiring their horses, and be able to overcome any obstacles they may meet with on the road. All these qualifications must be brought to perfection by a thorough course of training and constant practice. The horses used in carrying despatches must also be specially chosen for their light weight, their speed, &c., and must receive a special training. It is proposed that three detachments of despatch-bearers, each detachment consisting of twelve non-commissioned officers, ninety-six men and 108 horses, to be attached to the 1st, the 16th and 17th Army Corps in order to test the system. The men employed in this branch of the service will wear a particular sort of uniform by which they may be known, and which will be made to combine the quality of lightness, and be of a color which will be as indistinguishable as possible from a distance. The despatch-bearers will be armed with a sword and revolver, and will be well drilled in the use of these weapons. The idea that bicycles or tricycles would prove useful in carrying despatches in war-time is now quite an exploded one; for although they often beat horses in speed on made roads, messengers on horseback in rough country far surpass them. The tricycle will still hold its own in ordinary orderly duty, but it can never replace the mounted despatch-bearers.

—*Army and Navy Gazette*, February 2nd, 1895.

(d). Schools—England.

Our two military colleges will shortly commence work again. Some facts with regard to them possess a special interest not only for the Army, but for cadets and their parents. Two returns appended to the reports of the Board of Visitors show the sources from which the cadets are obtained, *i.e.*, the professions of their parents, and the colleges or schools from which they have come. Taking the Woolwich returns first, it appears that no fewer than 89 of the cadets studying at the academy at the time the visitors reported were the sons of officers of the Army. The next highest figure is 46 under the head of "private gentlemen, merchants, &c." Then comes the Indian Civil Service, 16. After the Indian Civil Service stands the Home Civil Service, 14; the legal and medical professions give 10 each; the Church and civil engineering, 7 each; officers of the Navy, 4; one cadet is the son of a baronet and one the son of a member of Parliament.

Three schools sent an equal number of their students to Woolwich—Cheltenham College, Clifton College, and Bedford Grammar School giving 17 each. But of the 17 sent up from Cheltenham, 16 went up direct, and only one had other assistance. Of the 17 sent from Clifton 12 went up direct; of the 17 sent up from Bedford 14 went up direct. Charterhouse stands fourth on the list with 15, 7 of whom went up direct. St. Paul's School, West Kensington, sent up 11, 8 of whom were passed on direct; Wellington College and Marlborough gave 9 each, 7 of the 9 going up straight in the case of Wellington, and only 4 from Marlborough: Harrow gave 8 and Eton 7, 5 of the former and 4 of the latter going up direct; Rugby sent 5, all of whom passed the ordeal unaided by outside tutors. The figures we have quoted are valuable as showing which of the public schools can claim to be the best training places for the scientific corps. The record of Cheltenham is especially good, and Bedford and Clinton are to be congratulated on their success also. They gave the same number of pupils, and the fact of their sending up 14 and 13 direct speaks well for these educational institutions.

Now, as to Sandhurst. Here again the sons of officers of the Army are greatly in the majority. No fewer than 190 of the 380 cadets are from this source. Private gentlemen, merchants, &c., come next with 89; then come clergymen, 28. The Indian Civil Service gives 17, the legal profession 15, the Navy 12, peers and the medical profession and civil engineering 9 each, princes and the Civil Service 1 each. In preparing boys for Sandhurst, Wellington College very properly occupies the premier position with a total of 35, Eaton coming second with 32. Both colleges sent up the same number, 13 direct; the others were assisted outside. Following Eaton comes Clifton with 28 (11 direct), and after Clifton, Cheltenham 25 (10 direct). Bedford Grammar School stands fourth with 18 (9 direct). St. Paul's School, West Kensington, and Marlborough College are bracketed together with 15 each, but the former only passed 2 direct and the latter 1. Eighth on the list stands Charterhouse with 14 (only 1 direct); Winchester takes ninth place with 12 (4 direct). Harrow comes tenth with 11 (only 2 direct). Rugby and Westward Ho produced 10 each. The latter turned out 5 direct and the former 4.

There are altogether 94 schools included in the list. We have satisfied ourselves by picking out those which have made the best returns. In all there are 389 cadets accounted for; of these 110 were sent up direct from their schools to the Royal Military College, whilst 270, after being educated at public schools, had to be sent to the much-abused "crammer" to be prepared for their "little go"! It is a good thing, of course, for the Army to receive a fair proportion of its officers from the public schools, but to the average Army officer the expenses of a public school training for his son are prohibitive. And yet no one having any knowledge of and sympathy with the Service would wish to see the soldier's son elbowed out. His adoption of the profession of his father, frequently that of his grandfather and great-grandfather, is very much to be encouraged.

—*Army and Navy Gazette*, January 19th, 1895.

D. MATERIAL.

(A). ARMAMENT AND EQUIPMENT.

(a). Inflammable Decks.

If nothing else had been learnt from the fight off the entrance to the Yalu River it has abundantly proved one thing, and that is, that wood must no longer be employed in the construction of our war ships, or even in the articles of furniture, &c., now in general use on board them. From the testimony of those present on board the Chinese ships we know that all, or nearly all, caught fire from the Japanese projectiles, and that two of them were reduced to mere shells; from the same source we gather a decided conviction that wood must be evicted and be replaced by something less inflammable. In consequence of the results of this fight the German Government have already issued orders to the effect that no more wood is to be employed in the construction of their vessels, and it is to be hoped that our own Government is equally alive to the necessities of the case, and that steps are already being taken in the matter. The question now arises, What substitute is to take the place of wood? The chief difficulty seems to be as to the decks. There is certainly nothing that can vie with wood in appearance and comfort, and the snow-white decks, the glory of the first luff and the admiration of every visitor who places foot upon a British man-of-war, can never be replaced, for effect, by any other material. Again, the difficulty of keeping the decks equally healthy, warm, and comfortable has to be overcome, though it is possible in the case of all except the upper deck that this might be met by using some special kind of linoleum or something of that nature. Something more durable and more solid will have to be found for the upper deck, possibly some form of un-inflammable vulcanized indiarubber. Concrete has been sometimes employed, but has not proved a blessing either in wear, comfort, or appearance. As regards the boats, bulkheads, mess tables, stools, bread-barges, cabin furniture, &c., and also the linings of the ships themselves, aluminium seems, at first sight, to be almost the only substance on account of its lightness and other good properties; its chief drawback would seem to be the coldness of the metal itself. This, however, might be obviated to a considerable degree by covering with cork, or cork and leather, and is a matter for the scientists to determine. The broad fact remains that, "our wooden walls" having long since vanished, the wooden interiors of their substitutes have likewise to follow suit, regrettable though it must necessarily be to all who have to live in them, and who pride themselves upon the smart appearance of their respective vessels.

—*Army and Navy Gazette*, January 19th 1895.

(b). **Navy—Turkey.**

The Constantinople correspondent of the *Reichswehr*, in a despondent article upon the Turkish Fleet, remarks that as a fighting force it has played its part, and is no more to be reckoned with. His picture of the corrupt and wasteful system of administration is instructive, and he gives some interesting facts concerning the manning of the fleet, in support of his contention as to its worthlessness. The flagship *Assar-i-Tevfik*, launched in 1868, on board which the old commander of the squadron, Mehemet Pasha, lives, has been without boilers for two years. His complement is but 150 men, while the *Mesoudiyeh* has 260, the *Hamidiyeh*, *Osmaniyeh* and *Aziziyeh* between 125 and ninety-five each, and the *Assar-i-Shefket*, *Avni-Illah*, *Feth-i-Boulend*, *Mouin-i-Zaffer*, and *Nedjim-i-Shefket* between fifty and thirty each, or, in round numbers, 950 men altogether. But these, instead of receiving a proper sea-training, are largely drafted ashore for arsenal work. The correspondent describes the *Hamidiyeh*, *Osmaniyeh*, and *Aziziyeh*, the ships most frequently visited by foreign officers, as in a better state of efficiency than the rest. The last two, however, with the sister barbette ships, *Mahmoudiyeh* and *Orkaniyeh* (6,400 tons), are old vessels, dating from 1864–65, while the *Hamidiyeh* is a central battery armorclad launched in 1885. Of the torpedo flotilla also the correspondent has nothing satisfactory to say. A 39-meter boat and a 55-meter "catcher" came from the Germania yard last year, and lie at the Admirality quay, and are reported to be seriously rusted and in need of repairs, while a larger "catcher" remains at Kiel, her price not having been paid. The Sutludsha torpedo station on the Golden Horn is still unready. The correspondent remarks that the unsatisfactory state of the fleet is the reason why the old title of Kapudan Pasha is no longer officially borne by the Minister of Marine, since it would give him precedence over the Seraskier, or War Minister.

—*Army and Navy Gazette*, Jan. 19th, 1895.

(c). Field Guns—France.

The work of replacing the French Field Artillery material, concerning which the greatest secrecy has been observed, has now actually been begun, according to the *France Militaire*, and will be carried on, not only in the national gun factories, but in the great private establishments, so that the new pieces may be delivered without delay. The Cail works are engaged in this labour, under the direction of Captain Piffard, the colleague of Colonel de Bange. M. Laur, an engineer of that establishment, recently gave our contemporary some facts concerning Colonel Deport's gun, which is that adopted, though nothing is divulged concerning its essential parts. The gun consists of two pieces—a cylindrical tube about 8ft. 6in. long, with 2.95in. calibre, wholly enveloped at the breech end by another tube about 3ft. long, to which is attached the breech mechanism, described as of a modified Nordenfelt character and as exceedingly simple in construction. M. Laur would say nothing of the special features of the gun nor of its mount, but he spoke in the highest terms of the quality of steel to be employed. The *France Militaire* is able to add that the new gun will theoretically permit from twelve to fifteen rounds per minute. The powder-charge and the projectile are united, so that the gun is loaded by a single action, and the spent cartridge-case is removed automatically. Further, an ideal mount has been devised. Colonel Deport's gun has been for some time under trial, but nothing has been published concerning it, and the *France* even now charges the *Temps* with indiscretion in discussing it. The *Avenir Militaire* is anxious to know where the money for the great work of renewing the field-guns is to come from, and the *Deutsche Heeres-Zeitung* remarks that if France has some millions to spare, it would be well to fill up her skeleton infantry companies to equal the effective of the Germans, but that, meanwhile, it is foolish to moot the question of guns.

—*Army and Navy Gazette*, January 19th, 1895.

(B). ARMOR AND PROJECTILES.

(a). Manufacture.

1. *Electric Annealing.*

It is now some time since the application of electric welding was made to projectiles for the purpose of building them up and for producing shells or uniting hardened tips on armor piercing shells, etc. The present statement, however, will refer to the use of electricity in a novel way to render the armor plate more vulnerable, more especially to the drills and taps of the artisan and not to projectiles, that is, to make them workable for the drills and taps when the armor plate is being made ready for placing in position, or after it has been placed in position on a modern war ship. The armor plates as now produced are frequently "Harveyized," that is provided with a skin of hard steel of greater or less thickness. This coating has been produced by keeping the plate hot in contact with carbon so that the carbon enters the face of the plate, or enriches the face of the plate in carbon, which by a subsequent chilling operation acquires the properties of very hard steel; when struck by a projectile this hardened surface acts to damage the projectile or break up its puncturing end and so prevents entrance into the body of the plate, which is of soft material back of the Harveyized surface. The thickness of the Harveyized chilled coating may vary from ½ to ¾ inch, more or less.

While it is possible in producing the armor plate to protect certain areas from carbonization and thereby retain some portions of the face of the plate soft when the armor plate is finished, still it is very difficult to arrange that these soft places shall be exactly where they are wanted, or that they shall surely be in a condition to admit of drilling and tapping.

Soon after the introduction of the Harveyized plates, it became a great desideratum to be able to locally anneal or soften the chilled surface to a depth sufficient to include all the hard steel at any particular point where it might be necessary to drill the plate in assembling it upon the war ship under construction. Various means, such as the application to the surface of the most intense flames of the oxy-hydrogen blowpipe, were found ineffective to accomplish the result desired. The matter coming to the attention of the Thomson Electric Welding Company, was referred to its experts and pronounced by them to be capable of accomplishment by the passage of heavy currents locally through the surface of the plate. A number of experiments with sample pieces of plate did not, however, at first yield the desired results, and it was only by the establishment of a process of working or distinct method that the result could be accomplished. This method was patented to Mr. Hermann Lemp, the electrician of the Welding Company, by United States patent No. 531,197.

The process consists essentially in passing a current between two electrodes placed at a certain distance apart on the plate surface, and thereby heating a portion of the plate to an annealing temperature, after which by a very gradual and careful diminution of the current the temperature is slowly lowered so that the too rapid cooling by conduction of heat to the massive plate back of the heated portion shall be prevented from acting as a chill upon the heated metal. This provides that during the cooling there shall be a constant and continual application of the heating current and the production of heat, but at a rate which is made less and less, so that the metal back of the hardened surface, which is constantly abstracting heat, may be kept supplied, with the result that the fall of temperature at the heated or annealed spot may be controlled and kept such that no subsequent chilling takes place.

It will be seen that the operation is one of such nicety that it could hardly be expected that the use of the blow-pipe would suffice, first, from the difficulty of supplying the heat to the plate rapidly enough to make up for that which is conducted away into the body of the plate, and at the same time to continue the increase of temperature at the spot to be annealed, while sufficiently localizing the action; and, secondly, from the difficulty of controlling just the degree of heat and the rate of cooling of the metal, which would be required to prevent rehardening. The real object of annealing the spots on the armor plate is, of course, to enable holes to be drilled through the surfaces and screw threads to be cut into them by tapping, so that the plates themselves can be attached, or have other parts of the ship attached to them.

The apparatus used in the practice of the process consists of a dynamo furnishing alternating currents, suitably driven, these currents being such as are used in operating electric welding apparatus by the Thomson process. The currents from the dynamo feed the primary of a transformer, which is, in many respects, the same in general construction as a welding transformer. Instead, however, of the secondary terminals ending in clamps they are simply blocks of copper cooled by water circulation, and separated a certain distance. These blocks are applied to the face of the plate under some pressure and the current passing between the blocks heats up the metal between them, and here, as in certain welding operations, the fact of the use of alternating currents favors the concentration of the heating effect and the flow of current locally. The self-induction effect or reactance is least when the current flows near the surface of the plate between the electrodes, so that any current which branches from the electrodes and enters deeply into the plate not only has a longer path, but has a path in which the self-induction operates to limit the flow.

In actual practice with the apparatus at the Cramp shipyard it has been found that the results are highly satisfactory, the original apparatus being made to do, with facility, work in position and under circumstances which was not contemplated in its original construction, and for which other special arrangements were being worked out. The value of the process was more clearly demonstrated in the case of the warship "Massachusetts," which is under construction, as it was found that certain of the armor plates for the barbettes were hard, or possessed the hard Harveyized skin where it was absolutely necessary that they should be drilled and tapped. Indeed it was impossible to properly attach the barbettes without making tapped holes in certain portions of these plates. Strenuous efforts had been made to accomplish the result by blow-pipes, and such means did not succeed, while during these trials the building of the upper deck was delayed, and until the proper securing of the barbette plates had been accomplished. On the appearance of the electric annealing apparatus at the yard it was soon turned to the accomplishment of the work for the "*Massachusetts*," so that there was no further need of delaying the work on the ship from the cause mentioned. There is no doubt that the apparatus and process will soon become one of the necessary features of a modern establishment for the construction of armored vessels.

—*Electrical Engineer*, March 6th, 1895.

2. *Production of Plates.*

A paper on this subject was read before the Austrian Society of Engineers and Architects on the 24th of February, the subject being treated under the following heads:

1. Welding iron plates.
2. Compound plates.
3. Homogeneous steel plates.
4. Harvey plates.
5. Nickel steel plates.
6. Effect of projectiles.

The paper includes a description of the production of nickel steel plates at Witkowitz. The construction of the plant for the manufacture of armor plates was begun in the year 1889, at which date the new steel works and the 2000-ton press were already erected. The earlier ingot rolling mills were rebuilt in the year 1890, so that the armor plates might be rolled. The open-hearth arrangement of the new cast steel works consists of four furnaces having a capacity of 12 tons, the beds being formed of the basic material, magnesite. Each furnace is served by a shaft gas producer of five feet internal diameter in which coal is distilled, a blast giving a water gauge of 7.8 inches being employed.

The casting arrangements consist of a traveling ladle-crane that runs on a line of railway parallel with the row of furnaces. When very heavy ingots are required for the production of armor plates, the molten metal from several furnaces is collected in a single ladle which is moved by a 70-ton traveling crane, and has at the bottom a plugged hole through which the metal may be tapped.

The author describes the construction of the casting pits, which are rectangular in section and rest on a cast iron bottom, in the center of which is a mould, formed in sand, for the production of the trunnion by means of which the casting is manipulated at the forge.

The alloying of the molten metal with nickel is affected either in the open hearth itself, or, in small pieces, in the casting ladle.

The pit is warmed before casting is commenced, and the metal is poured slowly into it so as to prevent as far as possible the formation of deep cavities due to the great amount of contraction which the nickel suffers. When the ingots have become cooled to such a point that they can be lifted out of the pit, they are delivered to reheating furnaces, two of which are gas reverberatory furnaces, of large size with producers similar to those of the open-hearth, and the third a grate fired reverberatory. The hearths of these furnaces are 23 feet in length by 16.5 feet in width, and their working doors are raised and lowered by hydraulic power. In one of these furnaces the ingot is heated to such a degree that it may be forged to about half its thickness by means of a 2000-ton hydraulic press, built by Messrs. Tannett, Walker and Company of Leeds. The author describes this forging press in detail, and mentions others of greater power used elsewhere.

Ingots of 30.31 inches maximum and 28.34 average thickness are forged in three or four heats to about 15.74 inches. The forging trunnion is then removed, and the ingots thus prepared are delivered to the rolling mill, where, in one heat, they are reduced to the required thickness, usually 7.8, 10.6, or 12 inches.

The reheating furnace for the plate rolling mill has a rotary hearth after the Pietzka patent, and in its normal position, lies parallel with and opposite to the rolls, at a distance of about 130 feet. Behind the furnaces there is a hydraulic apparatus for drawing the ingots into and out of them; and between the rolls there are four small hydraulic lever arrangements by means of which the ingots are guided straight if going obliquely to the mill or are turned over if necessary.

The dimensions of such rolling mills do not differ considerably at the various forges, the length and diameter being, respectively, at Witkowitz, 147.8 and 37.4 inches: at Dillingen, 141.7 and 39.3 inches; and at Essen, 157.5 and 49.2 inches.

Engines of more than 1000 horse power are required for the driving of these mills. The rolled plates are, after thorough cooling, cut with a cold saw, and dressed by large planing and shaping machines. For the production of 100 kilograms (220 lbs.) of finished plates, 208 kilograms (457.6 lbs.) of ingot steel are required, or a charge of 227 kilograms (499.4 lbs.) in the open hearth furnace.

—*American Manufacturer and Iron World*, April 5th, 1895.

3. *Cementation—Creusot.*

Schneider, of Creusot, has just patented a method of cementation or carburization of armor plates by the use of gas. Two plates are placed in a very hot furnace, one above the other, with a space between them, the separation of the plates being accomplished by a frame of iron or steel placed between them. The joints between the frame and plates are made air and gas tight by the use of asbestos or some other suitable material. The furnace is closed and the cementing or carburizing gas admitted. As the cementation of the plates progresses best at the point where the gas enters, the gas is admitted at a number of points. In order to supply the carbon equally over the whole surface of the plates, the gas is supplied intermittently. The pipes supplying the gas and reaching into the furnace are enclosed in other pipes filled with water in order to cool the gas.

—*American Manufacturer and Iron World*, Jan. 18th, 1895.

(b). Tests.

1. *Reduced Harveyized Carnegie Plate.*

On Thursday last a highly interesting and successful test was made of rolled Harveyized armor plate made by the Carnegie Steel Company at Homestead. The plate was a 17-inch plate, reduced, after Harveyizing, to 14 inches. It was 15 feet 11 inches long, 8 feet 6.5 inches wide and 14 inches thick. It weighed 33 tons and was held up to a backing of 36 inches of oak by 24 2.8-inch bolts.

Press dispatches describe the test as follows: The first shot was a 10-inch 500-pound shell, striking 47 inches from one end and 35 inches below the upper edge. The charge was 217 pounds of brown powder, giving a velocity of 1859 feet a second, the highest velocity required for the acceptance of a Harveyized plate of this thickness. The shell penetrated 6 inches and broke up into five principal fragments and many small ones, all rebounding. The largest of the former was the head, which was scored and flaked. The flaking about the impact was very slight. One bolt was broken, but there were no cracks.

Lieutenant Stone, who represented the company, asked Captain Sampson to make the second impact close to the first, in order to determine the relative toughness of the plate, and it was placed 35 inches below the first. The second shot, also a 500-pound shell, was given a velocity of 1940 feet a second, with a charge of 225 pounds of brown powder. The shell, velocity and energy in this case were identical with those with which the Bethlehem 15-inch turret plate was tested last Tuesday. The shell penetrated 8 inches, breaking up as in the first case, the head welding fast and the body and base rebounding. Two bolts were driven to the rear, but there were no cracks. The plate was dished ¼ inch. It had, therefore, passed the acceptance test for a 14-inch plate first and then for a 15-inch plate.

Lieutenant Stone then requested that the plate be given the test required for the 17-inch plate. In this case a 12-inch 850-pound shell of special quality was used. The velocity was 1858 feet a second, given with a charge of 420 pounds of powder. The impact was located 36 inches from the edge of the plate, 48 inches from impact No. 1. The shell perforated the plate and backing and lodged in the butt. One bolt was broken.

In this connection the following statement may prove of great interest: Early in the summer of 1891 the Ordnance Department at Washington ordered from Carnegie, Phipps & Co. and the Bethlehem Iron Company armor plates to be Harveyized under the superintendence of the Harvey Steel

Company. These were the first Harveyized armor plates which Carnegie, Phipps & Co. and the Bethlehem Iron Company had anything to do with. The plates were manufactured by both companies in accordance with the prescriptions of the Ordnance Department.

The orders to Carnegie, Phipps & Co. were as follows: Four plates 8 x 6 feet x 10½ inches. The first plate is to contain 0.45 carbon, 3.12 per cent. nickel, 0.58 to 0.60 per cent. manganese and with phosphorus, silicon and sulphur as in 3-inch plate No. 4 of recent trial. The second plate must be identical in all respects with the first, except that it should contain 0.20 to 0.25 carbon. Both Nos. 1 and 2 are to be treated by the Harvey process at a thickness of 12½ inches, to be subsequently reduced in thickness to 10½ inches and then hardened. The third plate is to be identical with the first in carbon and all other qualities, except that it will not be treated by the Harvey process, but will be reduced at once to its final thickness and area. The fourth plate is to be identical with No. 3. except that it will have from 0.20 to 0.25 carbon. The two plates which are to be treated by the Harvey process should not be oil tempered. The other two, in the opinion of the Bureau, should be, but company is authorized to omit it if contrary conclusion has been reached. The proposal to increase silicon to about 0.05 per cent. is approved. Bolts are to be ordinary steel and of the material and qualities required by paragraph 192 of circular. One rolled plate 8 x 6 feet x 10½ inches is to be of simple steel and not to contain any nickel, to have 0.20 to 0.25 carbon, and at a thickness of 12½ inches to be treated by the Harvey process, then reduced to 10½ inches, annealed and hardened.

The orders to the Bethlehem Iron Company were as follows: Three plates 8 x 6 feet x 10½ inches. First plate is to contain 0.40 to 0.45 carbon, 3.12 per cent. nickel and the remainder of the composition at the discretion of the maker. This plate is to be treated by the Harvey process at a thickness of 12½ inches, to be subsequently reduced in thickness to 10½ inches, annealed and hardened. The second plate is to be identical with the first in all respects except that it will not be treated by the Harvey process; it is to be forged at once to its final dimensions, annealed and hardened in the usual manner. The third plate is to be of simple steel and is not to contain any nickel whatever; to have 0.20 to 0.25 carbon, and at a thickness of 12½ inches is to be treated by the Harvey process, then reduced to 10½ inches in thickness, annealed and hardened.

—*Iron Age*, Feb. 28th, 1895.

The latest test of armor plates made last week has developed the fact that the Pittsburg company which does so much work in that line, has recently succeeded in making what is without question the best plate in the world. Reports of this test state that the result was quite a surprise to ordnance experts. The plate tested was treated by a new method original with the Carnegie Company managers. The additional process is an improvement on the method of Harveyizing, and was intended to toughen the texture of the plate and minimize internal strains. Judging by the reports of the tests the process seems to have been quite a success. A plate 14 inches thick was arranged with the usual wooden backing and a 10-inch shot was fired at it. The shot penetrated about seven inches and then smashed, leaving no crack in the plate. Then a shot from the 10-inch gun was fired at a greater velocity, the maximum test imposed upon a 15-inch plate. This made no more impression than the first shot, although it was fired very close to the first point of impact. Finally a 12'' gun was pointed at the plate and a shot was fired at a velocity of 1858 feet, the maximum test for a 17-inch plate. This time the shot got through the plate, but still the latter exhibited no signs of cracking.

The most important point brought out by this test was that the plate by the new treatment was made equivalent to a 17-inch plate. This step in the direction of reducing the weight of armor plates without making it less efficient, is one which is now attracting the attention of ordnance experts. Of course it is too soon to ascertain the full extent of the improvement, but it is the general opinion that this may mean a great deal in the manufacture of armor plate. The advance made is of importance to the entire country, as it shows that we are ahead of Europe in the manufacture of projectiles, we can also make the best armor plate. Further developments by the Carnegie Company will be watched with interest.

—*American Manufacturer and Iron World*, March 1st, 1895.

2. *The Chase-Gantt Crome Plate.*

The following is the official report of an experimental 9-inch chrome steel faced plate manufactured under the Chase-Gantt patent, which has attracted great attention among the ordnance and armor experts:

Body of plate cast steel, 76 x 60 inches; chrome face 60 inches square; plate 9 inches thick; plate secured to 36-inch oak backing by six armor bolts, backed and held in against target structure by four 1½-inch tie bolts; calculated weight of plate, about 5 tons; distance from muzzle of gun, 322 feet, with line of fire normal to center of plate; gun used, 6-inch B. L. R. mounted on "*Dolphin's*" carriage.

Round 1.—Charge 51¾ pounds, S. M. A.; striking velocity, 2104 foot seconds; striking energy, $3072\frac{6}{10}$ foot tons, or 612½ foot tons per ton of plate; ratio of energy to that necessary to just perforate wrought iron of the same thickness, $2\frac{14}{100}$. The Carpenter 6-inch A. P. shell, hardened to 1 inch below bourrelet, of normal weight and dimensions, struck plate normally 18 inches from right edge of chrome surface, 24 inches from bottom, and penetrated about 5 inches and broke up, head of shell remaining welded in impact, with apex of cavity ¼ inch from surface of the plate. Plate was cracked into three large pieces; the lower right hand one, shearing its armor bolt, fell in front of the structure. Diameter of impact, 6½ inches; no front bulge; back bulge 1 inch high; two armor bolts were broken.

The Iron Age, March 21st, 1895.

3. *The* 18-*inch Carnegie Plate.*

The following is a synopsis of the official report of the ballistic test of the

"*Oregon's*" 18-inch Harveyized nickel steel side armor plate, Carnegie Steel Company, at Indian Head, Md., March 11, 1895:

The plate was secured opposite 12-inch gun, distant from it 385 feet, with line of fire normal to plate at center of the portion 18 inches thick.

Size of plate: length 198.5 inches, or 16 feet 6½ inches; height, 90⅝ inches, or 7 feet 6⅝ inches; width of part 18 inches thick, 3 feet 10 inches; width of tapering part, 42 inches; width at bottom, 8 inches. Had a slight bevel at the top and also a lip or ridge on the front surface extending 2 inches above the rest of the plate. Weight, 32⅔ tons. This plate was secured by the usual method. The gun was a 12-inch B. L. R.

Round 1.—Charge, 294$\frac{8}{10}$ pounds; velocity, 1465 foot seconds; striking energy, 12,662 foot tons; projectile, Carpenter 12-inch A. P., hardened to 2 inches below bourrelet, with point medium hard, of normal weight and dimensions; struck plate 78 inches from the left edge, 56 inches from the bottom and 14 inches above the bevel line, and broke up, the head of the shell remaining welded into plate, badly scored and cracked; angle of impact less than ½°. Diameter of shell in plate about 12 inches. This metal projected about 4¼ inches from the face of the plate; splash on plate about 15 inches in diameter; front bulge about 24 inches in diameter and ½ inch high near the shot hole; surface of plate was flaked uniformly about 2½ inches from impact all around; no cracks except a few fine radial cracks in the bulge were developed in the plate.

No armor bolts were broken, the plate and backing being set slightly to the front.

Round 2.—Charge, 443$\frac{4}{10}$ pounds; velocity, 1926 foot seconds; striking energy, 21,885 foot tons; projectile, Carpenter 12-inch A. P., hardened to 2 inches below bourrelet; point medium hard, of normal weight and dimensions; struck plate at an angle of less than ½° from the normal, 47 inches to the right of impact No. 1, 10 inches above bevel line, 75 inches from the right edge, and broke up, head remaining welded into plate, badly scored. Bottom of core of shell $\frac{3}{10}$ inch outside of surface of plate; diameter of shell metal about 18 inches; splash, 24 inches in diameter; front bulge and fringe 24 inches in diameter, almost entirely flaked off. This impact cracked the plate through from top to bottom, crack opening out about 2 inches wide, with the surface scaled off alongside of lower part of this crack to a width of about 5 inches. The Harveyized surface was about ¾ inch thick, and, commencing about 1 foot from both top and bottom of plate, the surface metal was filled with crystals to a depth gradually increasing to ½ inch at the middle of the plate. The plate and backing were set 1½ inches to the right and 1 inch to the front.

The charges used in this test were calculated from the chronograph records taken in November, 1894, when 255 pounds of W. S. No. 4 gave a muzzle velocity of 1341 foot seconds, and 440 pounds of same gave 1933 foot seconds. The plate was accepted.

—*The Iron Age*, March 21st, 1895.

4. *The 12-inch Bethlehem Plate.*

A successful test of 12-in. armor plate, at Bethlehem, Pa., on March 29, insures the acceptance of 650 tons of armor plate for the battle-ships "*Oregon*" and "*Iowa*." The plate tested was 21 x 7 feet 3¼ inches, and 12 inches thick, tapering to 7 inches. It weighed 71,500 pounds and had the usual oak backing. Two Holtzer 250-pound 8-inch shells were used. The first was a "cracking" shot, with 83½ pounds of powder, and it struck the plate 35 inches from the bottom and 15 inches to the left of center. The muzzle velocity was 1,678 feet per second; the shell was shattered, with a penetration of 3 inches, and the point remained imbedded in the plate. No crack appeared. The "penetration" shot, with 111 pounds of powder, left the gun with a velocity of 2,004 feet per second. It penetrated the plate probably 7 inches, and was again shattered, and one narrow crack appeared. The back of the plate was not bulged, nor were any bolts started. The Ordnance Board pronounced the test the most successful yet made.

—*Engineering News*, April 4th, 1895.

5. *Harveyized Plate—England.*

A trial of a Harveyed steel armor plate, manufactured by Messrs. John Brown & Co., Ltd., Sheffield, took place recently on board Her Majesty's ship *Nettle*, at Portsmouth. The plate was selected by the Admiralty authorities from a batch of plates forming one of the barbettes of Her Majesty's ship *Magnificent*, now building at Chatham, and had been reduced to the following dimensions: 8 feet in length, 6 feet in width, and 6 inches in thickness. Four 6-inch Holtzer projectiles were fired against the plate with the velocities of 1,507, 1,815, 1,960, 1,815 foot-seconds respectively. All the projectiles were completely broken up, the fragments of the third shot alone succeeding in just perforating the plate. The penetration in the other case was estimated at from 2 to 4 inches. The trial, which was carried out by Captain Douglas, R. N., of Her Majesty's ship *Excellent*, in the presence of Sir W. H. White and others, was considered very satisfactory.

—*Arms and Explosives*, March, 1895.

(C). ARTILLERY.

(a). Guns and Carriages.

1. *New Elswick Eight-Inch Quick-Fire Gun.*

This piece, which is shown in Figs. 1, 2, and 3, is of wire construction, and it is provided with automatic breech gear. The power is very great. It is fired with cordite charges, giving a working muzzle velocity of 2660 foot-seconds to a projectile weighing 210 pounds. In proof the projectile was fired with 2830 foot-seconds muzzle velocity. For armor piercing, a shot weighing 250 pounds is provided, which fired with a battering charge has 2670 foot-seconds, and with a full charge 2500 foot-seconds, the energies being 12,360 and 10,830 foot-tons, and the perforations through iron 29.0 and 27.1 inches respectively. As to rate of firing, a former pattern which was not fitted with automatic breech gear, fired at sea from the *Blanco Encalada* four rounds in sixty-two seconds, the ammunition being supplied from the magazine.

The length of the gun is 45 calibers. The rifling is of the new Elswick pattern, and increases from breech to muzzle, the final twist being 1 turn in 33 calibers. The breech mechanism is specially designed for rapid loading, but cartridge cases are not employed, and the obturation is performed by a modified de Bange pad. The breech screw is "coned," being made in two diameters, with the largest diameter in rear, and the front portion is tapered. Owing to its form the breech plug may swing out directly the threads are disengaged, thus dispensing with the withdrawal movement required with cylindrical plugs. The action is slightly modified, however, in this gun, as in order to withdraw the de Bange pad from its seat, it is necessary to move the screw a trifle directly to the rear. The motion is combined with that of swinging out in such manner that it appears as one movement.

The screw threads are interrupted in five places—see Fig. 2—and the interruptions on the rear portion are checkwise with those on the front or tapered portion. The breech screw, therefore, engages with the gun throughout its entire circumference. The breech plug is borne on a gun-metal carrier, and a block sliding in the carrier carries a pin which engages in the rear face of the breech plug, and operates in such a manner that if the block is moved laterally it revolves the breech plug. A link attached to a small arm carried by a worm wheel, which revolves on the carrier axis pin, is the means used to give lateral motion to the sliding block. The worm, gearing into the worm wheel, is carried by a shaft fitted with a hand wheel. The shaft is on the right of the gun—see Figs. 2 and 3—and the hand wheel is at a convenient distance in front of the breechscrew. The man who opens the breech is entirely clear of the men who are engaged in loading the gun, and is in such a safe position when the gun fires, that even if holding the hand wheel the recoil will not injure him.

Ten continuous turns of the hand wheel are required to open the breech, and this can readily be done in 3.5 seconds. The reverse motions for closing the breech occupy an equally short interval of time. In addition to the hand gear, the breech can be worked by automatic gear. If this is in action, the breech opens whilst the gun is running out, and after loading it is only necessary to pull a line for it to close again. The change from hand to automatic gear can be effected in about five seconds. Missfires sometimes occur with large guns when the primer is at the rear of the breech plug and the vent is very long. To obviate this the primer is attached to a "primer holder," and is inserted about a foot into the breech plug, leaving only about 10 inches of vent between the primer and the charge.

The primer holder provides for either percussion or electric firing, and is so arranged than it can be easily inserted or withdrawn, and the gun cannot be fired unless the primer holder is properly placed. It consists of a steel needle inclosed by a tube of insulating material; outside of this is a steel tube, which in turn is surrounded by a strong spiral spring, which either keeps the striker in contact with the electric tube, or serves to drive it against the percussion tube. The entire arrangement is contained in a steel case fitted in front with a short quick-motion screw, on which the cap containing the primer, either percussion or electric, is screwed, and is centered immediately in front of the striker. The striker can not be brought in contact with the primer during the operation of putting the latter in place, as the primer holder cannot be withdrawn from the gun unless the striker is drawn back and locked well clear of the primer.

Attached to a carrier is a trigger which may be put in gear for percussion firing or thrown out of gear when electric firing is used. If in the former position it is only necessary to draw the primer holder to the rear to enable it to engage with the trigger, or if the gun is being loaded the opening and closing of the breech performs this automatically. A lanyard may be attached to the trigger and worked from either the right or left of the gun. The cradle is made of steel, bushed with gun-metal where it comes in contact with the gun. There are trunnions on the line about which the loaded gun and cradle balance, and special anti-friction gear is used to reduce the friction caused by elevating, so that the gun can be easily elevated or depressed by one man. The recoil press is underneath the cradle, the cylinder being bored out of a solid steel forging. A tank in communication with the cylinder contains a reserve supply of oil, so that there may be no risk of the cylinder becoming partially empty. Two running-out springs are placed under the cradle, each in sections, so that in case of injury a spare section can readily be inserted. The springs can be removed from the mount in their compressed condition without difficulty. A bracket projects from the right side of the cradle, to which is fitted the sight, which is on the "Elswick bar and drum pattern." Two side brackets which support the trunnions of the cradle are riveted to a steel platform which forms the upper roller path. On the right side there are brackets for the elevating and training hand wheels, which are conveniently placed for a man aligning the sights.

While the convenience of sighting with the right eye has not been neglected, some important advantages have been gained by placing the firer on the right-hand side of the gun. The powder hoist is made to deliver the charge on the left side of the gun, and it can be served to the loader without being passed round the breech screw, which, when open, is on the right of the gun. This would be impracticable if the man who trains, elevates, and fires the gun were placed in the usual position on the left side.

The training gear of this mount can be worked by one man, although the revolving weight amounts to 42 tons; but the mounting is also fitted with electric training gear, on a most simple design. The man aiming manipulates the same wheel, whether training by hand or electricity; only in the latter case there is no perceptible effort required. If the dynamo is not at work and hand training has to be resorted to, assistance can be given to the firer by another working wheel on the left, which is coupled up with the training

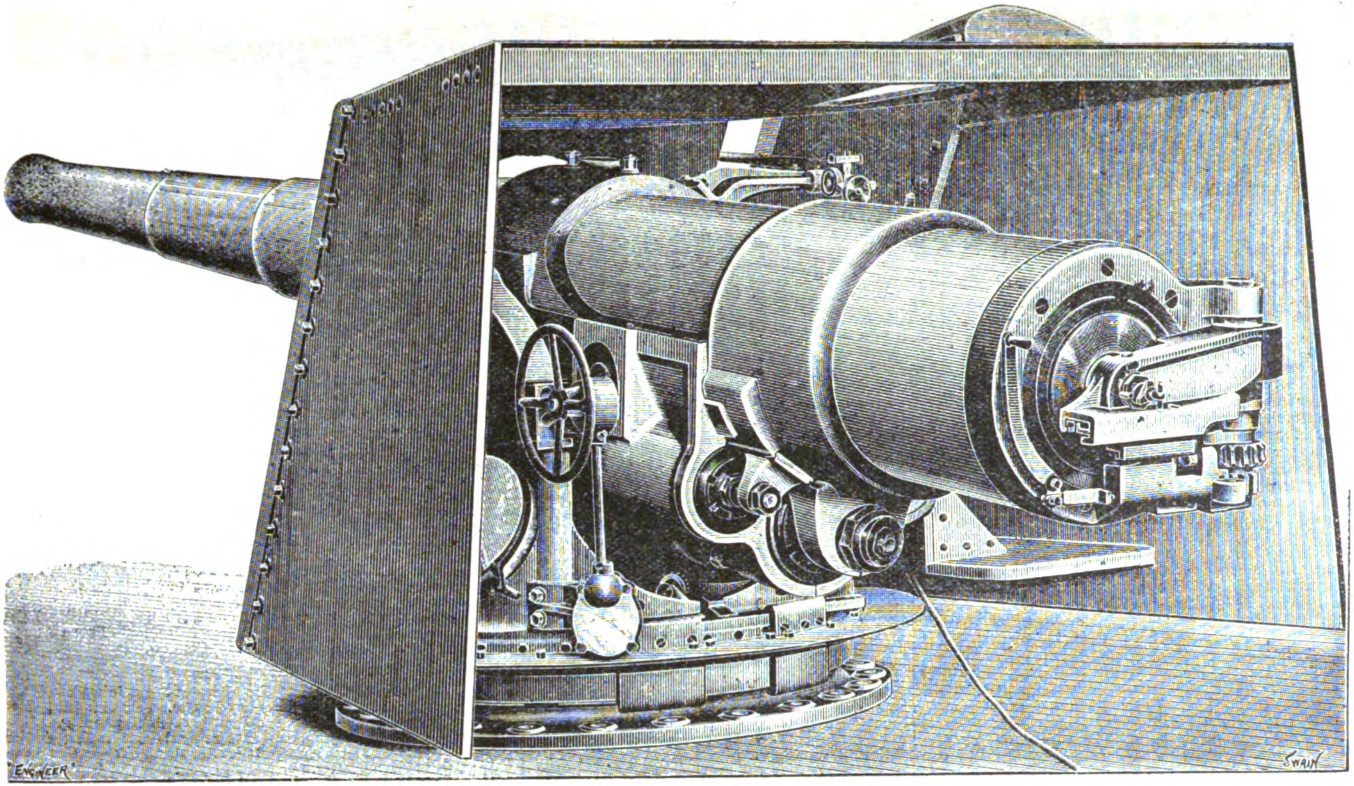

FIG. I.

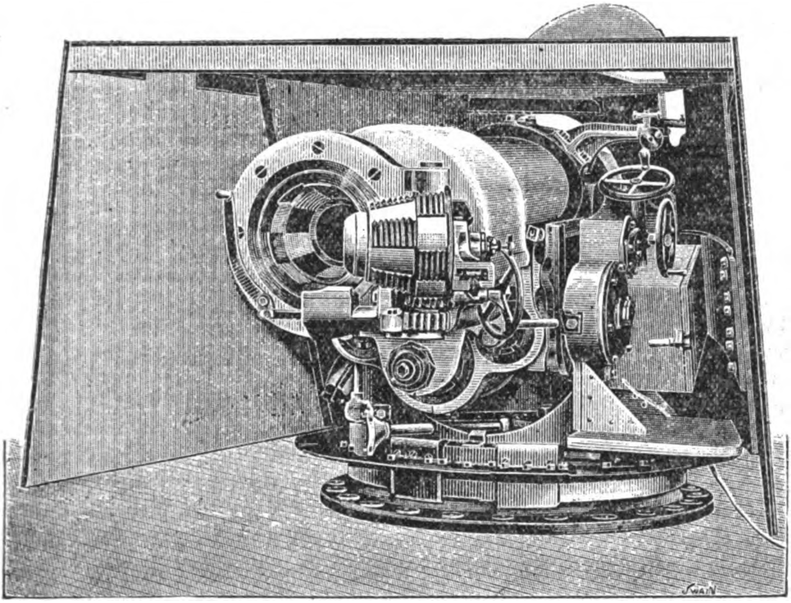

FIG. 2.

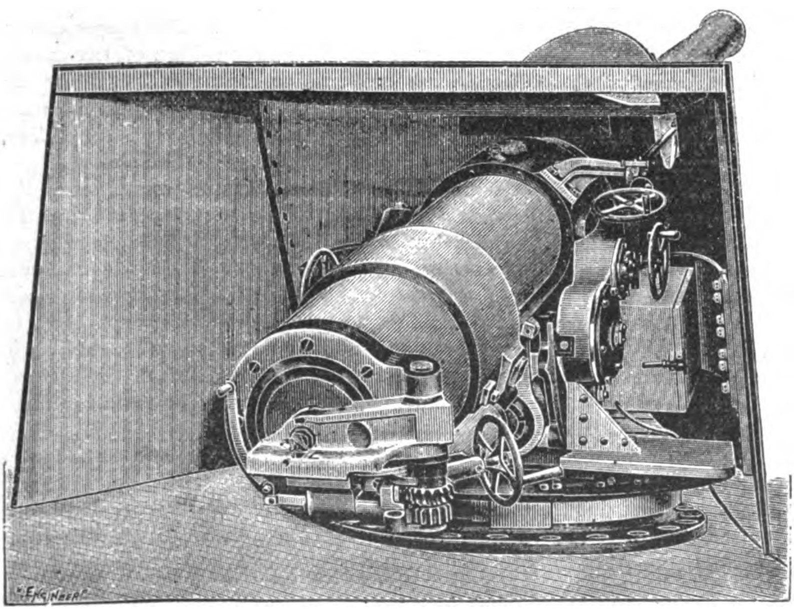

FIG. 3.

gear. The pistol for firing the gun by electricity is close to the elevating and training wheels. It is fitted with an electric sounder, so that each primer is automatically tested, and the firer is kept informed of the condition of the firing circuit. Another advantage of placing the firing position on the right side is, that the circuit is entirely on the same side of the gun as the hinge for the breech-screw carrier, and a short and simple circuit can therefore be arranged.

The mount works on a ring of live rollers, protected from hostile fire by being placed at a lower level than the deck, and surrounded by a plate. Clips attached to the upper roller path, and hooked under the lower roller path, prevent the front of the mount from rising when the gun is fired. The shield has a thickness of 4 inches; but the sides of this shield are prolonged to the rear by 1¼-inch plates, and the whole shield is so arranged that it balances about the axis of rotation of gun and mount. Special elastic attachments fasten the shield to the lower carriage, so that considerable distortion may be suffered without injury to the mount. Central loading is provided for in the case of the powder charge, but the shot are taken from racks placed close at hand. The powder hoist is capable of very rapid working. The cages travel in it in such a manner that as one ascends the other descends. The only weight lifted, therefore, is the weight of the charge, which is 52 pounds of cordite. By a simple shunting contrivance the cages pass each other in the middle of the hoist, and there is only one delivery orifice to the hoist for the two cages, this being on the left-hand side of the mount. The cages can be hoisted by a quick-working hand-winch, whatever the position of the mount. A door is formed at the bottom of the hoist, which can be inclined for supporting the cages when the charges are inserted. Although the cages incline at the bottom of the tube for receiving the charge, and at the top for delivering it, they are securely locked in a vertical position at all other times.

The hoist is well protected by armor-plates, which are arranged so that certain plates can be removed in case the hoists require examination. The cages do not travel in close tubes but in frames, which are well clear of the armor-plates. Before loading the projectile is placed in a tray provided with handles, which can be conveniently lifted by two men. The tray serves to protect the breech-screw threads and guides, and guides the shot into the gun. A separate motion for sponging is rendered unnecessary by combining the sponge and rammer; but the sponging is made very efficient by a sponge head, provided with alternate rings of wool and bristles. The function of the former is to contain water, while the latter are secured at an angle so as to offer no resistance when the shot is being rammed; but which endeavor to stand up as the rammer is withdrawn, compress the saturated wool, and effectually sponge out the chamber. Although the electric-firing system has many advantages, it is customary at Elswick to make such arrangements that percussion firing can be resorted to if necessary, and the transfer from one system to the other can be rapidly made.

Should a miss-fire occur, or should the electric sounder fail to ring when the gun is in the "ready" position, the spare circuit can be instantly connected by pushing a split pin, secured to the end of the wire, into a hole into the head of the striker; this will put the spare circuit in connection with the insulated pin, and cut out the ordinary circuit and battery. When the spare circuit is used it is necessary to fire with the McEvoy key.

The Elswick system of breech mechanism.—The breech screw is on the principle of the interrupted screw, but the forward portion is tapered, the rear portion being cylindrical. Two advantages are claimed for this arrangement:—First, the working of the breech mechanism is greatly facilitated, as the withdrawal and bringing away of the breech plug can be done in one motion; and secondly, the coned shape enables the screw to distribute the engagement over a much greater portion of the transverse section of the gun. The breech screw is further arranged so that the threads of the coned portion correspond longitudinally with the plain spaces of the cylindrical portion and *vice versâ*, thus the strain is distributed throughout the entire circumference of the breech screw. The breech plug passes on to the central projection of the carrier from the front, and is prevented from coming off by a bolt, which screws into the breech plug, and has a plain end fitting into a groove in the carrier, having the same pitch as the threads of the breech screw, and is of sufficient length to allow the bolt to be turned for screwing up the breech.

The gear is operated by means of a hand lever, on the lower side of the breech plug, which works in a horizontal plane. It pivots on the carrier, and is attached by a connecting rod to a sliding block. A pin in the breech plug works in a vertical slot in the sliding block, so that a horizontal motion of the latter causes the screw to turn. The centers about which the gearing works are on their dead points when the screw is closed, and it is therefore perfectly locked. When the lever is swung round it first unscrews and then brings away the breech plug, the two motions being combined so as to give the operator but one. The extraction in the larger rapid-fire guns is arranged to take place in two motions. The cartridge cases are started by a powerful extractor, which has only sufficient motion to insure their being free for the remainder of the extraction, the conical shape of the chamber rendering a small amount sufficient for this purpose. The cases are then withdrawn and placed on deck by means of a hand extractor, which fits over and firmly holds the primer. The mechanical extractor is worked by the carrier in opening the breech closure. It consists of a rod passing through one side of the gun, and fitting into the groove for the rim of the cartridge case, in such manner that when turned about its own axis, the fitted part acts as a lever and forces the cartridge case to the rear. A strong helical spring serves to return the extractor to place as the breech is closed.

—*The Engineer*, Feb. 22nd, 1895.

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(E) TORPEDOES AND TORPEDO BOATS.

(a) Experiments.

1. *Sturgeon*--*England*.

The torpedo-boat destroyer *Sturgeon*, built and engined by the Naval

Construction and Armaments Company of Barrow, whilst waiting her official trial in the Clyde, has made a series of progressive trials. On Monday last she was taken for a three hours' run under trial conditions, with a result that a speed of 28.1 knots was reached on the mile and a speed of 27¼ knots on the three hours. The engines of the *Sturgeon* are of the three-stage compound type usual with these vessels; the chief point of interest being the boilers, which are of the new Blechynden water-tube type, of which four are fitted. The working pressure of 200 lbs. to the square inch was, we understand, maintained with the greatest ease with 2½ in. air pressure, and the working throughout was most satisfactory. This is the first vessel fitted with the new type of boiler, the latter differing from other small tube boilers in the fact that each tube can be drawn and replaced without disturbing its neighbor or undoing large flanged and bolted joints.

—*Engineering*, March 22nd, 1895.

2. *Gustave Zédé—France.*

It is stated that the submarine vessel the *Gustave Zédé* has been subjected to a number of experimental trips, which have resulted very satisfactorily. This success may possibly be due in some measure to the numerous alterations which the craft has undergone, with the view of adapting her more specially to the work she has to do. She is now, it appears, able to sink to a depth of over 60 ft. and remain nearly three-quarters of an hour under water, and has been engaged in testing her speed, her gyratory powers, and her plunging down or diving capabilities. So long as the periscope she is furnished with, which is supported upon a platform, can keep its upper extremity just above water level she can steer her course, but when that becomes submerged, she, like all other ships of the same character, finds the value of her services seriously diminished.

—*The Engineer*, January 25th, 1895.

3. *Torpedo-boat No.* 60—*France.*

An interesting trial took place a few days ago in the passage of a French torpedo-boat, No. 60, attached to the mobile defence of Dunkirk, along inland waterways, from that port to Gravelines, and from Gravelines to Calais. It was thus shown that second-class boats, in case of blockade of the northern ports, could pass from one to the other, by way of the river Aa and the Bourbourg, Colme, and Calais canals. The French northern ports are busy with the trials of new and other vessels. The cruiser *Latouche-Tréville*, which gave satisfactory results in her preliminary trips, has been undergoing official trials at Cherbourg, and with 7,550 horsepower averaged 18 knots. She had to return to port after a three hours' run, owing to a leaky tube, but better provision having been made for the ventilation of the stokeholds, it is now expected that she will prove satisfactory. Torpedo-boat No. 191 (37 mètres, 80 tons), constructed by M. Normand, has arrived at the same port, and is expected to attain a speed of twenty-four or twenty-five knots. The torpedo gunboat *Cassini*, constructed by the Forges et Chantiers de la

Méditerranée at Havre, is also expected at Cherbourg for her official trials. The correspondent of the *Yacht* at Brest gives a better account of the cruiser *Friant*, but it appears that changes necessary at the base of her funnels will occupy three months. So great was the heat that the plates became red hot, and the funnels inclined on one side or the other. Thicker plates are to be introduced with intervening air space, and means are to be taken to prevent the flames always reaching the same places. At Toulon the sea-going torpedo-boat *Corsaire* has attained a mean speed of twenty-four knots, with 365 revolutions, during a three hours' trial. She is to join Admiral de la Jaille's flag with the cruiser *Cosmao*, in which many changes have been made, especially in the system of protection above the armored deck.

—*The Army and Navy Gazette*, January 26th, 1895.

4. *Halpine Dirigible Torpedo.**

Lieutenant Cyrus S. Radford, U. S. M. C., writing in the *Proceedings* of the United States Naval Institute, gives a description of this torpedo. It is in reality a hybrid between a torpedo proper and a torpedo-boat. In fact it may be regarded in the latter light, as it is but a boat carrying and discharging an explosive cartridge. It is cigar-shaped, of steel or galvanized iron, 17 feet long, 2 feet in diameter, and weighs complete 1,500 pounds. Its motive power is stored electricity, consisting of storage batteries of the commercial type; and from these is obtained the power, which, by means of a series-wound four-pole Storsy motor, lightened of absolutely all unnecessary weight, drives the screw-propeller, which is of brass, one foot in diameter, 14-inch pitch, and is protected by a circular metallic guard. The motor can impart a speed of 16 knots per hour. Beneath the body of the torpedo and near the stern is a balanced rudder, which is operated as follows: On the end of the tiller is fitted a curved bar of steel, on either side of which is a curved solenoid, which when electrified draws the helm to port or starboard as desired by attracting the curved yoke in its magnetic field. The rudder is so shaped that when the electrical influence is broken at the switch-board, the helm returns at once admidships.

Within the forward central part of the torpedo proper is fitted a reel which is introduced and removed through a hand-hole in the side. On it is coiled a fine three-stranded insulated wire, $\frac{5}{64}$-inch exterior diameter, and weighing 47 pounds to the mile, one end of the wire passing out through a watertight aperture to the operator; the other end leads to the switch-board within the torpedo. The reel has a wire-carrying capacity of four miles.

The electrical controlling mechanism consists of duplicate switch-boards, one within the torpedo and the other in the hands of the operator. It is compact, simple, and absolutely accurate. A detailed description is withheld on account of pending patents.

Forward of the reel compartment, and traversing the body obliquely downward to the front, is the discharge tube, in which the explosive charge is

* This was secretly installed on the Brazilian cruiser *Nictheroy*, and it has been commended by her officers.

placed, securely sealed within its own case. The charge case is made of copper, cylindrical in shape, and has a carrying capacity of 4,000 cubic inches. When seated in tube its rear end fits over a rocket case, the outer end of which is surrounded by a spiral spring which is now compressed, and when free to act forces the charge clear of its seat, at the same time tearing off a leaden patch from the end of the projecting rocket case, exposing a coating of metallic potassium to the action of the water. The potassium mixture is instantly ignited, and, burning rapidly, in turn ignites the rocket composition, producing a propelling force that drives the exploside charge forward and downward with considerable momentum and directive force. In the conical head of the case is stored a few feet of a slack chain, one end of which is here secure, the other being made fast to the harpoon-head.

Besides the explosive charge the case contains the firing device, consisting of a contact, time, and electric fuze. The charge is held in place by a catch, which is released automatically by a rod being forced aft when the torpedo strikes a net, ship or other under-water obstruction; or, at the will of the operator, the catch is drawn down by electro-magnets. The catch, besides holding the case in place, when tripped reverses the motor and backs the torpedo. Rigidly secured to the forward conical end of the torpedo is a hollow cylindrical tube four feet in length, forming a protecting shell for the rod, which performs the double function of tripping-rod and harpoon-spindle. A collar carrying four cross-arms is attached to this permanent rod by means of a soft copper wire. The actual harpoon head is attached to this collar by a similar wire. The action is as follows: The harpoon point having entered the net ring, the four cross-arms bring up against the net; the small wire offering some resistance pushes back the rod that trips the charge catch.

This wire is sheered off, when the rod brings up, and the collar slides along the rod against the heavy spring. This brings the rear end of the harpoon head against the rod, which not only shears off the (soft copper) wire that connects collar and rear end of harpoon, but releases the harpoon toggling arms, which spring open, and toggles the net between the collar and toggling arms. The motor being now reversed, the cartridge discharged, the collar slips off the permanent rod, and the torpedo backs off, leaving the harpoon toggled, with the charge free to act. To the upper ends of the guide or steering arms (for surface work) are secured double bulb steering lights for night operations.

This torpedo being designed to run almost submerged, the possibility of striking so small an object with anything but Gatling and small-arm fire is practically nothing, and being fitted with a light steel hood over the vital part so flattens the angle of impact that the possibility of penetration seems very small.

The angle at which the charge is at present secured places it upon discharge ten feet below the harpoon head or point of impact, which is five feet below the armor-shell. Should it be desired to explode at a greater depth, say twenty feet, a float is used, fitted with arms 10 feet long, the lower ends of which are strapped around the forward and after ends of the cylindrical portion of the torpedo, and the water compartments are filled to take away the torpedo buoyancy, and transfer a portion of the weight to the float, which travels on the surface.

From the extreme ends of the torpedo, curved upward to the float, and secured to a circular steel guard over the float, are steel arms kept in place by heavy springs which take the first shock on striking outer boom protection. These arms are so constructed that they slide into each other under pressure, and return to their former position when the pressure is removed.

The float is of such shape and buoyancy that it will lift lighter spars and steel hawsers, and, being forced down under heavier ones brings the torpedo at once to its original depth as soon as the obstruction is passed. The float is filled with cellulose, so that in the event of being penetrated it will still retain its buoyancy. When this device is employed, the electrical guide lights are carried underneath the steel guard.

The proper depth of immersion is given this torpedo by letting in or forcing water out of the water ballast compartments. These compartments are separated by bulkheads, so arranged that the water passes gradually from one compartment to another, and is not permitted to rush forward or aft, which would tend to unsteady its otherwise very stable action.

The torpedo being launched is at once under electrical control, and is directed by the operator, who with a glass watches its guide discs in the day or the guide lights at night until it strikes the net. The harpoon head being very small, there is every chance that it will enter one of the net rings. This brings the net against the four cross arms, and, forcing them back, brings the tripping rod and fixed rod of harpoon in contact, which drives the harpoon arms through the ring, permitting them to open, and thereby securely toggling the net. At the same time the explosive charge catch is tripped, the cartridge discharged, the motor reversed, and the torpedo now backs off, while the harpoon being toggled in the net is no longer attached to the torpedo, and the charge being secured at the forward end by the chain continues on beyond the vertical plane of the net until the chain is all played out, when it is forced upward under the vessel's bottom, the charge being exploded at will by contact or at a given time. The torpedo having gone astern sufficiently is once again started ahead and steered back to its starting point, where a new harpoon and charge is provided. By giving the tube a proper inclination the explosive can be thrown over the torpedo-net against a vessel's side or directly upon her deck.

To attack a vessel without net protection, either at anchor or under way, the difference is essentially in setting the time fuse, which, as shown by absolute experiments, can be adjusted at any time from six to forty seconds. Considering the vessel to be under way and unsheathed, the torpedo is guided to strike her well forward, the explosive charge being liberated by the harpoon head forcing back the tripping rod, and the time fuze set to allow the vessel to present her square bottom, where there can be no possible protection over the explosive point. To have a torpedo explode in contact with a ship's bow could do little more than to take out the head booms or fill the forward collision compartments, while by permitting her to pass over half her length, or about 200 feet beyond the point of detaching, the explosive charge is presented for action at the bottom of the ship in the vicinity of her boilers and engines.

If the attacked vessel be anchored in a tideway, the charge must drift down with the tide, and the long fuze would thus be necessary; while to attack with no tide the vital point must be sought directly, and a short-time or contact fuze employed. If the vessel be sheathed, as is now the common practice with battle-ships and cruisers in all countries except the United States, the torpedo is guided to the point of attack; the momentum of the torpedo drives the steel harpoon head into the sheathing, at the same time liberating the explosive charge and producing the same action of backing as previously demonstrated.

The electrical connections of this torpedo being so arranged that the charge may be liberated and the motor reversed at any time at the will of the operator, it would seem that its field of usefulness is not restricted solely to the destruction of vessels, but it is especially adapted for countermining and clearing a channel protected with planted mines, which is desired as an entrance for a man-of-war. Two of these weapons being sent in advance of a vessel by projecting and exploding charges could readily destroy all sunken mines within a known radius.

This torpedo can be loaded with the facility of a breech-loading rifle. Should it be captured, the operator can make it destroy itself by exploding the charge within it. The expense of the shell, including reduced charge, being eight or ten dollars, and the boat itself not being demolished, it can be sent out as often as desired, and valuable data obtained of the effectiveness of all classes of torpedoes.

A point which must not be overlooked is the simplicity of construction; and the facility and expediency with which any number of these torpedoes can be constructed within a very short time. It is essentially a commercial type of weapon, any and all of its parts being readily obtainable from first-class firms. The hull being of No. 12 gauge steel or galvanized iron, and consisting of a cylinder and two conical ends, the forward end being riveted on, and the after one held in place by four set screws against a rubber washer, may be obtained complete from almost any boiler shop or worker of galvanized iron. The motor and batteries are of the standard pattern, readily obtainable in open market, and the cable and switch-boards can be had at small expense.

—*United Service Gazette*, February 23rd, 1895.

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E. MISCELLANEOUS.

(A). ARGON.

(a). Discovery.

The discovery of a new constituent of common air by Lord Rayleigh and

Professor Ramsay, which was briefly announced at the meeting of the British Association held last autumn, has now been put into the class of ascertained facts beyond the possibility of cavil. Those who, with a temerity not according to knowledge, were hasty in belittling with shallow, half-baked criticism the original pronouncement of two observers, honest, competent, and candid, are reduced to the silence that would have befitted them at first. To the eminent physicist and scarcely less famous chemist whose good fortune and high skill have enabled them to place to the record of science as cultivated in this country a fact of first-rate importance in itself, and of deep potentialities in its relations, congratulations are superfluous. The consciousness of their achievement must be a greater source of satisfaction than any external laudation could be.

Argon, as the new substance is provisionally termed, was first suspected to exist in the air, on account of the observation of Lord Rayleigh that the gas left after the removal of oxygen from air, otherwise pure, had a density greater than that proper to nitrogen obtained from other sources. The difference in density is not great—about 0.5 per cent.—but it is constant, and altogether unaffected by the most varied experimental conditions. Such difference might conceivably arise from the presence of a heavy constituent in atmospheric "nitrogen," or from the occurrence of some light impurity—for example, hydrogen, in "nitrogen" won by methods purely chemical. The second hypothesis having been negatived, both by the use of widely different methods for preparing nitrogen of non-aërial origin and by direct experimental proof that impurities added to such nitrogen could be readily eliminated, the alternative supposition merited the closest investigation. The only quality which the unknown heavy constituent of atmospheric "nitrogen" appeared, on *a priori* grounds, likely to possess, was an inertness equal to or exceeding that of nitrogen itself. It became necessary therefore to prepare atmospheric "nitrogen" and eliminate the true nitrogen contained therein. The number of methods capable of causing the direct combination and absorption of gaseous nitrogen is not great. In consonance with the general inertness of this gas, direct union can only be effected with a few elements, among which magnesium is prominent. An alternative process of combining and suppressing nitrogen consists in passing a succession of electric sparks through a mixture of nitrogen and oxygen, and absorbing the resulting oxides of nitrogen in a solution of caustic potash. The first method was successfully employed by passing atmospheric "nitrogen" (obtained by removing the oxygen by passing air over red hot copper) over heated magnesium turnings, a certain residuum of gas being always found to persist in spite of repeated and prolonged treatment. A similar residue was observed when sparking with oxygen was resorted to. About one hundred years ago, Cavendish, that masterly experimenter, similarly found a certain fraction of atmospheric "nitrogen" which failed to be absorbed on repeated sparking, and with characteristic caution summed up his observations by saying, "If there is any art of the phlogisticated air of ou r atmosphere which differs from the rest, and cannot be reduced to nitrous acid, we may safely conclude that it is not more than $\frac{1}{120}$ of the whole"—the proportion being singularly near to that now found. This is not the place in which to trace the laborious progress that was made in the preparation of a tangible quantity of argon from the air between the time of the first announcement of its existence and the present date. It suffices to say that enough has been obtained to allow of the determination of the chief physical constants of the gas. The gaseous argon A_1 has a density of 19.90; it is soluble in water to the extent of four volumes per 100; the ratio of its specific heat at constant pressure to its specific heat at constant volume is 1.63. Chemically it is the most inert substance known, all attempts to induce its combination with other substances having been hitherto futile. In order to procure the best possible data for certain others of the properties of argon, the discoverers of the gas have obtained the aid of Mr. Crookes for its spectroscopic examination, and of Professor Charles Olszewski, of Cracow, for the determination of its behavior at low temperatures. Mr. Crookes, who has embodied his results in a separate communication made to the Royal Society after the reading of the main paper by Professor Ramsay, finds that two spectra of the gas can be obtained by varying the method of examination. The nature of these spectra precludes the idea that argon may be identical with any substance already known, but raises a supposition that two substances instead of a single elementary gas may be present. Such double spectra are not, however, unprecedented in the case of other elements. Professor Olszewski, who is the recognized authority on all matters concerning the behavior of gases at extremely low temperatures—he having been the first to determine the physical constants of the so-called permanent gases when liquefied—has examined argon in an exhaustive manner. The methods he employed need not here be recapitulated, as a general knowledge of their rationale has been disseminated by various popular lectures at the Royal Institution. It suffices to say that, using the classical Cailletet apparatus, he has found argon to possess a critical temperature of —121 deg. C., a boiling point of —187.0 deg. C., and a freezing point of —189.6 deg. C., while the density of liquid argon, which is colorless, is about 1.5. The density of gaseous argon being higher than that of oxygen, it was assumed by rash critics that the liquefying point would also be higher—an assumption which doubtless betrayed Professor Dewar into putting forward the belief, now exploded, that the supposed argon would have been detected previously by virtue of this property, which it does not possess, if the existence of the gas were more than subjective. As a matter of fact, the boiling point of oxygen is —182.7 deg. C., appreciably above that of argon.

The most remarkable peculiarity of argon has, however, not yet been more than hinted at. A certain weighty deduction follows from the fact that the ratio of the specific heat of argon at constant pressure to that which it possesses at constant volume approximates to 1.66, viz., that heat imparted to the gas is only concerned in the production of translatory motion of its molecules, and not in the performance of intra-molecular work. The molecules of argon must consequently either be monatomic, or be composed of atoms so intimately associated as to be incapable of relative motion or stress. Taking the first hypothesis as the more probable, it is obvious that the atomic weight of argon must be double its density—that is, 39.8. But in the periodic classification of the elements there is no place in which an element of this atomic weight and of the nature of argon can be reasonably inserted. Several speculations have been put forward on this point, but no satisfactory conclusion has yet been reached. The periodic law is a generalization which has had its value proved by the repeated verification of the data which it has foretold, and it cannot be cast aside because of the occurrence of even a glaring exception to its operations. Nevertheless, belief in its validity must not induce any glossing of facts or straining of interpretation. In science, the ascertained experimentally verified fact alone is sacred and permanent. Hypotheses—"laws" the unwise calls them—are as but the dust of the balance when a fact is on the opposite pan; but be sure it is a fact.

Recent as is its introduction to the society of recognized elements, argon is already the subject of the paralyzing inquiry, "What is the use of it?" Let us say at once, and unmistakably, that there is no use for it, nor is there likely to be. The cynic philosopher parodying Lord Melbourne's deathless remark anent the Garter, would say that one of the chief advantages of argon is that "there's no d——d utility about it." Without adopting this impregnable position, we are content to remark that any possible application that may, in spite of its exceeding inertness, be found for argon, can scarcely be looked for within six months of its original isolation. A host of keen workers will doubtless turn to its investigation in all possible directions, and if utility is to accrue, it will be arrived at in due time by their exertions.

—*The Engineer*, February 8th, 1895.

(b). Compounds of Argon.

M. Berthelot has communicated to the Academy of Science the fuller details which he promised concerning his experiments upon argon. Towards the end of February he received from Professor Ramsay 37 cubic centimeters of the gas, with which small quantity he has obtained positive results of the greatest interest. Following the process by which he formerly effected the direct combination of nitrogen with various organic compounds, he finds that argon is equally absorbed by these bodies, though apparently with somewhat less facility. The action of the silent discharge upon a mixture of argon and benzene vapor is accompanied by a feeble violet luminosity visible in the dark. In one of five experiments he found that a fluorescent substance was produced, which developed a magnificent greenish light and a peculiar spectrum. M. Berthelot took 100 volumes of Professor Ramsay's gases, added a drop or two of the hydrocarbon, and exposed the mixture to the silent discharge at a moderate tension for about ten hours. The excess of benzene vapor being removed in the usual way, the mixture was found to have been reduced to 89 volumes. More benzene was then added, and the experiment was repeated with higher tension, which in three hours produced a reduction of volume equal to 25 per cent. On again submitting the gaseous residue with benzene to very high tension discharge he found the final result to be 32 volumes. Analysis showed this residue to contain only 17 volumes of argon, the other 15 volumes being hydrogen free or combined and benzene vapor. In other words, M. Berthelot has effected the combination of 83 per cent. of the argon under experiment, and was prevented, the *Times* says, only by the dimensions of his apparatus from carrying the condensation yet further.

The quantity at his disposal was too small to permit of complete examination of its products, but he is able to say that they resemble those products when nitrogen mixed with benzene is submitted to the silent discharge. That is to say, they consist of a yellow resinous matter condensed on the surface of the glass tubes employed. This matter on being heated decomposes, forming volatile products and a carbonaceous residue. The volatile products restore the color of reddened litmus paper, proving the production of alkali by the decomposition, though the quantity of matter at command was too small to allow of its nature being demonstrated. In any case, M. Berthelot concludes, the conditions in which argon is condensed by hydrocarbons tend to assimilate it yet more closely with nitrogen.

He adds that if it were permitted to assume 42 instead of 40 as the molecular weight of argon—an assumption which the limits of error in the experiments hitherto made do not, in his opinion, exclude—this weight would represent one and a-half times that of nitrogen; in other words, argon would stand to nitrogen in the same relation as ozone to oxygen. There is, however, the fundamental difference that argon and nitrogen are not transformable into one another, any more than the isomeric or polymeric metals. Without insisting on points which are still conjectural, M. Berthelot observes that in any case he has demonstrated that the inactivity of argon disappears in the conditions he describes. When the gas can be obtained in considerable quantities, he says it will be easy by ordinary chemical methods to take these primary combinations, or their analogues obtainable with oxygen, hydrogen, or water, as a point of departure for the preparation of the normal series of more simple compounds.

—*The Engineer*, March 29th, 1895.

(c). Discovery of Helium.

In a communication to the London Chemical Society, March 27th, Prof. W. Ramsay says: In seeking a clue to compounds of argon I was led to repeat experiments of Hillebrand on cleveite,* which, as is known, when boiled with weak sulphuric acid, gives off a gas hitherto supposed to be nitrogen. This gas proves to be almost free from nitrogen; its spectrum in a Pflucker's tube showed all the prominent argon lines, and, in addition, a brilliant line close to, but not coinciding with, the *D* lines of sodium. There are, moreover, a number of other lines, of which one in the green-blue is especially prominent.

* Cleveite is a variety of uraninite, chiefly a uranate of uranyle, lead, and the rare earths. It contains about 13% of the rare earths, and about 2.5% of a gas said to be nitrogen.

Atmospheric argon shows, besides, three lines in the violet which are not to be seen, or, if present, are excessively feeble, in the spectrum of the gas from cleveite. This suggests that atmospheric argon contains, besides argon, some other gas which has as yet not been separated, and which may possibly account for the anomalous position of argon in its numerical relation with other elements. Mr. Crookes has identified the yellow line with that of the solar element to which the name "helium" has been given. Mr. Crookes thus stated that he had been enabled to examine spectroscopically two Pflucker tubes filled with some of the gas obtained from the rare mineral cleveite. The nitrogen had been removed by "sparking." On looking at the spectrum, by far the most prominent line was seen to be a brilliant yellow one apparently occupying the position of the sodium lines. Examination with high powers showed, however, that the line remained rigorously single when the sodium lines would be widely separated. On throwing sodium light into the spectroscope simultaneously with that from the new gas, the spectrum of the latter was seen to consist almost entirely of a bright yellow line, a little to the more refrangible side of the sodium lines, and separated from them by a space a little wider than twice that separating the two sodium components from one another. It appears as bright and as sharp as D_1 and D_2. Careful measurements gave its wave-length 587.45; the wave-lengths of the sodium lines being D_1 589.51, and D_2 588.91. The spectrum of the gas is, therefore, that of the hypothetical element helium, or D_3, the wave-length of which is given by Angstrom as 587.49, and by Cornu as 587.46.

—*Engineering and Mining Journal*, April 13th, 1895.

BOOK NOTICES.

Notes on the Years Naval Progress General Information Series No. xiii, from the Office of Naval Intelligence, Washington, D. C.

The annual budget of "Information from abroad" in Vol. No. XIII from the Office of Naval Intelligence, Navy Department, Washington, D. C., is well up to the best standard of preceding years. The excellence of this publication has caused it to be be eagerly looked for each year, and carefully studied by all who wish to be *au cuorant* with matters pertaining to foreign navies. As these foreign navies constitute our possible assailants along the coast, coast artillerymen find in these volumes as much information almost, bearing upon their work in defending the coast, as naval officers themselves. It would be an excellent thing if every artillery officer could be supplied with a copy of the issues of this series and be required in some way to make a study of the contents.

In the volume under review the "Information" is given under the following heads:

I. Notes on Naval Administration. By Lieutenant J. C. Colwell, U. S. Navy, Staff Intelligence Officer.

II. Notes on Ships and Torpedo Boats. By Lieutenants E. J. Dorn and J. C. Drake, U. S. Navy, Staff Intelligence Officers.

III. Notes on Ordnance. By Lieutenant E. F. Qualtrough, U. S. Navy, Staff Intelligence Officer.

IV. Notes on Small Arms. By Lieutenant Lincoln Karmany, U. S. Marine Corps, Staff Intelligence Officer.

V. Notes on Naval Dynamo Machinery. By Lieutenant J. B. Murdock, U. S. Navy.

VI. Marine Boilers. By Passed Assistant Engineer Robert S. Griffin, U. S. Navy.

VII. Conclusions and Recommendations of the Committee appointed by the Lords Commissioners of the Admiralty, to consider existing types and designs of propelling machinery and boilers in Her Majesty's ships.

VIII. The Qualities and Performances of Recent First Class Battle Ships. By W. H. White, Esq., C. B. LL.D., F. R. S., Assistant Controller of the Navy and Director of Naval Construction.

IX. Some Naval Maneuvers of 1893, including the English Maneuvers; by Lieutenant J. C. Colwell; the French and Italian Maneuvers, by Lieutenant P. V. Lansdale, U. S. Navy.

X. Revolt in Brazil. By Lieutenant C. C. Rogers, U. S. Navy, Intelligence Officer.

XI. Some standard books on professional subjects.

These notes together make up a book of 458 pages.

The leading feature of I is a series of compactly prepared charts, showing graphically the organization of the English, Austrian, French, German, Italian and Russian navies. It appears that Germany and Italy have the best and most recent type of organization. The distinguishing characteristic of these latter is a distinct separation throughout of personnel from material, each having its own separate head.

Notes on Ships and Torpedo Boats (II) gives, in alphabetical order, the vessels proposed, laid down and launched during the year, also accounts of steam trials and vessels dropped from the lists of all the principal foreign powers. Illustrations are given of the English ships *Hood*, *Dryad* and *Hornet;* the French ships *Charlemagne*, *Chasseloup-Laubat*, *Jauréguiberry*, *Chevalier*, *Mousquitaire* and *Corsaire;* the Russian ship *Tri Sviatitelia* and the Spanish ship *Infanta Maria Teresa.*

The third division treats of ordnance, torpedoes and armor, considering each separately for each of the principal powers.

We are told that ordnance authorities in England expect wire to take a prominent place in future gun construction. "The first of the new 12-inch steel wire-wound guns (English) has been completed and proved. Five more of these guns are in an advanced state of construction." On page 81 is given the English method of constructing wire-wound guns. The charge for the 12-inch wire-wound gun is expected to be about 168 lbs. of cordite made up in quarter charges, the cordite to be in solid sticks 14 inches long and 1.5 inches in diameter. Should cordite prove unsatisfactory, the chamber will be reamed out and adapted to a charge of 440 lbs. of brown powder. Recent experiments with cordite in a smooth-bore gun indicate that grooves parallel to the axis for some distance from the seat of the projectile would be advantageous.

Much attention is being given abroad to everything bearing on the time involved in loading, aiming, firing and reloading guns. The recoil of the gun is being utilized with guns as large as 10-inch and 12-inch to diminish the time required to reload and to reduce the number of men required to handle the gun. Ordinarily the operations of opening and closing the breech occupy about one minute; with the automatic recoil gearing these operations are performed in about six seconds, the opening being accomplished while the gun is moving to the rear and the closing as it moves to the front; thus it is only necessary to insert the projectile and powder. The obturation is accomplished by means of short cartridge cases.

Bearing upon long range bombardment, explanations and illustrations are given of the new Elswick mount for 9.2-inch and 10-inch naval guns, which admit of an elevation of 40 degrees; that is up to the angle of maximum range. The Jubilee Shot was fired from a 9.2-inch gun at 37 degrees elevation and gave a range of over 12 miles. Mounts admitting of elevation of from 35 to 40 degrees may hereafter be considered usual. The *Centurion* and *Barfleur* as fitted up by Sir Joseph Whiteworth & Company, have mounts which admit of an elevation of 35 degrees. The newer mounts will allow the latter limit. A test made showed that the gun could be moved throughout the full limit of the elevating arc, and the ammunition cases whipped up to the gun in 33 seconds.

A description and an illustration of the new Elswick 8-inch R. F. gun is given. It is a 40 caliber gun and was recently fired by a crew of five men at the rate of one shot every fifteen seconds; the interval for the ordinary service B.L.R. being about one minute every fifteen seconds. To obviate missfires a "primer holder" is let into the breech-block which carries the primer in to within ten inches of the charge. The "primer holder" is arranged to fire either by electric or percussion primer.

The Elswick breech mechanism is described, the leading feature of which is that the forward part of the screw is tapered, the rear part being cylindrical as usual. The advantages claimed for it are: first, the working of the breech mechanism is greatly facilitated, as the withdrawal and swinging to one side is done in a single motion, and secondly, the cone-shaped part distributes the pressure over a much greater portion of the cross section of the gun than if it were cylindrical. Illustrations and descriptions are given of the new mark III. rapid-fire mounts for the English 4-inch, 4.7-inch and 6-inch R. F. G.

The new British H sight is described and illustrated. One feature of it is especially worthy of note. The graduations are made on strips of aluminum which are fitted to slide into grooves cut in the sight-bars. A new strip can be inserted to correspond with any change which might take place, either in the muzzle velocity due to a change of powder or in weight of projectile.

The Maxim-Nordenfelt automatic 6-pounder R.F.G., the Maxim automatic 1.46-inch machine gun are described and illustrated.

Under the sub-heading "France" the following items of interest are extracted:

The French Minister of Marine has directed that in future all naval and coast-defense guns are to be designated by their exact calibers in millimeters. The time required to build a 164.7 mm. gun at the Naval Gun Factory at Ruelle is reported to be about 8 months; to build a 300 mm. gun, about 18 months.

The main armament of the new French battle-ships will be 11.81-inch guns, 45 calibers long in the bore, and 6.48-inch R. F. G. The 11.81-inch gun L/45 weighs 45.4 tons and is 45.9 feet long.

The new naval mounts provide for training the guns laterally by electric motors, and a description of these motors is given on page 96.

All R. F. ammunition is loaded with smokeless powder.

Recent changes in the well known Canet R. F. G. involves a considerable increase of length of bore, a strengthening of the reinforce rings and a modification of the shape of the chamber and bore to better adapt them to the new smokeless powders. The cartridge cases have also been altered, especially giving them more clearance in the chamber.

An account is given of some interesting experiments with a Canet 3.94-inch R.F.G., 80 calibers long. Among the results recorded is noted a muzzle velocity of 3301 f. s., with a pressure of 17.68 tons per sq. in.

There are descriptions and illustrations of the following guns:

The 2.24-inch Nordenfelt R.F.G. with new breech mechanism; the Hotchkiss 6-pounder R.F.G., 50 calibers: the Hotchkiss 10-pounder naval loading gun; Schneider & Co's. 15-cm. R.F.G.; the Krupp exhibit at the Chicago exposition, including the 42-cm. coast defense gun, 30-cm. gun, 28-cm. gun, 24-cm. gun, 21-cm. gun, 15-cm. R.F.G., 11-cm. R. F. G., 8.7-cm. R. F. G., 7.5-cm. R.F.G., 4.13-inch siege gun, 2.4-inch boat gun, 2.95-inch mountain gun, 2.36-inch mountain gun, 1.46-inch bush gun, 24-cm. mortar, 2.95-inch field mortar, 2.24-inch new Gruson R. F. G.

Referring to Russian ordnance the announcement is made that the Krupp breech closer has been discarded and the interrupted screw adopted.

In regard to torpedoes the information is given that compressed air is being superseded by gunpowder or some other explosive as a propellant for discharge. Ranges have increased somewhat. There appears to be a general tendency to discredit the use of nets on account of hinderance to maneuvering and the efficiency attained by cutters. A detailed account of experiments and torpedo practice abroad during the year, follows with illustrations and patent specifications of late improvements in discharge tubes, and the adaptation of them to explosive propellants.

The subject of armor is carefully treated. Details are given of all important trials made abroad during the year 1893-4, including the Austrian trials at Pola, with diagrams of plates; the English trials as given in the table of Mr. C. E. Ellis, published in his paper on "Recent experiments in armor"; the French trials at Gâvre in the spring of 1893; the test of the plates of the Russian battleship *Tri Sviatitelia* at Le Creuzot; the test of a Chatillon-Commentry plate made of "St. Jacques" metal, harveyized at St. Chammond, September 26th, 1893, with photographic reproductions of plates after test, showing the remarkable performance of the French specially treated steels; test of a piece cut from one of the deck plates of the battleship *Charles Martel*, with photographic reproduction of plate after test; trials at Gâvre of Harveyized plates in April, 1894; the Holland trials at Texel in August, 1893, with photographic views of plates after trial; finally the Russian trials at Ochta in June, 1894, giving account of the action of the so called "magnetic" armor piercing shell. The details of these trials, except the last, will be found in table given at page 438, Volume III, of this *Journal*. In the Ochta trial of last June, the plates were finished, one by Cammell & Co., and two by Brown & Co. The Cammell plate and one of the Brown plates were six inches in thickness, the second Brown plate was ten inches thick. A 6-inch Aboukoff gun, 45 calibers long was used throughout the trial. The projectiles were of two kinds, one being the ordinary Holtzer A. P. shell made in the Putiloff works, and the other a similar shell with a secret improvement applied by the Russians. The trial of these plates and the action of the so-called "magnetic" shell will be found discussed at some length in this *Journal*, Vol. III, page 696, and Vol. IV, page 137.

Lieutenant Karmany's notes on small arms (IV) are very interesting and instructive. The latest phases of the small caliber magazine problem are carefully explained, and illustrations are given of the Daudeteau rifle (Mexican) caliber 0.256'', the Mannlicher rifle, model of 1892, caliber 0.256'', adopted by Roumania, and the Spanish Mauser, model of 1893.

Speaking in a general way the author says, the opinion of the best experts is, that unless a heavier metal than that now used can be found for bullets at a moderate cost, the caliber will not be reduced below about 0.23''. A bullet of smaller diameter than this will not possess sufficient shock power. Also there must be a sectional density of at least 3000 grains per square inch to secure the desired ballistic results, and with the present bullet metal, this calls for a bullet over five calibers long with 0.256'' caliber, and these very long bullets, in turn, require a very rapid twist which brings a great strain on the barrel through the very high pressures developed.

The author refers in a suggestive way to the possibility of using in the future "some such propelling agent as liquified gas," and in such an event he looks to the employment of a "semi-automatic rifle." A few years ago a French gun was tried in which liquified carbolic acid gas was used as the propelling agent, but as nothing came of the tests then made, it is presumed it was not a success.

The magazine arm proper is giving way to the multiple loader. In the former the rifle is used ordinarily as a single loader and the magazine is held in reserve, in the latter the cartridges are fed to the gun in small packets, and, except when necessary to insert a new packet, no time is required to handle the cartridges, and it takes little or no longer to attach a new packet than it does to insert a cartridge in the single loader.

A valuable table is given containing the following data of the small caliber rifles of all important foreign countries: system: date; caliber; breech system; length; weight; barrel—length, rifling; cartridge; bullet—sectional density, envelope; powder; initial velocity; magazine—kind, number of rounds; number of rounds carried by soldier; bayonet.

"Notes on Naval Dynamo Machinery" (V), by Lieutenant J. B. Murdock, U. S. Navy, like all the writings on electrical subjects of this officer, has a value of a special nature. There is no higher authority on electrical matters in either service than Lieutenant Murdock, and what he writes becomes for us at once standard literature. It will be so of this treatment of "Naval Dynamo Machinery." The first part of the notes were published originally in the *Proceedings of the Naval Institute;* some "additional notes" are added here to the original article at the request of the Chief Intelligence Officer. Artillerymen may, perhaps, be permitted to cast a glance ahead to the time when we shall have modern guns, carriages and appliances for serving the guns; much of what Lieutenant Murdock has to say will have a bearing on the electrical material we shall have to deal with, and many of us no doubt will have occasion to refer to this paper.

He first treats of the generating sets provided for some of the new ships, referring especially to those installed or in process of installation in the *Maine*, *Cincinnati*, *Raleigh*, *Montgomery*, *Marblehead*, *Columbia*, *Puritan*, *Terror* and *Amphitrite*. He then takes up in succession the subjects of *wiring*, *search lights*, *switch boards*, *motors*, *comparison of American and foreign specifications* and *care of plants*.

Lieutenant Murdock in speaking of electric motors as a substitute for steam motors consider them advantageous, "in all places where auxiliary engines operate continuously for extended periods, for ordnance purposes where the demands for powder are not excessive, and in isolated places where power is necessary." Speaking of the Chilian cruiser *Capitan Prat*, he says: "She has probably the most extensiye electric plant of any man-of-war as yet built. The ship is lighted throughout by incandescent lights, is fitted with search lights, operates all its guns and ammunition hoists by electric motors, and has an elaborate system of internal electrical communications." The turrets of the *Capitan Prat* are operated also by electric motors, and a detailed description of the plant is given with diagrams and illustrations. Besides these latter the article is well illustrated throughout, reproductions being given of generators, motors, switch boards and search lights in use on our war ships, and of the Schuckert horizontal lamp for search light.

Passed Assistant Engineer Robert F. Griffin's essay on "Marine Boilers" (VI) discusses with considerable detail a number of tubular, pipe and other special boilers which are just now attracting much attention among marine men.

Descriptions with illustrations are given of the following boilers: The *Word* boilers, including the cylindrical coil, "unique," royal arch, bronze; the *Mosher*; the *Roberts*; the *Almy*; the *Towne*; the *Seabury*; the *McBride* and *Fisher*; the *Warrington*; the *Babcock* and *Wilcox*; the *Belleville*; the *Thornycroft*; the *Yarrow*; the *Blechynden*; the *Lagrafel-D'Allest*; the *Oriolle*; the *DuTemple*; the *Nornand*; the *White*; the *Niclausse*; the *Fleming* and *Ferguson* and *Seaton*.

The paper is undoubtedly a very valuable one, but it naturally does not possess that interest for artillerymen that some of the others do, therefore a mere statement of the ground covered is given.

No. VIII of the volume is an extremely interesting paper on the qualities and performances of the recent English battleships by their designer, Mr. W. H. White, C. B., L. L. D., F. R. S., Assistant Controller of the Navy and Director of Naval Construction. The chief burden of the writer's remarks is apparently to defend the completed ships against certain criticisms which have been aimed at them, especially in regard to their stability. He first discusses the *Royal Sovereign* as the type ship of the class, and thus sums up his conclusion in regard to this ship: "It appears that during the period of her service, now approaching two years, the *Royal Sovereign* has, on the whole, proved herself steady and well-behaved at sea. The heaviest rolling of the class has occurred under conditions of a long, low swell, synchronizing, or approximately synchronizing, with their period of oscillation. In this respect the class resembles the *Hercules*, *Monarch* and other ships of remarkable average steadiness and about equal period. Under such circumstances the great inertia of the *Royal Sovereign* class, inevitable with their offensive and defensive arrangements, occasionally tends to produce considerable angles of inclination."

The behavior of the *Resolution* has caused more unfavorable comments than that of any of the other ships of the class, especially while off the English coast during a storm in December, 1893. She had just been commissioned and started from Plymouth at 2 p. m., December 18th, to join the channel squadron at Gibraltar. She was obliged to abandon the trip altogether and put into Queenstown December 23, at 9 o'clock a. m. Newspaper accounts taken from members of the crew were to the effect that she had been seriously strained by heavy rolling, which reached at times to angles of 30 or 40 degrees from the vertical. Dangerous leaks had developed, and she could only be kept afloat by continued pumping. Immense quantities of water were said to have passed down into the engine rooms and stoke holds, and the crew suffered much discomfort from the excessive rolling. Mr. White replies to this as follows: "The *Resolution* was, in fact, put to a severe test at the very commencement of her service, when those on board had not grown familiar with the vessel, and particularly with the fittings provided for use in rough weather. She was not fully prepared when the sea first broke on board, and the washing away of certain fittings which were not well secured, or which were left in place instead of being stowed, permitted water to pass below. This involved discomfort but not danger, and statements to the contrary are unfounded. So are the accounts that were published in regard to the straining and leaks produced by rolling. As to the extent of the rolling there is no exact information, but there was undoubtedly exaggeration in the published reports."

Mr. White speaking as the designer of the *Centurion* and *Barfleur*, ships designed specially for service as flagships on distant stations, compares them with the *Royal Sovereign* class, and calls attention to loss of offensive and defensive power in the former caused by the effort to reduce the cost to 30 per cent. He says very positively the *Centurion* "is distinctly inferior to foreign ships of the first class now building, in offense and defense. Her heaviest guns cannot perforate the armor on the hulls and heavy-gun emplacements of those ships. Their heavy guns can readily perforate her defense."

Lieutenant Colwell gives a very full and careful analysis of the English naval maneuvers of 1893 in "IX."

These maneuvers were entirely naval in their character, and by having no connection with coast defense, do not possess that interest for coast-artillerymen which previous English maneuvers have, and which the French and Italian maneuvers of 1893, which follow, have.

The English maneuvers included three distinct sets of operations, viz:

1. The mobilization of 89 vessels of all classes with full crews, ready for any service, to supplement the seven ships of the channel squadron, already in active service in home waters.
2. A week of "preliminary exercises" to drill the officers at tactical maneuvers, the crews at their stations, and make fleets of the assemblages of ships.
3. Ten days of strategical maneuvers to demonstrate certain problems which might require solution in case of foreign war.

Not the least valuable result connected with these mobilizations and war maneuvers, is to reveal the weak points in the arrangements for war. The English, for example, discovered that there was a great deficiency of skilled firemen, engineers and gunners, that the ships which had been out of commission for a time showed lack of proper care and need of more frequent docking, that the signal force was inefficient, that it is a mistake to associate old type slow ships in a fleet with fast modern battleships, and the need of swift scout-boats and more and faster torpedo-boat catchers.

The French maneuvers consisted of two distinct sets. One set of maneuvers took place off Toulon and the coast of Corsica and North Africa, the others off the north coast, bordering the English channel. In the former, one fleet defended the island of Corsica, and a section of the coast of Africa included between Bougie on the west and Cape Bon on the east. The land defenses within this limit assisted the defense. The defense was successful. The admiral in command of the attacking fleet by a sudden change of plans, after beginning operations confused the problem to such an extent as to make it difficult to draw definite conclusions. After the maneuvers proper, some interesting experiments were carried out in firing at elevated objects on shore, while the ships themselves were moving. The place chosen for the practice was the Gulf of Porto on the west coast of Corsica. The target was on the summit of Cape Rosso which forms the southern limit of the gulf. One ship took position from which the results could be observed. The *Formidable*, *Courbet*, *Redoutable*, *Hoche*, *Admiral Duperré* and *Devastation* took part in the practice. At first the range was 8750 yards, the speed 10 knots, the guns used 6.3-inch and 5.5-inch caliber. Later the range was reduced to 3800 yards and guns of all calibers were used, the ships moving at eight knots. Finally the *Formidable*, *Hoche* and *Courbet* fired a second time at 8750 yards, steaming at ten knots in the arc of a circle of which the target was the center. Unfortunately the details of this firing are not given, the only comments recorded are "the results are said to have been only moderately satisfactory."

The general idea of the channel maneuvers was as follows: The enemy's squadron threatens the north coast of France from the North Sea. The defending squadron, keeping in communication with the shore, is warned of the approach of the hostile squadron and is to move to the defense of any threatened seaport. The attacking squadron tries to slip through the Straits of Dover without being detected, and then to fall upon the French coast, avoiding any decisive action. The attacking fleet was successful. It slipped through the straits, avoiding the scouts of the defenders, and steamed on Boulogne which it bombarded before the defending squadron could get there. Having bombarded Boulogne, the attacking squadron took to its heels and escaped punishment.

The Italian maneuvers are extremely interesting from a coast defense point of view. The general idea was a strong hostile fleet threatening the Italian coast from Genoa to Naples from the direction of France. The object of the attacking fleet was, first, to seek the defending fleet, come to action with it, and gain command of the sea. If the defending fleet retired, evading a combat, to endeavor to bring it on by bombarding undefended towns. Later an attack was to be made on Naples, and, finally, after the reduction of the defending fleet by casualties to a certain point, the attacking fleet was to escort a large fleet of transports carrying troops to be landed on the coast at a point out of range of the artillery of the permanent fortifications. These plans were well carried out. The attacking fleet accomplished its objects, although its efforts were stubbornly contested and the umpires had many close decisions to make. In real warfare the solution of the problem might easily have gone the other way.

It is to be noted to the credit of the Italians, that the mobilization was affected smoothly, and there was not a single break down in the whole lot of ships, including 18 squadron ships, 4 torpedo-vessels and 54 first class torpedo-boats, although these ships were maneuvering night and day for a month.

An interesting mathematical discussion by Captain Betollo of the Italian Navy is given, in which he deduces a formula for finding a numerical expression for the coefficient of military power of a battleship.

Tne most interesting and instructive paper to coast artillerymen in the entire volume is Lieutenant Rogers's account of "The Revolt in Brazil" (X).

Lieutenant Rogers was an eye witness to most of the events he chronicles, and what he says has a special value from this fact alone. The details of the fighting in the bay of Rio de Janeiro are very full, amounting almost to a diary of the events. The events in other portions of the theater of war are introduced in chronological order, and the whole makes up a most satisfactory connected history of the revolt, from its inception to its close. Two excellent maps accompany the article, one, a general map of Brazil and South America from the 5th parallel of north latitude to the 35th parallel of south latitude, the other, a local map of Rio de Janeiro and the bay of Rio de Janeiro, with position of forts, search-lights, anchorages of rebel ships, foreign men-of-war and merchant ships marked, and the map is colored to show the holdings of the government forces and rebel forces during the latter part of the contest. Rio de Janeiro Bay is a typical place to defend from the shore. The entrance of the bay from Sugar Loaf Point to Fort Santa Cruz is about 1580 yards wide, with a small island on which Fort Lage is located, almost midway between. This necessitated that a hostile ship must pass within 400 to 500 yards of the guns of the forts in running in or out. From Rio de Janeiro across to Nictheroy is about 4000 yards, and from this line north, 6000 yards would include the extreme limit of positions occupied by the rebel war ships. The government forces had batteries and forts placed along both shores to the north, at Caju Point, Bom Jesus Island, Ribeira Point on the west shore to the north of Rio de Janeiro, and at Armacao, Areia Point, S. Lourenco, S. Pedro, Point Velho, and Point S. Goncalo on the east shore to the north of Nictheroy. That is, the east and west shores of Rio de Janeiro Bay were lined with batteries and forts on each side from the entrance north for about nine miles; the distance across from shore to shore varied from about 1600 yards at the entrance to about 9000 yards north of Rio de Janeiro. Thus at all times the rebel ships were within 5000 yards, at least, of the shore guns, and often within 4000 yards. Lieutenant Rogers says the armament at Fort Santa Cruz consisted of two 10-inch Armstrong rifles with several smaller guns; Sao Joao, one 10-inch Armstrong with smaller guns; Fort Lage, three 6-inch Whitworth guns; Fort Gragoata, one modern high power gun about 6-inch caliber. Many small field guns were placed in batteries along the shore, the more prominent forts having from one to three 10-inch Armstrongs or 6-inch Whitworth guns. It seems almost incredible that the rebel fleet consisting of the *Aquidaban*, *Tamandaré*, *Liberdade*, *Guanabara*, *Trajano*, and many armed merchantmen, tugs and torpedo-boats, altogether about 26 vessels, occupied the limited water area above described for over six months, passed and repassed the forts at the entrance, and, as Lieutenant Rogers says, "made no attempt to keep out of range, and steamed, even with lighters in tow, direct to their destination, the shells following either one-fourth of a mile beyond them or as much short."

The artillery defense was, in truth, a farce. It was more than discreditable that the Brazilian artillerymen should not have done better execution with 10-inch Armstrongs and 6-inch Whitworth rifles. These are good guns, and, if properly served, can be made to hit. Bad powder may, of course, have had something to do with the poor gunnery, but the muzzle velocity of *any* powder can be determined by firing ten shots and then, after that, there should be no absurd range variations at least. Probably the ignorance of the Brazilians of the effect of *jump* and *density of loading* had as much to do with the variations of range reported as any thing. It is only comparatively recently that we ourselves have awakened to the importance of these two factors in practical gunnery. The accuracy of fire of the fort guns improved decidedly toward the close of hostilities and many hits were made, but the fire was still far from what it ought to be.

It may be stated quite positively that our naval brethren had better not accept the Brazilian defense as a just measure of the efficiency of shore fire. With trained commissioned officers in charge, it is not a difficult matter to score between 70 and 80 per cent. of hits on a ship target moving at any place within the limits of the field of fire, even with our old M. L. 8-inch guns, and with the newer B. L. guns a higher percentage of hits could be made.

Lieutenant Rogers gives a stirring account of Admiral Benham's action in January, 1894. He does not bring out, however, the fact that Commander Brownson ordered the 6-pdr. Hotchkiss shot to be put in about six feet *abaft* the stern of the *Trajano* instead of in front of it, but his order was incorrectly transmitted by a messenger; it is, perhaps, on this little accident that a general engagement hung.

An excellent photographic reproduction of the *Aquidaban* is given, showing the terrific effect of the torpedo which sank her.

Every page of Lieutenant Rogers's article possesses some special interest for artillerymen, and it is simply impossible to give any adequate review of it within the limits here permitted.

The list of "Standard Books on Professional Subjects" (XI), as given in former numbers has been received and extended; it must always be a valuable source of reference to naval officers, and others investigating the technical subjects covered by it.

ERASMUS M. WEAVER,
1st Lieutenant, 2nd Artillery.

The Naval Annual, 1894. Lord Brassey, K. C. B., and F. K. Barnes, M. I. N. A. Edited by T. A. Brassey.

This, the eighth edition of the *Annual* was compiled and passed for press within a little over a month, in order that it might make its appearance on May 1st. It presents in five parts a comprehensive view of matters of interest, not only to persons in naval life but also to those employed in land forces.

Part I is subdivided into thirteen chapters, contributed by different writers. In the first chapter it is stated that the year 1893–94 has seen greater increase in the naval strength of the British Empire than any preceding year but; that, omitting torpedo-boat destroyers, fewer ships have been laid down.

Among the most important events of the year are mentioned trials, deemed satisfactory especially as to machinery contained and stability at sea, of the six first class battleships of the *Royal Sovereign* class and of the *Centurion* which, like the *Barfleur*, is a modified type of that before mentioned. These latter two vessels are regarded by many people in England as sea-going fighting machines, superior to those of the *Royal Sovereign* class, each at two-thirds the cost price of the latter. However, the *Majestic* and the *Magnificent*, with the seven new ones of the same general type laid down or about to be laid down, show by their extreme size that the *Royal Sovereign* class is the type to which England adheres for establishing naval supremacy at points where her interests are most vital.

The rehabilitation of the old sea-going mastless turret *Devastation;* the addition of quick fire guns to the *Agincourt;* the taking in hand for repairs of other antiquated vessels, and the laying down of cruisers and torpedo gun boats indicate that the Empire is active to more nearly approach the accepted standard for her naval strength.

Chapter 2 sets forth that little of importance has happened in the navies of the world during the year; that the speed of battleships of 18 knots, of cruisers 20 to 22 knots, of torpedo-boat catchers 27 to 30 knots is accepted; that the indications are that liquid fuel will soon be carried on many ships; and that 2600 f. s. initial velocity for guns appears satisfactory. This chapter also gives in detail the progress of foreign navies during the year.

The British and foreign naval maneuvers are described in Chapters 3 and 4, with conclusions from them that the seagoing torpedo-boat is an overrated weapon of offense; that some useful lessons in the use of search lights had been learned, and that the transportation of an army by sea and its landing on hostile territory are undertaken in face of great difficulties and under menace of overwhelming disaster, to say nothing of the difficulty of keeping up maritime communications so as to prevent destruction of the army if once landed.

The resources of Toulon—the chief seat of French naval power in the Mediterranean; the comparative strength of British and of Russian and French navies; the English strategic position in the Mediterranean, and the agitation in 1893 for the increase of the English navy, are treated in Chapters 1 to 8 inclusive. They may be regarded as all having a bearing on Captain Eardley Wilmot's conclusion—borrowed from the *Daily News*—in Chapter 8, that the sound lines for the English naval policy should be to "lay down a battleship for every battleship begun by either of the powers that might act in concert against us, and for every cruiser built by them we must build two."

Chapters 9 to 13 inclusive, give an account of the loss of H.M.S. *Victory* and the resulting action of the Admiralty; an argument from history for moderate dimensions in battleships,—with resulting larger numbers for the same expenditure; an account of the naval revolt in Brazil; a description of the resources of the British Empire in war-time for building warships, and an estimate of the protection of commerce by convoy.

Part II contains tables and plans of British and foreign torpedo-boats, and of their armored and unarmored ships.

This part gives much useful data to the artillerist, as from it he can approximate to the resisting power of each vessel to the projectiles from his guns, and to the strength of armament each may bring to bear to silence him.

The armor on British warships is, in general, compound, placed on the water belt amidship, but extending only about two-thirds of the length of the hull. It is then carried athwart ship near both ends so as to protect the machinery on all sides. The remainder of the hull is protected only by a curved deck. The wisdom of this system of placing armor was brought into question when the *Victoria* was rammed by the *Camperdown*; but, among the Admiralty conclusions quoted in Chapter 9, we find "the fact that the *Victoria* was not armor belted to the bow, had no influence upon the final result of the collision. No armor belt could have prevented the ripping open of the *Victoria* below the water line by the rambow of the *Camperdown*," and that the "general structural arrangements of the *Victoria* with the arrangements of water tight doors, armored belt and protective deck did not by any fault of principle contribute to the loss of the ship." In general the United States and Italy use this, the central citadel, system of placing armor on their warships; but France, Russia and Germany follow quite closely the complete water belt armor system.

Captain Orde Brown, R. A., reviews armor, ordnance and quick-fire guns in Part III, also furnishes therein, in detail, tables of British and foreign ordnance. He states that the effect of the increased penetrative power of the projectile has led to use of armor arranged as double shield, an outer to stop or break up the projectile and an inner to stop fragments. This principle finds its best expression in bending or curving the armored deck downward to meet the lower edge of the water line armor belt, hence a projectile, finding its way through the latter, meets inclined armor before it can reach the vital part of a ship.

He states that "In England it has been decided not to use nickel in Harveyized armor plates, because the resisting power against penetration is greater without nickel though toughness is less. It also appears that nickel causes crystallization at a low temperature, and further that high carbon steel containing nickel cannot be drilled even by the "arc light process." Further in this volume in Part IV,—which by the way is given to statistics, official statements and papers—the First Lord of the Admiralty, in explanation of the navy estimates for 1894-95, says as to the non-use of nickel steel "this new system will be a great saving in cost for a given defence." It may be remarked that experiences in the United States as to cost and usefulness of nickel in all kinds of armor plates are so satisfactory as to commit us to its use.

Part V is given up to a discussion, by Lord Brassey, of the English naval positions in 1894. It is a review, in thirty-five pages, of the strength of the Mediterranean fleet; the naval strength of England, compared especially with the combined strength of France and Russia; of the English naval policy; of battleships with especial reference to those of the United States, and of cruisers in general.

While regretting that the English naval policy causes increasing and larger expenditures each year, he hopes that continued adherence to it will cause "rival Powers to relax their efforts to deprive us of our naval supremacy. For ourselves we cherish no scheme of agression, but that Great Britain should be strong at sea is the surest guarantee for the peace of Europe."

On the whole the *Annual* comprises, in 520 pages, contributions from at least a dozen well known and able writers—including Vice Admiral Colomb and Captain Robinson, the naval editor of the *Army and Navy Gazette*—who set forth their opinions and conclusions in such a manner that this volume sustains the reputation of its predecessors, and furnishes to the student of naval matters a clear insight into the naval policies of the various nations, and the inherent strength of their armored and unarmored warships. H. C. C.

Balistique Expérimentale. Par E. Vallier, chef d'escadron d'artillerie, correspondent de l'Institut. Paris. Berger-Levrault, 1894. Pp. 239.

This work was first published serially in the *Revue d'Artillerie*. It was unquestionably suggested by Ingalls' *Handbook of Problems in Direct Fire*, and is in many respects an obvious imitation of that invaluable work. This does not mean that the *Handbook* is the unique source of M. Vallier's materials, nor does it mean that the work under notice is wholly a compilation. M. Vallier has drawn more or less freely on all accessible sources of information, as well as on his own wide experience as a member of the *Commission de Gâvre.*

The opening chapter gives the reasons why Hojel's laws of the resistance of the air have been selected in preference to other published expressions of these laws. Then follows a statement of the various formulas for rectilinear motion and for fire under angles less than 5°, accompanied by a table of ballistic functions. Chapters III and IV (pp. 23–102) treat of the solution of the various problems of fire, in precisely the same manner as these same problems had been previously presented by Ingalls in his *Handbook.* Pages 72–102 are given up to tables of the auxiliary functions. Chapter V takes up a few cases of curved fire, and is rounded out by Otto's tables, as amended by Siaccei and Sardillon. Convenience of reference would seem to suggest that these and the other principle tables spoken of should have been collected at the end of the volume. Chapters VI and VII discuss, the former the principles and conditions that should control experimental methods, and the latter the construction of range tables. In these, as in the preceding chapter, the author deals with matters more or less well known, but the idea of arranging in logical sequence the principles and rules of action involved is to be commended. We have accordingly, first a discussion of the establishment of a program, a subject of the first importance in view of the great cost of target practice. Then follows the execution of the program, as related to determinations of the M. V., jump, resistance of the atmosphere, and wind allowance. Passing by several theoretical discussions of points brought up in these last two chapters, we reach Chapter VIII, containing nothing but a bare statement of some of the velocity and pressure formulas of Interior Ballistics. Glennon is not mentioned. The author, however, adds some formulas of his own. Chapter IX deals with the effect of projectiles on earth, masonry and armor. Chapter X discusses briefly the application of probabilities to fire, and gives, *inter alia*, a formula connecting the probability of fire with effect of projectile on target, as a basis for estimating the amount of ammunition necessary to secure a definite result. This formula appears to be of questionable utility.

From this brief indication of contents, it is clear that M. Vallier's book offers nothing that is particularly new. As a *working* handbook it will not be found as useful as that of Ingalls. It does not offer nearly so many variations of the different problems that occur in practice. As already stated, it is largely a compilation. Now, in getting up a handbook, compilation is not only unavoidable, but it is, so to speak, a condition of existence. But it is the duty of the compiler to indicate as far as possible the sources whence his material is drawn. Of course there are some results so long established as to be thoroughly well known. and therefore not needing special reference to origin. But in the general case, and quite apart from any other considerations, reterences are always welcome to the investigator who wishes to draw independent conclusions. In this respect, and in more or less contrast with his treatment of non-American authors, M. Vallier has left a good deal undone so far as one or two American investigators are concerned. For example, the formulas given in 2° and 3°, p. 38, are due to Ingalls, but Major Vallier does not say so. Under "XI. Derivation," although general reference is made to *Ingalls's Handbook*, yet more particular credit might have been well given, as some of the formulas given by M. Vallier were first published by Captain Ingalls. Other instances of unacknowledged indebtedness may be found on p. 55 (cf. *Ingalls's Handbook*, p. 84); p. 67 (Ingalls *op. cit.*, prob. XXII); p. 70 (example taken bodily from Ingalls, p. 117); p. 162, "Régle de Chauvenet" (translated from Ingalls p. 244). On p. 208, where Weaver's penetration formulas are treated, although credited to him, yet reference should have been made to the periodical in which the formulas were first published, if only because Vallier has modified them. This view is further justified by the fact that the modified formulas have been lately communicated by M. Vallier to the Academy of Science at Paris, while the form in which Weaver writes them is not given at all.*

In some respects, the title of the book under notice is a misnomer. For example, a handbook of *experimental* ballistics might well, it would seem, devote some attention to the various ballistic instruments in use. But leaving out a very brief summary of Gossot's method by acoustic interrupters, and some few remarks on the setting up of screens, this subject is left untouched. In general, details of proving ground economy are not dwelt upon. In justice to the author, however, it should be recollected that his aim has not been the preparation of a ballistic aide-mémoire. Within the limits selected he has produced a work of value and of interest. We may note in conclusion, as of special interest to us, that the author holds mortar fire to be of small value as against ships; he evidently regards chance as the main factor in obtaining a hit from a mortar. Believing as he does that high power guns of large caliber firing A. P. projectiles are of necessity limited in application; he casts his

* See *Comptes Rendus*, January 21, 1895. It is worth noting that where Weaver puts

$$\frac{r}{d} = 3.125 + 0.11\,(t-d),$$

(t and d being in inches) Vallier writes

$$\frac{r}{d} = 10^{0.0012\,(t\ d)},$$

(t and d being in millimetres). There is no other difference. The second form agrees in results so closely with the first that the choice between them, other things equal, reduces to a question of ease of computation, since

$$\log\frac{r}{d} = 0.0012\,(t-d).$$

vote for medium power guns firing shells of large capacity filled with high explosives. When we recollect that the other authorities would have no S.C. gun of caliber greater than 8″, and even then would rely chiefly on R.F. guns, we may conclude that the problem of the best nature of S. C. defense has as yet apparently received only an approximate solution.

C. DeW. W.

DEPARTMENT OF SCIENTIFIC AND MILITARY INFORMATION.

Revue d'Artillerie.

(5 *Rue des Beaux-Arts, Paris, France. Monthly. Per year* 22 *Fr.*)

JANUARY.—The Artillery in the naval combat of the Yalu.

This article is compiled from the last published accounts found in papers of different countries. The forces, ships, arms and guns on each side are given with suitable comparisons and conclusions.

Armor plates and projectiles. Status of the question in January, 1895.

This article is a supplement to *Balistique Expérimentale* by Vallier, who endeavors to bring the subject up to date. The two long tables dealing with Harveyized plates, showing results of recent experiments, are valuable. Another table gives comparative results of Texel experiments in 1892. Here six different manufacturers (English 3, French 2 and German 1) were represented and seven shots were fired at each, varying in velocities from 440 to 573 m. The table is so arranged as to make comparisons simple. An additional table gives comparative results obtained with capped and ordinary projectiles.

Distribution of the deformations in metals subjected to stresses (continued). The Krupp Artillery at the Exposition of Chicago. The influence of the inclination of the threads of the screw upon the strength of the breech mechanism. Bofor's 12 c. m. rapid firing gun mounted upon an armored carriage.

FEBRUARY.—Reflections upon the maneuvers of the German Artillery. The horse shoe for ice in the Scandinavian countries. Upon the law of resistance of the air.

In this note Commandant Chapel continues the discussion of the law of resistance and gives cases showing pressures upon head and base of the projectile.

MARCH.—The Artillery Corps of France. The Russian field mortar. The Simplon tunnel. Upon the law of resistance of the air.

Application to ballistic calculations.—The writer having previously shown that the equation $R = aV - b$ expresses quite accurately the law of resistance for high velocities, he goes on to claim that this formula may be substituted for $R = K V^n$ and that his simple equation of the first degree with respect to V covers the interval of velocities between 300 and 1100 m. He shows how this new relation may be used in ballistic tables and gives several problems illustrative of his method.

Upon steel in the bore. New rewards for firing. Great German maneuvers, 1895. Winter maneuvers in Germany.

Revue Militaire de l'Etranger.

(*L. Baudoin, Rue et Passage, Dauphine* 30, *Paris, France. Monthly. Per year* 15 *Fr. Single number* 1 *Fr., plus postage.*)

JANUARY.—German regulations of July 20th, 1894, upon the service in the field. The Italian colonial troops in Erytrea. The military organization of the Ottoman Empire. Creation of two new field mortar regiments in Russia.

FEBRUARY.—Artillery of large calibers in armies. Reforms effected in 1894 in the Austro-Hungarian army. Opening of railway lines.

MARCH.—The Congo free state and its military forces. The Chino-Japanese War. The winter exercises in Germany. The Italian general-staff. Construction of railroads in Germany in 1894.

Revue du Génie Militaire.

(*Berger Levrault Cie, Rue des Beaux-Arts* 5, *Paris, France. Bi-monthly. Per year* 27 *Fr.*)

NOVEMBER–DECEMBER.—The mission of the engineers in the Congo in 1893–94. An abacus for facilitating the solution of problems relative to the distribution of waters. Upon the thrust of earth against retaining walls. A lantern for siege purposes.

Revue Maritime et Coloniale.

(*L. Baudoin, Rue et Passage, Dauphine* 30, *Paris, France. Monthly. Per year* 56 *Fr.*)

DECEMBER, 1894.—Our commander. Our nationality in Atlantic ports. The influence of sea power on history. Description and operation of the hydraulic apparatus for the 340 mm. guns, model 1887. Vocabulary of powder and explosives.

JANUARY, 1895.—The naval battle of the Yalu. Our first-class battleships, and what they are worth. The *Volta* in China and on the Tonkin. Chemical and micro-biological researches upon the alterations and the protection of the ordinary metals in sea water.

FEBRUARY.—English torpedo gun boats of the first-class. Report upon the process to be employed in determining the impurities of olive oil. Study upon existing carriages of large pieces. Quick determination of the variations of the compass. Geometry of diagrams,—economic questions upon indicator curves.

Revue de Cavalerie.

(*Berger Levrault Cie, Rue des Beaux-Arts* 5, *Paris, France. Monthly. Per year* 33 *Fr.*)

JANUARY, 1895.—The work of General Galliffet. The Italian cavalry. The strategic role of cavalry in 1870–71. The assembling of the two cavalry regiments. The pace of horses revealed experimentally. A running race at the cavalry school of Hanover. The compass-field-glass of Lieutenant Giraud.

FEBRUARY.—Cavalry at the maneuvers. The cavalry division of the guard in the campaign. Studies upon cavalry fighting on foot. The mobilization of two reserve regiments of cavalry.

MARCH.—The effectives of cavalry in France and in Germany. Microcosm of the operation of the cavalry. The Italian cavalry. The food and labor of the military horse. Cavalry against cavalry upon the service of security. The Anglo-Arabian horse.

L'Avenir Militaire.

(13 *Quai Voltaire, Paris, France. Semi-weekly. Per year* 18 *Fr. Single number* 5 *centimes.*)

JANUARY 1, 1895.—The armies on January 1, 1895. Rapid firing cannon,—Schneider system.

JANUARY 4.—The structure of the army.

JANUARY 8.—Military degradation.

JANUARY 11.—The general inspections. Promotion. Espionage.

JANUARY 15.—Non-commissioned officers schools in Germany and France. The effectives on January 15. The budget of the Legion of Honor.

JANUARY 18.—Revision of the military code.

JANUARY 22.—The superior war school.

JANUARY 25.—New construction in France. Autumn maneuvers. The Crimean War.

JANUARY 29.—Combat tactics. Discipline in armies.

FEBRUARY 1.—Marshal Canrobert. The reorganization of the land army. The circular of January 12 (continued).

A circular relating to the efforts of the Minister of War to act in harmony with the other departments with respect to civil employees.

FEBRUARY 5.—The war budget. The Madagascar expedition. Belgium in the Congo.

FEBRUARY 8.—The Madagascar transports. Remount of officers. Electric locomotives and the defense of places.

FEBRUARY 12.—The budget of 1895.

FEBRUARY 15.—The intellectual work of the officer. Colonial politics. Strategic transports.

FEBRUARY 19.—The new army. Desertion. General de Rivière and Colonel Stoffel. Geography and the science of the terrain.

FEBRUARY 22.—Belgium and Congo. General de Rivière, Thiers and Bazaine. Prince Eugène.

MARCH 1.—Society for aid to military men. German winter maneuvers. The replenishment of the field artillery.

MARCH 5. Promotion. France and Italy. The war game in Russia.

MARCH 8.—Heavy artillery for the field. The war budget and the *Chambre*. France at the Kiel celebration.

MARCH 19—The army and the financial budget. Europe and Japan. The personnel of the naval arsenals.

MARCH 22.—The convocation of the officers of the land army. The war budget and that of France. War dogs in Madagascar.

MARCH 29.—The German Emperor and Bismark. Espionage.

La Marine Française.

(23 *Rue Madame, Paris, France. Semi-monthly. Per year* 30 *Fr. Single copies* 1 *Fr.* 50 *centimes.*)

JANUARY 10, 1895.—The question of the *Brennus*. The prices of naval material.

JANUARY 25.—Submarine cables and the navy. *Légion d' Honneur*, commanderies, advancement and tables. The question of Terre Neuve. The geographic and Colonial movement.

FEBRUARY 10.—The new minister. Sphere and object of the navy in its relation to politics and diplomacy. The arsenals of England, their work for 1895 and the new program. The Battenburg route indicator. Statistics of maritime construction. Composition of the Italian squadrons Classification of the fleet. The German financial budget for 1895-6. The Russian budget for 1895. Russian naval constructions. The port of Vladivostok. Danish and Swedish budgets. The Hontoria guns. The Holland submarine boat. A lesson from Japan. The Italian armored ship *Re Umberto*.

FEBRUARY 25.—Coast defense and the navy. Submarine vessels. Colonial doctors and doctors of the navy. An hypothesis of evacuation of the Mediterranean by the English. Price of construction of ships of the naval defense act. Statistics of naval construction. The *Majestic*. Naval budget, new construction and armaments.

MARCH 10.—The coast defense and the navy. Colonial doctors and navy doctors. England and the Mediterranean. France at Kiel.

MARCH 25.—Custozza and Sadowa. The ministry of the national defense. The discussion of the naval budget. The artillery of the *Charles Martel*. The English naval budget.

Revue du Cercle Militaire.

(37 *Rue de Bellechasse, Paris, France. Weekly. Per year* 27 *Fr. Single copies,* 50 *centimes.*)

JANUARY 5, 1895.—Reserve cavalry regiments, and horses by requisition. The Loris bullet-proof blouse and the Daudeteau gun.

JANUARY 12.—The instruction platoon in artillery (continued). The fundamental data of photogrammetry.

JANUARY 19.—Photography at great distances (continued). War against the Touareg (continued).

FEBRUARY 2.—Safety apparatus for preventing premature explosion. Cavalry in the presence of the new fire-arms.

FEBRUARY 9.—The Japanese army (continued). The 13th Army Corps during the war of 1870 (continued).

FEBRUARY 23.—The Lefebvre carriages and the expeditionary corps to Madagascar (continued). The horse-shoe for ice in Denmark, Sweden and Norway.

MARCH 16.—The medical statistics of the French army in 1892.

Le Yacht—Journal de la Marine.

(55 *Rue de Chateaudun, Paris, France. Weekly. Per year* 30 *Fr. Single copies,* 60 *centimes.*)

JANUARY 5, 1895.—The navy in 1894 (continued). The armored coast-guard ship of 6000 tons, the *Jemappe*. The stability of sailing vessels (continued). The installation of electric lights on board yachts. English constructions for 1894. Light armor and its substitutes. The river flotilla for Madagascar.

JANUARY 12.—The second-class cruiser *Friant*.

JANUARY 19.—M. Félix Faure, President of the Republic. Trials of war-ships. A dispartable boat.

This boat, constructed by the Pennsylvania R. R. Co., is divided into sections, and each section is mounted on an ordinary railway flat-car for transportation.

Madagascar war flotilla.

JANUARY 26.—The ministry of M. Félix Faure. The Madagascar gun-boats. The Italian armored ship *Sardegna*.

FEBRUARY 2.—Vice-Admiral Besnard, Minister of the Marine. The end of the flying squadron.

FEBRUARY 9.—The loss of the *Elbe*. The question of transports to Madagascar, and the merchant marine.

FEBRUARY 16.—The destruction of the Chinese fleet. Submarine telegraphy.

FEBRUARY 23.—The question of transports. The surrender of Wei-Hai-Wei. The German armored coast-guard ship, the *Bayern*.

MARCH 9.—The armor question. The ram-torpedo-boat of the Italian navy.

MARCH 16.—The English marine budget. The French marine budget.

MARCH 23.—The navy in the Chamber of Deputies. The Spanish armored cruiser *Carlos V*.

MARCH 30.—The navy and the House of Commons. Studies upon the Italian navy.

Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils.

10 *Cité Rougemont, Paris, France. Monthly.* 36 *Fr. per year.*

November, 1894.—Notes upon the application of aluminum to naval constructions.

Le Génie Civil.

(6 *Rue de la Chaussée d'Antin, Paris, France. Weekly. Per year* 45 *Fr. Single copies,* 1 *Fr.*)

January 5, 1895.—Study of sub-marine torpedoes. Elevated electric railway of Liverpool. The 162-ton crane of the port of Malta. Respiratory masks as protectors against dust.

January 12.—The great thin gas-motor. Graphic calculation of the strength of joists and studs (continued).

January 19.—Experiments on the methods of reducing the water-resistance of boats. New war material of Turpin. Electrical welding of tramway rails. New dust-collector.

January 26.—Gas motors applied to river navigation. Motive force at Liverpool. New improvement of the steam engine.

February 2.—The theory of public lighting. The water system of Yokohama. Study upon the temper of steel. A glance at the German budget (continued). The Algerian-Tunisian phosphates. Experiments upon the work of straight pieces subjected to an eccentric pull (continued).

February 9.—Treatment of the residue of gold mills by cyanide of potassium. Public illumination by arc lamps. Apparatus for the combustion of garbage. New methods of transporting logs.

February 19.—The Chicago canal to the Illinois basin.

February 23.—Gun-boats for the Madagascar expedition. Discovery of a new gas in the air.

March 2.—Notes upon high-speed engines constructed by Schneider & Co., Creusot. Sub-marine boats. Statistics of the mineral industry in France for 1893. New process of extraction of sulphur from iron-pyrites with simultaneous production of sulphate of iron. A new method of putting in place short span metallic bridges.

MARCH 9.—Electric towing on the Bourgogne. Locomotive of great speed using liquid and solid combustible. Construction of béton wharf.

MARCH 16.—The new bridges of Paris. New compound locomotive of great speed. A new artificial cement. The L'Eclair counter of electric energy. Note upon the use of gas.

MARCH 23.—The progress of the British navy. American locomotives at the exposition of Chicago. Study upon the friction of belts. Lamp without wick for petroleum illumination.

MARCH 30.—Electric draw-bridge of Van Buren street, Chicago. Application of photography to the construction of plans. The present upward movement of Scandanavia. Bimetalism in Germany. Resistance of trains,—traction.

Revue de l'Armée Belge.

(22 *Rue des Guillemins*, *Liége*, *Belgium*. *Bi-monthly*. *Per year* 13 *Fr.*)

NOVEMBER-DECEMBER, 1894.—The Congo. The Arab war. The Universal Military Exposition of Anvers. Note relative to the rapid firing 7.5 cm. field gun of the Nordenfelt system. The war material of the *Compagnie des Forges et Acieries de la Marine de St. Chamond* (*Loire*) at the exposition of Anvers. Borchardt repeating pistol. History of the development of the military forces of Prusso-Germany during the 19th century. Permanent fortification and siege warfare from the latest sources. The Argentine Mauser rifle—model of 1891.

JANUARY-FEBRUARY, 1895.—The Russo-German and Russo-Austrian frontier,—the fortresses of the Eastern Prussian provinces, and the fortresses of Poland and Western Russia.

This is a continued article giving descriptions of the German, Russian and Austrian border forts, and treats generally of the history and present value of the works and of their strategic relations to one another.

The annexation of the Congo to Belgium. The Congo before the country. The law of air resistance according to thermodynamics. Rapid firing 120-mm. gun upon fixed carriage and with limited recoil. The tactics of great masses.

La Belgique Militaire.

(*Rue St. Georges* 32, *Ixelles, Belgium. Weekly. Per year* 12.50 *Fr. Single copy*, 5 *centimes.*)

DECEMBER 30, 1894.—The army contingent for 1895. Mobilization maneuvers on varied ground in 1894.

MARCH 10, 1895.—Press opinions upon the project of the military reforms of the government.

MARCH 17.—Study upon the public force (continued). Remount in case of mobilization.

Revue Militaire Suisse.

(*Escalier-du-Marché, Lausanne, Switzerland. Monthly. Per year* 10 *Fr. Single number* 1 *Fr.*)

JANUARY, 1895.—The schools of fire in the infantry (continued). Mountain artillery in 1894 (continued). The health and food of the horse in the field. Moltke. Mean of the results obtained in the firing exercises of the schools, and courses of artillery in Switzerland.

FEBRUARY.—Canrobert.

MARCH.—The army corps. The health and food of the horse in the field. Belgium and Switzerland.

Memorial de Artilleria.

(*Farmacia, num.* 13, *Madrid, Spain. Monthly. Per year* 18 *pesetas. Single copies*, 1 *peseta*).

DECEMBER, 1894.—The rupture of cannon by dynamite.

A short article giving data of general procedure of bursting cannon; it gives illustrations showing positions of charges in a given case, and methods of exploding them.

Force of explosives. Diary of the march of a section of the 9th mounted regiment.

JANUARY, 1895.—Definitions of force in powders and explosives.

The author here gives a brief history of the question and discusses the absolute, explosive, and maximum force and draws conclusions from the interpretation of the formulas expressing their values.

Considerations upon the defense of coasts. Improvement of the breech-mechanism of the 14 cm. cannon, using fixed ammunition, to the end that a percussion or an electric primer may be used.

This is a device by which an electric primer may be used in firing the gun:

each gun having its dry battery and the necessary equipment. It is so constructed as to operate automatically. The gun is provided with an ordinary percussion apparatus by which it can be quickly fired in case the electric primer fails.

Reform in the instruction of artificers.

JANUARY.—New pieces for field artillery. Memoir upon the change of draft horses, and trials of new harness, collars, etc. The reception of steel for small arms. The origin of modern fortifications.

MARCH.—Memoir upon maneuvers and transportation of the Whitworth and Ordoñez material from Cadiz and Carraca to Torregorda. The progress of aerial navigation (continued).

Revista General de Marina.

(56 *Calle de Alcalá, Madrid, Spain, Monthly. Price U. S.* 22 *pesetas. Europe* 20 *pesetas. Single numbers* 2.50 *pesetas.*)

JANUARY, 1895.—Spanish torpedo-boat maneuvers in 1894. The gulf current. Origin of ocean currents. Vocabulary of powders and modern explosives. New notes upon the combat of the Yalu. Aid to the shipwrecked and wounded in maritime wars.

FEBRUARY.—The national flag and pendant. The manner of applying oil to allay the waves of the sea. The combat of the Yalu. The brief ideas of reform.

MARCH.—Lecture given in the Army and Navy Club upon Asia. A few lessons drawn from the combat on the Yalu. Memoir upon the Chino-Japanese war. Mats for stopping leaks. Automatic transmission of compass indications to a distant point.

Revista Cientifico Militar.

(5 *Calle de Cervantes, Barcelona, Spain. Semi-monthly. Per year* 32 *Fr.*)

JANUARY 15, 1895.—The Military Order of Santa Maria of Roncesvalles. History of partisan warfare (continued).

FEBRUARY 15.—Study upon the armament of infantry. Heavy field artillery. War dogs.

MARCH 1.—The health of the soldier. A Spanish geometer of the 17th Century.

Boletin del Centro Naval.

(438 *Alsina, Buenos Ayres, Argentina Republica. Monthly. Per year* $11.00.)

NOVEMBER, 1894.—Short historical points upon modern naval warfare (continued). Water tube boilers. Vocabulary of powders and explosives. General maritime geography (continued).

Circulo Naval,—Revista de Marina.

(*Casilla num.* 852, *Valparaiso, Chili, S. A. Monthly*).

OCTOBER-NOVEMBER, 1894.—The 6.5-mm. Mannlicher rifle. Data relating to the revolving and rapid firing guns of the Hotchkiss system. Recent naval progress. Target practice. Observations upon the different services which effect directly the operations of a squadron and the urgency of providing in its organization for higher efficiency in case of war. Official tests of some ships of our navy. A project of regulation for organization and duties of the marine guard.

DECEMBER.—The launching of the Whitehead torpedo on board the cruisers *Pinto*, *Errdzuriz*, and *Capitan Prat*. The most common practice of prevention of infectious diseases on board war ships. Launching torpedoes in a naval action.

Revista Militar de Chile.

(*Santiago, Chili. Monthly*).

JANUARY, 1895.—Fernando Von Schill. Military literature. List of members of the Military Society. The necessity for improving the means of recruitment. Points upon artillery. The 8th Infantry battalion.

Revista Militar.

(262 *Rua da Princeza, Lisbon, Portugal. Semi-monthly. Per year* 2$220)

JANUARY 15, 1895.—From 1849 to 1895.

JANUARY 31.—Colonial military organization. Military schools of gymnastics, fencing and firing in foreign countries (continued).

FEBRUARY 25.—Reorganization of the service and of manufacture and general storage of war material. A new law of promotion.

MARCH 31.—Colonial military organization.

Revista do Exercito e da Armada.

(*Escadinhas de S. Luiz* 22, *Lisbon, Portugal. Monthly. Per year, for Europe,* 300 *reis.*)

JANUARY, 1895.—Division General Joao Malaginas de Limos. General considerations upon the organization of the army. The reorganization of the service of factories and of the magazines of war material. The military velocipede.

FEBRUARY.—The military year. Cavalry. Upon combat tactics. Institutions of aid to the shipwrecked.

MARCH.—General considerations upon the organization of the army. Colonial armies. The French expedition to Dahomey, commanded by General Dodds.

Revista Maritima Brazileira.

(*Rue do Conseheiro Saraiva n.* 12, *Rio de Janeiro, Brazil. Monthly. Per year,* $10.00. *Single number,* $1.00).

JULY, 1893 to DECEMBER, 1894.—*Revista Maritima Brazileira.* The President of the republic. The minister of the navy. Auto-biography of a Whitehead torpedo (continued). The reorganization of the navy. Electricity. Construction of guns of the American system.

JANUARY, 1895.—The military defense of the port of Rio de Janeiro. The construction of cannon. The war between China and Japan. The reorganization of the navy. National navigation.

FEBRUARY.—The reorganization of the Brazilian navy. Torpedo boats. The war between China and Japan. The torpedo boat *Gustave Sampaio.*

Revista da Commissao Technica Militar Consultiva.

SEPT., OCT., NOV. and DEC., 1894.—Artillery of large caliber. De Bange system of artillery. Schneider system of field guns of 75-mm. caliber. The nitro-cellulose compounds.

Rivista di Artiglieria e Genio.

(*Tipografia Voghera Enrico, Rome, Italy. Monthly. Per year,* 30 *lira*).

JANUARY, 1895.—Notes relating to the theory of resistance of long beams subjected to a force of longitudinal compression. Progress and regress of the infantry arm. Upon the factors of fire for the quadratic law of resistance. Upon the probability of fire of the coast artillery.

An analytical discussion of the question in connection with moving targets.

The account of the artillery in combination with the other arms. The Krupp obturator for rapid-firing guns. Material of the Schneider system of rapid-firing field guns, model 1893. Experiments in firing carried out in Austro-Hungary with different kinds of bullets. A new mechanical fuze. Alloys of nickel.

FEBRUARY.—A glance at the portable armaments of Europe. The laws of resistance of the air according to thermo-dynamics. Pointing apparatus for indirect laying of siege guns. Notes upon the great maneuvers in Switzerland in 1894. The reorganization of the technical artillery in Austro-Hungary. Armor and projectiles. Couriers and scouts. The measurement of the internal pressures in guns. Wounds of the small caliber projectile. A new drawing apparatus. The Amsler tachometer.

MARCH.—Ballistic tables. A few ideas upon the manual of field fortifications. The present status of field gun questions. The elements of coast artillery fire. The theorem of Stephanos. The German field artillery maneuvers. The new instruction upon the fire training of the Russian field artillery. Fortifications of the Bosphorus and Dardanelles.

Rivista Marittima.

(*Rome, Italy. Monthly. Per year*, 25 *lira. Single number*, 5 *lira*).

JANUARY, 1895.—The condition of the Italian merchant marine. Upon the solution of problems of orthodromic navigation with special regard to the new editions of the gnomonic charts. The sporting marine in 1894. Explosive mixtures in boilers. The Madagascar question (continued). Upon the defense of our coast line.

FEBRUARY.—The corrosion of the engines and keels of ships. The navy of Cosimo I, and of his immediate successors (continued). Upon electrical fans. Points upon circum-meridian observations. The coasters of the Adriatic.

MARCH.—Naval strategy,—laws of maritime power. Upon maritime meteorology. Tests of vibration carried out with a model of a ship. Modern naval machinery. Notes and bibliography.

Archiv fur die Artillerie-und Ingenieur Offiziere.

(*Koch Strasse*, 68-78, *Berlin*, *S. W.* 12, *Germany. Monthly. Per year* 12 *M. Single number* 1 *M.*)

JANUARY–FEBRUARY, 1895.—Expression of various thoughts upon the organization of the technical arms. Upon the air resistance to projectiles with very great velocities. Upon the twist in modern artillery. Upon the history of bastions. An additional word with respect to the one firing and the figure fired at.

In this short discussion General Rohne continues his investigations with respect to the probability of hitting under various combinations of practice and circumstances. The article is replete with tables giving the probable number of hits for artillery against infantry, artillery against artillery, infantry against infantry and infantry against artillery.

MARCH.—Consideration of the various views upon the organization of the technical arms. A contribution to the firing instruction of field artillery officers.

Jahrbuecher fuer die deutsche Armee und Marine.

(*Mohren Strasse*, 19, *Berlin*, *W.* 8, *Germany. Monthly. Per year* 32 *M. Single number* 3 *M.*)

JANUARY, 1895.—In Frederick's day,—his personal care of the sick and wounded of his army. The partisan leader Frederick Von Hellwig, and his expeditions from 1792–1814 (continued). Improvised fortifications (continued). The French regulations of the 21st of March, 1893, with respect to prisoners of war. Emperor Alexander III and the Russian art of defense. French army matters in 1894. The prosperity of the nation and its readiness for war.

FEBRUARY.—The English naval maneuvers in 1894. Orderly service for the cavalry. A few remarks on the new edition of the field service regulations of July 20th, 1894. The operation of the field gun from 1815 to 1893. Military affairs in Russia. The green table of peace and the realities of war. French field artillery firing exercises in the provinces in 1894. The Russian fortress troops.

Militaer-Wochenblatt.

(*Koch Strasse*, 68, *Berlin*, *S. W.* 12, *Germany. Semi-weekly. Per year* 20 *M. Single number* 20 *pf.*)

No. 1. 1895.—Upon the training and command of cavalry (continued). Additional impressions of the artillery maneuvers. The new field service regulations (continued).

No. 3.—The instruction of the Russian field artillery in shooting (continued). Life and works of General Carl V. Grolman.

No. 4—Field artillery with horses. The new strategic roads in France.

No. 5—The mobility of the artillery; can it answer the present demand; how and where can it be aided (concluded). Corn and smaller grains as important sustenance and forage with especial regard for their value as sustenance for the army.

No. 6.—Study on the shrapnel fire of field artillery. German cavalry in 1870-71.

No. 7.—Upon Frederick's days. The militia army viewed from the other side. Upon unity of action in the infantry attack.

No. 10.—The army order of his Majesty the Emperor and King, January 27th, 1895. Order of rank list of the Royal Saxon army for 1894. Changes in organization of the army corps of the Russian army.

No. 11.—Do we need armored cruisers? The French mobilization test with two reserve cavalry regiments in October, 1894.

No. 12.—History of the north army in 1813 (continued). Plinzner and Fillis.

No. 13.—The firing regulations of the five principal armies of Europe (continued).

No. 14.—The General Commanding the III Army Corps at Spicheren and Vionville. Troop-cars, columns and trains up to the battles west of Metz. Unity of action in the assault.

No. 15.—Thoughts upon the mobility of field artillery. A contribution to the history of the years 1847-48. The combat of Asau, July 29th, 1894.

No. 16.—The pioneer service of infantry. A new field-gun.

No. 18.—War and peace exercises. The new *landwehr* in Erytrea.

No. 19.—How shall the soldier keep his feet warm in winter? Upon the annual reports of the secretaries of war and navy.

No. 20.—The march of field artillery to and on the battle field (continued). The riding school.

No. 22.—The French army exercises. Controlled or uncontrolled form of attack.

No. 23.—The jubilee of the Uhlans. The peace strength of the French batteries.

No. 24.—French horse mobilization.

No. 27.—The cavalry division in peace (continued). The combat of the Dutch upon the Lombok in 1894.

No. 30.—The scouting corps of the allies in 1813. The infantry horse in France.

Beiheft zum Militaer-Wochenblatt.

(*Koch Strasse*, 68, *S. W.*, *Berlin*, *Germany*).

No. 1., 1895.—Views of Von Moltke upon flanking movements. The movements of the reserves in battle.

No. 2.—The development, command and employment of cavalry. Johann Jacob Munsch.

Marine Rundschau.

(*Koch Strasse*, 68-70, *Berlin*, *Germany*. *Per year*, 3 *m.*)

JANUARY, 1895.—The naval expedition against Morocco. Safety contrivance for the avoidance of wear and tear of the machinery and the protection of the stokers from scalding by steam (continued).

FFBRUARY.—Study of the history of sea warfare. The sea conflict of Hai-yun-tan (Yalu).

Allgemeine Militaer-Zeitung.

(*Darmstadt*, *Germany*. *Semi-weekly*. *Per year*, 24 *m.*)

No. 1, 1895.—The new year. The status of the military *Capellmeister* in the German army. The new French field ration.

No. 2.—The military condition of the Kingdom for 1895-96. The importance of the Russian language for German officers. An English opinion of the Chinese generals.

No. 4—The royal Saxon army. The times of Hesse-Darmstadt, 1760–62. The firm of Ludwig Löwe and Company, Berlin (continued). Prince Blücher and the Jena bridge in Paris, 1815.

No. 5.—The vindication of the Prince of Prussia as army commander after the rout at Kolin, on the retreat through Lusatia (continued). Japanese war maps.

No. 6.—Upon the snow shoe exercises.

No. 7.—The Emperor's birthday.

No. 8.—Discipline (continued).

No. 9.—The new French war minister, General Zurlinden.

No. 19.—A contribution upon the knowledge of the German army in the time of Ludwig XIV.

No. 20.—Upon the celebration of the sixty years military service of his Royal Highness, Prince Luitpold, of Bavaria.

No. 21.—A naval victory. Women and war.

No 22.—Emperor William II. The naval celebration at Kiel, and Jules Simon. The effect of the small caliber projectile in the Chino-Japanese war.

Kriegswaffen.

No. 8, Vol. vi.—Breech screw mechanism for breech-loading guns. A new device for the cylindrical breech mechanism of the rifle. A projectile with a high explosive charge.

Schweizerische Zeitschrift fuer Artillerie und Genie.

(*Frauenfeld, Switzerland. Monthly. Per year* 8 *Fr.* 20 *centimes.*)

January, 1895.—Summary of the average results of the firing exercises in the schools and courses of artillery, 1894. Train organization of army corps. Behavior of the guns and ammunition in the schools and courses, 1894.

February.—Notes upon our artillery. The 8th Artillery brigade at the maneuvers of the 4th Army Corps. A new field glass.

March.—Notes relative to our artillery. The purchase of artillery horses. Budget reduction. Small arms.

Monatschrift fuer Offiziere Aller Waffen.

(*Frauenfeld, Switzerland. Monthly. Per year* 5 *Fr., plus postage.*)

January, 1895.—Military training. Maneuvering against an assumed enemy and against an opposing one.

February.—The Chino-Japanese war (continued). The Chinese management of the war and the battle of Ping-Yang (continued). Something upon the fourth half battalion of the German army and the ten years service.

March.—Division and corps cavalry.

No. 23.—A view of the proportions of Austro-Hungarian army service.

No. 25.—The 80th birthday of Prince Bismark.

Allgemeine Schweizerische Militaer-Zeitung.

(*Basel, Switzerland. Weekly. Per year,* 8 *Fr.*)

JANUARY 5, 1895.—Harmony in military affairs. Military news from Italy.

JANUARY 12.—Why does not the man in the bullet-proof blouse fall when the armor is struck by the shot? Infantry and artillery in Switzerland and its neighboring states.

JANUARY 19.—French expedition against Madagascar. Reports upon drills and exercises during the Winter season (continued).

JANUARY 26.—The war situation in China.

FEBRUARY 2.—Military report of the German Empire, January 17, 1895.

FEBRUARY 9.—Military matters in Italy. Snowshoe exercise and its necessity.

FEBRUARY 16.—Discipline or destruction (continued).

FEBRUARY 23.—The French court martial.

MARCH 2.—Archduke Albert.

MARCH 9.—The capture of Wei-Hai-Wei.

MARCH 16.—The new army reorganization in Denmark. Military notes from Italy.

MARCH 23.—The French maneuvers for 1895. Military news from Italy.

Mittheilungen ueber Gegenstaende des Artillerie und Genie-Wesens.

(*Wien, VI, Getreidmarkt* 9, *Austria. Monthly. Single number* 1 *Fl.* 50 *Kr.*)

No. 1.—Further considerations upon the elementary theory of fork-movements.

Relates to an analytical treatment of the variations and movements of the fork under variable conditions.

Provisional fortifications. Data upon forty Russian balloon wagons.

No. 2.—The admissibility of indirect fire in siege warfare. Remarks upon modern explosive preparations with respect to explosion at varying temperatures. The patent and its military interest.

No. 3.—A military range finder. The employment of the technical troops in the great army maneuvers of 1894. Indirect sighting methods of the Italian field artillery. Automatic apparatus for blowing up hostile trains.

Mittheilungen aus dem Gebiete des Seewesens.

(*Pola, Austria. Monthly. Per year,* 12 *marks*).

No. 1, JANUARY, 1895.—Speed and capacity for "going about" in maneuvers. The events of the naval war in Eastern Asia, including the battle of the Yalu. The electric signal telegraph (system Pabel-Schaschl).

No. 2, FEBRUARY.—His Majesty's ship *Kaiserin und Königin Maria-Theresa.* The English naval maneuvers for 1894. The French naval maneuvers for 1894. A method for determining astronomical points without the use of logarithms. The defensive works of Tarentum. The Corinth ship canal. The Italian battle ship *Re Umberto.* The English battle ship *Magnificent.* The torpedo boat destroyers *Ardent, Conflict* and *Dragon.*

Organ der Militaer Wissenchaftlichen Vereine.

(*Wein I, Stauchgasse No.* 4, *Austria. Per year,* 6 *Fl.* 8-14 *mumbers per year*).

No. 1.—The Russian small arm. The present status of fortification questions. Researches upon the tactics of armies in masses.

No. 2.—The battle of Dettingen, June 27, 1743. A word upon the formation and tactics of infantry.

No. 3.—Small caliber and the question of wounds. The Caucasian Cossack brigade in the Balkan campaign of 1877–78.

No. 4.—Upon the theoretical education of officers and cadets. Notes upon new works in the domain of photography and the modern process of reproduction.

The Engineer.

(33 *Norfolk Street, Strand, London, England. Weekly. Per year* 2£ 6*d.* *Single copies* 6d.)

JANUARY 4, 1895.—Third class torpedo-boats U. S. Navy (continued). The engines of the *Blanco Encalada.* Chinese criticism of Chinese war policy. H.M.S. *Magnificent* and *Majestic.* War material.

JANUARY 11.—The Simplon tunnel (continued). Mountain railways. Continuous current hinged pole piece dynamo.

JANUARY 18.—Science in 1894. The midship section of H.M.S. *Magnificent*. Acetylene as an illuminant.

JANUARY 25.—The French battleships *Magenta* and *Hoche*. Branet's rock drills. Phosphorescence and photographic action. Modern electricity.

FEBRUARY 1.—On the calculation of frame works with superfluous parts (continued). The Thompson-Marsden recorder. The machinery of our ships of war. Japanese guns at Yalu. Launches and trial trips.

FEBRUARY 8.—Argon.

This is the name given to the new constituent of the atmosphere, recently discovered by Lord Rayleigh and Professor Ramsay. It is considered that the existence of this element in the atmosphere is now settled beyond reasonable doubt.

The floating of H. M. S. *Majestic*. An improvised cartridge closing machine. The *Baden* Krupp gun accident.

A brief note explaining away the error made in published accounts of this affair. It appears that, contrary to the first account, the gun did not burst at all, and that the accident was caused by a premature ignition of the charge—while being inserted into the chamber. The gun was in no way injured except by the breech-block being blown off.

FEBRUARY 15.—Destruction of the Chinese war ships at Wei-Hai-Wei. Priming and governing engines.

FEBRUARY 22.—The life of railway axles. Recent development of coal mining in Japan (continued). American naval comments on the battle of the Yalu river.

MARCH 1.—A new great northern engine. A remarkable boiler explosion.

MARCH 8.—The utilization of Niagara. The admiralty distribution of naval engineers in the fleet. The navy estimates. Engineers and ships of war.

MARCH 15.—The navy estimates. Protection for gun crews on British and French ships.

MARCH 22.—Iron and steel at welding temperatures. Forty H.P. oil engine. Electrical tramway with underground conductor.

MARCH 29.—Light railways in Belgium. Waves and vibrations. A comparison of the battleships *Magnificent* and *Charlemagne*.

Engineering.

(35-36 *Bedford St., Strand, London, W. C., England. Per year,* 2£ 6*d. Single copy,* 6½*d.*

JANUARY 4, 1895.—The Blackwall tunnel. Thames bridges (continued). French second-class cruiser *Latouche Tréville*. The *Capitan Prat*. French railway servants. Application of electricity to working ship turrets (continued). Direct production of electricity from gas. The Berlin-Vienna long distance telephone.

JANUARY 11.—Hydraulic machinery for ships' turrets. Nebraska City bridge. The port of London. Post-office telegraphy. Electric traction (continued). The cost of electric power. The extension of railways in India. Mountain railways. Blast furnaces of the United States. Shipbuilding and marine engineering in 1894.

JANUARY 18.—The draining of the Zuyder Zee. The steam life-boat "City of Glasgow," 50 horse power gas engine.

JANUARY 25.—The Schmidt motor. Fowler's safety valves. James Watt and ocean navigation. Duplex high speed gas engine. On relative tests of cast-iron.

FEBRUARY 1.—Statically indeterminate structures and the principle of least work. The coming naval estimates. The cost of the French navy.

FEBRUARY 8.—The Blackwall tunnel. Early Atlantic steamers. The corrosion of iron and steel. Governing steam engines. Results of evaporative tests on land boilers.

FEBRUARY 15.—The new Nordenfelt guns (continued). The pneumatic pyrometer. The cost of vessels of the naval defense act. The appliances of fire brigades. Coast protection in Holland. Determination of the dryness of steam.

FEBRUARY 22.—Hadfield's steel foundry. The Hoxton boiler explosion.

MARCH 1.—Comparison between modern standard systems of quick firing field artillery of 75 mm. (2.97-inch) caliber. London water supply. Naval maneuvers. The propogation of magnetism. The machinery for warships. The determination of the dryness of steam.

MARCH 8.—Irrigation in Peru (continued). Short air-space dynamos. The 27-knot torpedo boat destroyers. Naval estimates. The *Rocket* and the *Shark*.

MARCH 15.—The Blackwall tunnel. Statically indeterminate structures and the principle of least work. Navy estimates. Balancing of locomotives.

MARCH 22.—The making of a bicycle. Armored turrets for coast defense. The navy in Parliament. Combined engine and dynamo.

MARCH 29.—The Blackwall tunnel. French railways and the state. The power absorbed by rope and belt transmission. Strength of rings.

Engineering Review.

(29 *Great George Street, London, S. W., England. Monthly. Price single copy* 7½*d.*)

JANUARY, 1895.—Engineers of to-day and yesterday (continued). Recent growth of electrical engineering. Civil, mechanical, electrical, mining and metallurgical engineering in 1894. Digest of current engineering literature. Engineering industries of Glasgow.

FEBRUARY.—Nickel steel, its special value for armor. A modern African gold extracting plant.

MARCH.—The works of Charles Cammell & Co., Sheffield, England.

Description of the works and considerable space given to the manufacture of armor and the tests to which it has been subjected.

Recent progress in electrical engineering. A new patent excavator. A rapid cargo transporter. The tube manufacturing industry in Scotland. The Rudlie air compression system. Storage batteries.

Aldershot Military Society.

(*Gale & Polden*, 2 *Amen Corner, Paternoster Row, London England. Single copy* 6*d.*)

NOVEMBER 13, 1894.—The role of cavalry as affected by modern arms of precision.

DECEMBER 11.—Umpiring at field maneuvers as practised by various foreign nations.

JANUARY 22, 1895.—How far the lessons of the Franco-German war are now out of date.

Arms and Explosives.

(*Effingham House, Arundel Street, Strand, London, W. C., England. Monthly. Per year* 7 *s. Single copies* 6*d.*)

JANUARY, 1895.—Size of grain in blasting powders. Explosives and their modern development. The Spanish Mauser rifle. U. S. Navy report, 1894. Testing safety explosives in Westphalia. Fuse for projectiles. Detonating compounds for shells. A magazine rifle. Smokeless explosives. Improved process of imitating cellulose.

FEBRUARY.—Gunmakers and the chamber of commerce. Service ammunition for small arms. Carrier pigeons in war. Manufacture of cordite in India. The cost of a gun. Safety explosives and the north of England report. Lancaster's cartridge turn-over machine. Revolver shooting in Piccadilly. Measuring pressures in bores of guns (continued). The magazines of modern military rifles. Cartridge filling machine. Time and percussion fuze. New system of hammerless gun.

MARCH.—Pistols legislation up to date. Cartridges for quelling riots. Austrian Small Arms Company. Driggs Schroeder rapid firing gun. Colt's Besley revolver, model 1893. Mannlicher automatic rifle.

United Service Gazette.

(4-6 *Catherine St., Strand, London, W. C., England. Weekly. Per year,* 1*£* 10*s* 6*d. Single copies* 6*d.*)

JANUARY 5, 1895.—The surgical significance of small caliber rifles (continued). British seamanship. Selection V. Seniority in the army medical staff. Royal military college, Sandhurst. Naval retrospect for the past year. The army record for 1894.

JANUARY 12.—Results of target practice in India. Home district rifle meeting. The navy league. Mr. Robertson on the navy. Musketry in India. Recollections of the China war of 1859-60.

JANUARY 19.—The military systems of America. Army rifle association. A seaman's chaplain. The personnel of the navy—expansion in war time. Musketry experiments in India. The field practice association.

JANUARY 26.—Traveling claims. The report on last year's cavalry maneuvers (continued). Lessons of the Franco-German war. The health of the navy (continued). Power of mounted troops in war. Marriage in the army.

FEBRUARY 2.—The death of Marshal Canrobert. Defeat of the Somalis in British East Africa. Instruction at the schools of musketry in India, 1893. The Indian medical service. Volunteer non-commissioned officers.

FEBRUARY 16.—Extemporized rafts. China and Japan. Facing odds. What is a sufficient navy? A mutiny averted.

FEBRUARY 23.—The Halpine dirigible torpedo. The Royal United Service Institution. Naval reserves. Health of the army.

MARCH 2.—The prospects of the national rifle association. Field fortifications in modern war. The naval maneuvers,—umpire's report. Fighting on the Niger. How can the navy be made ready for war? The cavalry maneuvers for 1894. Plevna, 1877-78.

MARCH 9.—The army estimates. The navy estimates (continued). Heavy guns in fortress defense. The health of the army. Artillery practice in 1894. The north-west frontier of India.

MARCH 16.—Appliances for crossing rivers and landing troops. Army recruiting. Naval policy. Training of British officers.

MARCH 23.—The military use of collapsible boats. The employment of soldiers. The Royal dockyard. The requisite strength of our navy. The army estimates debates. Practice of horse and field artillery in 1894. War duties of the soldier.

MARCH 30.—The volunteer force. Field artillery fire and Okehampton experiences. Chitral, Hunza and the Hindu Kush. Our small wars. The future of field artillery. The manning of our navy.

Journal of the Royal United Service Institution.

(17 *Great George Street, London, S. W., England. Monthly. Single number one shilling.*

JANUARY, 1895.—The Austro-Hungarian maneuvers, 1894 (continued). The vicissitudes of regimental colors (continued). Notes on the Lee-Metford rifle. Water tube boilers. Naval and military notes.

FEBRUARY.—The national flag. An account of the operations on the Benin river in August and September, 1894.

MARCH.—Battles of Chillianwalla and Goojerat. From Leicester to Langport in 1645. The army during the revolution, 1789-94. Fortifications since the introduction of high explosive shells.

Journal of the United Service Institution of India; Simla, India.

No. 118, 1894.—On facing odds. Extemporized rafts. The Franco-Austrian campaign of the 29th of April to the 4th of June, 1859. On the details of ammunition supply in the field.

No. 119.—The breeding stud of an Indian Prince. Notes on cavalry. The training of railway volunteer corps. Rough scheme for the formation of a reserve of veteran battalions with view to the improvement of the fighting efficiency of the native army of India. A scheme for the reorganization of the field troops of the British and Indian armies in compliance with imperial needs. On the tactical training in district concentrations best fitted for preparing the army of India for war.

Army and Navy Gazette.

(3 *York Street, Covent Garden, London, England. Weekly. Per year £1 12s 6d. Single copy 6d.*)

JANUARY 5, 1895.—The past military year. The distribution of the fleet. China and Japan. "*Ultima ratio.*"

This paper relates to the present conditions of the European and colonial questions, gives statistics relative to the armies of the great powers of Europe and the insufficiency of England's army, and advocates compulsory service or giving up protection of the colonies by the home government.

The Pamirs. The royal marine light infantry. Imperial federation and defense. India. The Highland brigade in India.

JANUARY 12.—The Indian army reorganization. Madagascar. The Wei-Hai-Wei affair. Rules of the road at sea. Degradation of Captain Dreyfus. Australian horses. The colonels' list. The staff college. Selection in 1894.

JANUARY 19.—Musketry in India. Inflammable decks. Army sanitation. The field practice association. Field firing in India.

JANUARY 26.—War lessons in peace time. Naval engineering. Navy notes. Waziristan. Cavalry maneuvers. The capture of

Pekin, 1859-60. Army organization. The Pamirs. Aid to the wounded. The soldier's rations. Recruiting in Scotland. Lord Randolph Churchill. Mobilization. Death of Colonel Money.

FEBRUARY 2.—The cavalry maneuvers. The defeat of torpedo attack. The evolution of torpedo craft. The *Majestic*. The defense of London. Our cavalry in India (continued). Marshal Canrobert. Cavalry expenses. Employment of old soldiers. Musketry experiments. The Waziristan expedition.

FEBRUARY 9.—The shipbuilding program. The Bengal army. The defense of London. India. Lord Menthen's experiment.

FEBRUARY 16.—The Indian cavalry camp. The Dardanelles. Army remounts. The militia in 1895. Small bore experiments. India.

FEBRUARY 23.—The conquerer of Custozza. The persistence of error. Plevna, 1877-78. The rising of the Niger. Musketry in the home district. Musketry in the army. Our position in Egypt. Soldiers and rioters. The soldier's load. India.

MARCH 2.—Army remounts. Fleets in the far East. Fighting on the Niger. Machine guns for India. The late Archduke Albert. Field fortification. Egypt. The status of the soldier. The Waziri expedition. India.

MARCH 9.—The 1895-96 reliefs. Military functions of the navy. The navy estimates. In aid of the civil power. Cavalry expenses. Ismail Pasha and the Soudan. The ordnance store department. The army estimates.

MARCH 16.—The army estimates for 1895-96. Admiralty administrative reform. The Kashmir frontier. The Duke of Connaught. Army recruiting. The training of officers. British officer's expenses. Egypt, 1869-1895.

MARCH 23.—Army recruiting. Little England and the navy. The loss of life at sea. The militia. Boats for military purposes. The difficulty in Chitral, India.

MARCH 30.—Field Marshal Sir Patrick Grant. The straits settlements difficulty. Cavalry maneuvers. The new forest maneuvers. Field artillery fire. The services in parliament. Indian frontier policy. The Chitral expedition.

Journal of the Military Service Institution.

(*Governor's Island, N. Y. City. Bi-monthly. Per year* $4.00. *Single copy* 75 *cts.*)

NOVEMBER, 1894.—A paper on military libraries. The new small caliber rifle. The multiplication of calibers. Book-keeping for post exchanges. Non-existence of martial law proper. The military service of Indians. The proposed deep waterway. The Mexican Army.

JANUARY, 1895.—The Military Academy. Reform in the Quartermaster's Department. Physical training in the British Army. Artillery practice at Shoeburyness. Thoughts on methods of attack. Principles and practice of saddling. Field music. A bit of history.

MARCH.—Discipline in the U. S. Army (prize essay). Preliminary examination—West Point. From the Great Lakes to the ocean. The Royal Artillery College at Woolwich. The infantry drill regulations.

The Engineering News.

(*Tribune Building, New York City. Weekly. Per year* $5.00. *Single copies,* 15 *cents*).

JANUARY 3, 1895.—Track laying by machinery. Comparative values of coarse and fine sand for cement and mortars. Ball bearing axles for wagons and carriages.

JANUARY 10.—Comparative fuel consumption on electric and steam railroads.

JANUARY 17.—The Reno rapid-transit system. The heat value of Western coal.

JANUARY 24.—The Leuhrig gas-motor for street railways. The Puget Sound dry dock, Port Orchard, Washington. Fire-proofing processes and paints. Chemical methods of preventing and extinguishing fires.

JANUARY 31.—Rustless coatings for iron and steel. Steel axles. Small caliber rifles. Movement of water over a dam with wide horizontal top.

FEBRUARY 7.—A bridge works rules for drafting room work. American types of movable dams and their development. Preservative works for iron work. The engineer's plans for a New York rapid transit railway. Test of a locomotive using oil fuel.

FEBRUARY 14.—The Illinois and Mississippi canal lock works. Specifications for structural steel. Can we make it rain? Recent experiments on wind pressure. The weight and power of rain. The proposed Montreal bridge.

FEBRUARY 21.—The Van Buren street rolling lift bridge. Materials for hydraulic concrete and the best methods for mixing. The development of percolating underground waters. Municipal engineering in Indianapolis, 1894. The McPherson switch and movable frog. Reasonable railway rates. Gauging the discharge of the Niagara river. The electric motor in the machine shop.

FEBRUARY 28.—Tests for steel bridges.

MARCH 7.—Tests for a new design of electric railway power station. Specifications for a suspension bridge over the Hudson river at New York.

MARCH 14.—A new Darien ship canal route. Transverse strength of Douglas fir. Storage batteries in an electric railway power station. Wind pressures in engineering construction.

MARCH 21.—The new underground electric railway in Buda-pest. Diagram of comparative weights of railway bridges. Tests of lap welded iron pipe. Stopping the flow of water in a drill hole. Damp-proof and fire-proof construction for mills. Recent progress in railway car lighting. Underground or elevated construction for the New York rapid railway. Adapting the bear trap gate to canal locks. The Ferris wheel analysis in modern framed structures. Buff and Berger's reversion level. Casting rail joints solid for continuous rails.

MARCH 28.—Comparative test of building-stones. Rate of evaporation in fire-engine boilers. Wind pressure and suction. A simple method of preventing hydrants from freezing.

American Engineer and Railroad Journal.

(47 *Cedar Street, New York City. Monthly. Per year* $3.00. *Single copy* 25 *cts.*)

January, 1895.—The machinery of warships. Some tests relative to the introduction of steam. A steam inspection car. Compound locomotive on the Paris, Lyons and Mediterranean railway. Water-tube boilers and their application to war vessels (continued). Captive balloons. The problems of aerial navigation. Hydrogen gas apparatus for the U. S. signal service.

Voyage of the balloon *Svea* at Stockholm, October, 1893. Balloons in the British Army.

FEBRUARY.—Early days of the iron manufacture. Railways and Engineering in Japan. Aerial railways. Logging railways. The Western Siberian railway. Report of board of railway commissioners, state of New York. A shipment of mortar carriages. Schmidt's superheated steam boiler and engines. Aeronautical notes. U. S. war balloons.

MARCH.—Engines for the St. Gothard railway. The Friedeberg apparatus for burning coal dust. The U. S. armored cruiser *Maine*. The gas motor street car in Germany. The Joy valve gear. Physical reasons for rapid corrosion of steel boiler tubes. The deterioration of locomotive and marine boilers due to expansion, and means of lessening the same. The cruiser *Cincinnati*. Tests of the pneumatic guns. The electric motor in a boiler shop.

The Iron Age.

(96–102 *Reade Street, New York City. Weekly. Per year* $4.50. *Single copy* 10 *cts*.)

JANUARY 3, 1895.—Colmè's leak arrester. A new type of shell for the British service. Tests of bridge material.

JANUARY 17.—British ship building in 1894. Fluctuations in the prices of finished iron and steel (continued).

JANUARY 24.—Steam trials of warships.

JANUARY 31.—Effects of different elements on cast-iron. Open-hearth steel. Vauclain apparatus for counterbalancing wheels.

FEBRUARY 7.—The big wheel at Earl's Court, London. Comparison of basic and acid steel rails. Present condition of Niagara Falls power plant. The best metal for field magnet frames. Electric furnace for heating iron strips. A Pompeiian boiler.

FEBRUARY 14.—Electrically driven angle iron shearing machine. Electric power transmission.

FEBRUARY 21.—Mesuré and Nanel's optical pyrometer electric motor in the machine shops.

FEBRUARY 28.—The solubility of basic slag. Tests of bridge steel.

MARCH 21.—The Bristol recording ampère meter. Electric annealing of armor plate. The Carnegie armor plate test.

Engineering and Mining Journal.

(253 *Broadway, New York City. Weekly. Per year* $5.00. *Single copy* 15 *cts.*)

JANUARY 5, 1895.—The iron trade in 1894. New York metal market in 1894. The McGeorge gas engine.

JANUARY 12.—U. S. geological survey. Mineral productions of New Zealand. New process (Mond's) of obtaining chlorine. A new device for making pipe-joints tight.

JANUARY 19.—Mineral productions of Idaho. Copper productions of 1894. The British iron and steel market. Australian coal.

JANUARY 26.—Production of pig iron in 1894. The U. S. geological survey. Gold production at home and abroad. The Leadville gold belt. The condition of carbon in steel. The present and prospective development of electric tramways. Nitrate in Egypt.

FEBRUARY 2.—The use of compressed air. The mineral industry of Italy. The Walker-Wilkins non-polarizing voltaic battery.

FEBRUARY 9.—The theory of the suspension bridge. Ancient coinage of China. The minerals of Brazil.

FEBRUARY 16.—The gold movement for four years. The Schafer-Heinemann storage battery. The Dixon hand drill.

FEBRUARY 23.—British vs. American iron and steel. The gradient telemeter level.

MARCH 2.—A new electric mine hoist.

MARCH 9.—A new short arm analytical balance.

MARCH 16.—Uehling's pneumatic pyrometer.

MARCH 30.—The physics of cast-iron.

Electric Power.

(36 *Cortlandt St., New York. Monthly. Per year,* $2.00. *Single copy,* 20 *cts.*)

With the beginning of the year this periodical has changed its form from a quarto number of about 40 pages to an octavo pamphlet of 96 pages. The change is certainly an improvement as regards appearance and convenience. The typographical work of the magazine is fascinating, its clear print and illustrations being a pleasure to the eye. The following are the principal articles published.

JANUARY.—Electrical transmission at Niagara Falls. Theory of electrometallurgy (continued). Training of the electrical engineer. The uses of paper as an insulator. Wanted an expert fireman. Conduit *versus* trolley (continued). American Institute of Electrical Engineers. Electric telegraphs.

FEBRUARY.—Notes on the protection against lightning collected during the summer of 1894. Training of the electrical engineer. Some hints and some errors in electric construction. A critical resumé. Municipal plant statistics. Electrical transmission at Pardenone. Editorial and financial notes.

MARCH.—Action at a distance. Reminiscences of some early experiments in long distance telegraphy and telephony. Constancy of the rotary magnetic field. On the uses of paper as an insulator for electrical conductors. Conduit *versus* trolley. Practical testing. Electricity the underwriter's friend. Motor installation in an African wine factory. Table of magnetic values.

The Engineer.

(106 *Fulton Street, New York City. Semi-monthly. Per year* $2.50. *Single copy* 10 *cts.*

FEBRUARY 2, 1895.—Shearing stress on crank pins. Engineering lectures at the Naval War College, Newport, R. I. Liquid fuel.

Electrical Engineer.

(203 *Broadway, New York City. Weekly. Per year* $5.00. *Single copy* 10 *cts.*)

JANUARY 16, 1895.—Niagara to-day. Professor Rowland's electro-static voltmeter. Transmitting pictures by electricity.

JANUARY 23.—The Rowland immersed electro-static voltmeter.

MARCH 6.—On the delineation of alternating current curves when the alternator is not accessible. Recent electrical developments in France and England. Niagara power.

Public Opinion.

(*Washington, D. C. Weekly. Per year,* $2.50 *Single copies,* 25 *cents*).

JANUARY 10, 1895.—Alsace-Lorraine and peace. The Armenian commission. The Pamir question settled. For and against state militia.

JANUARY 17.—The proposed cable to Hawaii. The truth about the Port Arthur affair. Mexico's progress. The telautograph. A new constituent of the atmosphere.

JANUARY 24.—Military systems of Europe and America. The Hampton extradition case. The United States as mediator. The surrender of the two Japanese students. From Casimir Perier to Faure. Royalist uprising in Hawaii.

JANUARY 31.—The young Czar and his advisers. Mexico and Guatemala. The situation in France. A scientific study of mobs. A notable discovery in electricity.

FEBRUARY 7.—Governor McKinley sustains Col. Coit. The Armenian question. The Japanese in Hawaii. New weapons of the United States army.

FEBRUARY 14.—How to repel train robbers. Liliuokalani. Strikes and how to prevent them. Our military strength. How to save the forests.

FEBRUARY 21.—The question of Alsace-Lorraine. Elements of danger in France. Germany bi-metalism. Russian nihilism up to date. United States of South Africa. Lincoln the first American. A side light on Napoleon.

FEBRUARY 28.—The Hawaiian cable. Stepniak's Russia. The week in parliament. The prosperity of France. Germany's colony building. The partition of Africa.

MARCH 14.—Appropriations of the last three Congresses. The Nicaragua canal investigation. The truth about Port Arthur. Military drills in the schools. Argon. Why the Napoleonic "craze"?

MARCH 21.—The affair of the Aliança. New Orleans and the Walsenbury riots. The Baltic canal.

MARCH 28.—Japan: its present and future. The Reichstag and Bismark. The true continental danger.

The Army and Navy Journal.

(*Bennett Building, New York City. Weekly. Per year* $6.00. *Single copy* 15 *cts.*)

JANUARY 5, 1895.—England as mistress of the sea. Fiske range finder. Grounding of the *Cincinnati*. Reorganization of the army. Why should we increase the army? Shooting out an Indian difficulty.

JANUARY 12.—Napoleon and Wellington. Discipline at the Naval Academy.

JANUARY 19.—The Japanese in China. The Yellowstone Park. Short sighted economy. Admiral Meade and the department.

JANUARY 26.—The Hawaiian situtaion.

FEBRUARY 2.—Army uniform. The weapons of the new army. The army in pulpit and forum. The fast cruiser *New York*. Army reorganization.

FEBRUARY 9.—General Wolseley on China. The grade of Lieutenant General. A service corps proposed. Coddling deserters. Winfield Scott Hancock. The new power of the west. Navy yard ships.

FEBRUARY 16.—Report of the Inspector General. Rules of the road at sea. A lesson at Wei-Hai-Wei.

FEBRUARY 23.—A service corps. Japanese and Chinese artillery. Americans in Japan. Target practice and discipline.

MARCH 2.—Medical corps of the navy. New naval vessels and their assignment. New vessels for the navy. Japan, England, and the United States. Uniform for garrison and field. The new rifle. More men for the navy. Signaling for the army and navy.

MARCH 23.—Substitutes for wood in navy vessels. Plans for new gunboats. The United States and new Japan. The new rifle approved.

MARCH 30.—International obligations. Cruise of the *Chicago*. Turkey's army and navy.

Marine Review.

(*Cleveland, Ohio. Weekly. Per year*, $3.00).

JANUARY 10, 1895.—The new tonnage for 1895.

JANUARY 17.—Passing signals in fog.

JANUARY 24.—Calculations on the horse-power and speed of ships.

JANUARY 31.—The new torpedo boats. Pleading for more torpedo boats.

American Manufacturer.

(*Pittsburg, Pa. Weekly. Per year*, $5.00. *Single copies*, 10 *cents*).

JANUARY 11, 1895.—Blast furnace reactions. Blast furnace gas as a motor. Failure of steel through segregation. Explosions in coal mines. Gas by electricity.

JANUARY 18.—The French two-seas canal. What explosives should be used in a mine. Gas from explosions in mines. The normal glass. Reduced cost of iron and steel production.

JANUARY 25.—The Baltic and North Sea canal. A new direct process. Steel for ship-building. Artificial production of gas as a fuel. A 320 H. P. gas engine.

MARCH 1.—Elements in cast-iron. The latest armor tests.

MARCH 22.—Recent progress in steel manufacture. Electric welding. Welding of iron and steel. Nickel steel. Material for hulls of ships. British iron and steel exports to the United States.

The Scientific American.

(361 *Broadway, New York City. Weekly. Per year* $3.00. *Single copy* 10 *cts.*)

JANUARY 5. 1895.—Torpedo-boats for the cruiser *Maine.* Nine hundred horse-power compound engine. The light of the future. Japanese troops. Improved gatling gun. U. S. battleship *Indiana.* American armor plates. Army ordnance factories. Sub-marine detectors.

JANUARY 12.—The forests of the national domain. Problem in railroad transportation—carrying big siege mortars to Fort Point. The bearing power of various soils as foundations. The battle of the Yalu river. The return of the Columbian relics by the U. S. S. *Detroit.*

JANUARY 19.—The new warships *Texas* and *Oregon.* The type-writer telegraph. Needed increase of the army.

JANUARY 26.—American fire arms in Germany. The telautograph in Europe. Military science at Yale University. Repairing Chinese warships. Bridge of concrete.

FEBRUARY 2.—Large angle sextant. Professor Löwe's experiences in a balloon.

Cassier's Magazine.

(*World Building, New York City, and* 33 *Bedford St., Strand, London, W. C., England. Monthly. Per year,* $3.00. *Single copies* 25 *cents*).

FEBRUARY, 1895.—Electricity in textile manufacturing. Recent American direct-connected engines and dynamos. Something about fire-engines. Direct electric-driven machines. Tubed gears, or ropes and belts of to-day. Combined efficiencies of mechanical and electrical machinery.

MARCH.—A twelve-mile transmission of power by electricity. Locomotive cranes. A remarkable steam-engine performance. Town refuse for steam raising. Modern boiler making. Electric cooking and heating.

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VOL. IV. No. 3 JULY 1895. WHOLE No. 16.

EXPERIMENTS WITH A NEW POLARIZING PHOTO-CHRONOGRAPH, APPLIED TO THE MEASUREMENT OF THE VELOCITY OF PROJECTILES.

BY

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ASSISTANT PROFESSOR OF PHYSICS, DARTMOUTH COLLEGE,

AND

DR. GEORGE OWEN SQUIER,
FIRST LIEUTENANT, THIRD ARTILLERY, U. S. A.

INTRODUCTION.

The experiments forming the subject of this paper were conducted between the dates of the 27th of December, 1894, and the 12th of January, 1895, at the United States Artillery School, Fort Monroe, Virginia. This time was chosen because it came during the holiday vacation, and was the only time that either of us could devote uninterruptedly to the work. The object in making these experiments was to test a new instrument as applied to the measurement of the velocity of projectiles. In May, 1894, a paper* was read by one of us at the general meeting of the American Institute of Electrical Engineers in Philadelphia.

* "*A Reliable Method of Recording Variable Current Curves*," by Dr. A. C. Crehore.
Transactions of the American Institute of Electrical Engineers, October, 1894.
The Physical Review, No. 2, Vol. II, 1894.

This paper described a new method for measuring any kind of a variable electric current, no matter how sudden or abrupt the change in the current. The superiority of this instrument over other known methods of measuring currents is due to the fact that in recording a variable current, no *ponderable matter* is required to be moved as is the case with all other instruments for this purpose. Many examples of other instruments might be mentioned, but in each case a certain amount of ponderable matter possessing inertia is required to be moved, as for instance when a telephone is used upon the disc of which is mounted a mirror that permits a beam of light to be reflected from it; any vibration of the disc gives an angular motion to the beam of light, and this motion is in turn recorded upon a moving photographic plate. In this instance the matter which is required to be moved is the disc and the mirror mounted upon it. When the current varies it is compelled to *do work* in moving the disc on account of the inertia of the moving part. As a consequence of this, the motion of the beam of light lags behind the position it should occupy to accurately represent the current. To express this in other words, we may say that an unavoidable difficulty is introduced because the forced oscillations of this "ponderable matter," however small in amount, become so superimposed upon those of the current which it is desired to measure, that they are inseparably mixed together. and the record does not show the true current but the resultant vibrations of the instrument. That this is the case with the method of the telephone above referred to has been established beyond a doubt, it seems, by experiments conducted at Cornell University by Mr. Henry Floy. Other examples of instruments for this purpose might be mentioned: such as a wire carrying a variable current which is deflected in a magnetic field or a small stream of mercury which is so influenced; but in each of these instruments it is noticed that an appreciable amount of ponderable matter is required to be moved.

It may not be evident at a glance what the relation is between an instrument which will accurately measure a variable electric current and the measurement of the velocity of projectiles. In regard to this it may be said that any good instrument for measuring a variable current, possesses the essentials of a chronograph, and a chronograph is the essential instrument for measuring the velocity of projectiles. A good current measurer must give sufficient data to construct a curve, the horizontal axis representing time and the vertical axis the current. The time intervals between any phenomena can therefore be measured by such an instrument, if the phenomena referred to are capable of either interrupting the electric current or changing its strength in any way.

Upon the publication of the October number of the *Transactions of the American Institute of Electrical Engineers* which contained the article referred to, it occurred to one of us, who was at the time considering means for improving the known methods of measuring the velocity of projectiles, that this instrument would be well adapted for the purpose. This led to correspondence between us, one being at the Artillery School, Fort Monroe, Virginia, and the other at Dartmouth College, Hanover, New Hampshire. It was decided to undertake these experiments if possible at the earliest opportunity, and accordingly authority was sought and obtained from Colonel Royal T. Frank, Commandant of the Artillery School, for the necessary ammunition and the use of the resources of the laboratories of the school for the prosecution of the work, and it was to his support and encouragement throughout that these experiments were made possible. Preparations for the experiments were immediately begun at each place. A temporary proving ground was fitted up about seventy-five yards distant from the laboratories of the Artillery School, and the necessary ballistic lines and screens installed for operating two Boulengé instruments. At Dartmouth College where the original apparatus was prepared, a special camera was made which is described later, and the whole instrument was shipped to Fort Monroe on December 19.

For the purpose of a chronograph the original instrument is simplified by omitting the part of the apparatus producing the spectrum, and by recording instead the persistence and interruptions of the white light emerging from the analyzer. The nature of this instrument is such that it is admirably adapted for recording the passage of the projectile at a number of points of its trajectory, which points of observation may be as near together as is desirable. For this reason it was made an object to study the *law of variation* of the velocity of the projectile near the muzzle of the gun. Observations were generally taken within a distance of forty-five feet from the muzzle at various regular intervals. As many as ten observations at regular intervals of only five feet beginning at the muzzle of the gun, and extending to a distance of forty-five feet were obtained. From measurements on the negatives obtained, it is clearly evident from each that the velocity of the projectile actually increases after leaving the gun. This is a fact which has long been suspected, but which so far as we know has not previously been demonstrated experimentally.

II. PRINCIPLES UTILIZED IN THE CHRONOGRAPH.

The method of measuring the velocity of projectiles described in this paper, is the same in one essential particular as the methods now practiced. The projectile passes through screens, and the velocity is obtained from the two independent measurements of the distance between the screens and the time interval. The instrument is not a "one point velocimeter," by which the velocity may be measured by a single observation of the projectile at one point of its trajectory, which is a conceivable thing; but is a new form of chronograph to measure the time interval between the screens. The spaces are measured independently. As a chronograph the instrument has a wide application to many phenomena of nature besides the single application to the measurement of the velocity of projectiles.

THE CHRONOGRAPH.

The desirable and possibly essential features of a good chronograph may be classed as follows: There must be some agent in the first place which can transmit, from the phenomenon to be recorded wherever it may be located, the occurrence of the event to a place where it can be permanently made a matter of record. In the second place the agent which is to receive the record must include with it some accurate means of measuring time. For brevity let us designate these two parts of any chronograph by the terms "transmitter" and "receiver." The transmitter will then include all those parts of any chronograph which are instrumental in conveying the occurrence of the event from the place where it happens, to the agent which finally receives the record. The receiver includes all those parts that are essential in receiving the record, together with an accurate means of measuring time.

(*a*) *The Transmitter.*

It would be said that a transmitter were a good one if the time interval that elapses between the occurrence of the phenomenon to be recorded, and the actual recording of it upon the receiver were absolutely zero. It need not be said that all we may hope to do in practice, is to approach that condition as nearly as possible. However where we are only concerned with differences in time, we have the fortunate condition that any error disappears in taking the difference, if the times of transmission are always exactly alike. The chance of error is also greatly reduced if these intervals of transmission are made as small as possible.

The particular form of transmitter used in these experiments depends for its action upon the use of polarized light. Though the principles of polarized light are undoubtedly familiar to many, such an essential part of the chronograph depends upon these principles, it is hoped that the following explanation is not entirely uncalled for.

Let us admit a beam of sunlight through a small aperture into a dark room, and let it fall upon a sensitized photographic plate. If the plate is moved transversely across the beam, it will be found that the negative shows a continuous band of light. Now suppose that the aperture which admits the beam of light is provided with a shutter that can be opened or closed at will. As the sensitive plate moves across the beam, let the shutter be successively opened and closed. The negative now shows an interrupted band of light, alternately light and dark, due to the opening and closing of the shutter. If the beam were admitted to the plate through a narrow slit, it would be possible to make the band of light stop off suddenly at a definite point on the negative.

If it is known just how fast this sensitive plate moves across the beam it would be easy, by measuring the distance between two points on the plate, to measure the time intervals between the opening and closing of the shutter. Again the shutter might be operated by some agent whose time interval we desire to know, and thus a measure of it is obtained If the shutter could be manipulated quickly enough by a projectile, we might thus measure its velocity. But if we should attempt to make any *material* shutter, that necessarily possesses a certain amount of *inertia*, move back and forth at the instant the projectile passes a screen, we must surely fail. The experiment is more successful, however, when we use a shutter that has absolutely *no mass*. This is the kind of shutter which was used in these experiments, and it was with this object in view, to obtain a massless shutter, that we have made use of polarized light.

In the path of the beam of white light admitted through the aperture is placed a Nicol prism (any other means of obtaining polarized light may be employed) in order to obtain a beam of plane polarized light. This prism is made of two crystals of Iceland spar, which are cemented together by Canada balsam in such a way as to obtain only a single beam of polarized light. The crystal is a doubly refracting medium, that is, a light beam entering it is in general divided into two separate beams which are polarized and have different directions. One of these beams in the Nicol prism is disposed of by total reflection from the surface of separation where the Canada balsam is located, and the other emerges a completely polarized beam ready for use. What happens may be thought of as follows. White light is made up of transverse vibrations in the ether having all sorts of directions. By the word transverse it is meant that all these vibrations are confined to planes which are perpendicular to the direction of the beam of light, and in white light the vibration is any sort of an irregular closed curve in these planes. In the doubly refracting crystal, when this beam is divided up into two, taking different directions, it is found that each beam has only one component of the vibration of the original light. One beam has all the up and down components, while the other has all the right and left components. Each of these beams is called plane polarized, because each has vibrations in a single direction only perpendicular to the direction of the ray. As the wave advances, all the motion will thus be confined to a single plane containing the ray. This is the plane of polarization. We may say then that the function of the Nicol prism is to sort out from a beam of light all those vibrations which are not parallel to a certain plane in the prism.

Suppose that a second Nicol prism exactly like the first is now placed in the path of the polarized beam. It too has the power of sorting out all vibrations not parallel to a certain plane in itself. If then the second prism called the "analyzer", is set so that its plane is just perpendicular to that of the first prism called the "polarizer," all the vibrations not sorted out by the polarizer will be by the analyzer. In this position, the planes being just perpendicular to each other, the prisms are said to be "crossed," and an observer looking through the analyzer finds the light totally extinguished as though a shutter interrupted the beam. By turning the analyzer ever so little from the crossed position, light passes through it, and its intensity increases until the planes of the prisms are parallel when it again diminishes; and if one of the prisms is rotated, there will be darkness twice every revolution.

In order to accomplish the same end that is obtained by rotating the analyzer without actually doing so, the following means is adopted: Between the polarizer and analyzer is placed a transparent medium which can rotate the plane of polarization of the light subject to the control of an electric current without moving any *material thing*. The medium used in these experiments was liquid carbon bisulphide contained in a glass tube with plane glass ends. There are many other substances which will answer the purpose, some better than others. This was selected because it is very clear and colorless, and possesses the necessary rotatory property to a considerable extent. It only possesses this property however when situated in a magnetic field of force. The rotatory power is proportional to the intensity of this magnetic field.

To produce a magnetic field in the carbon bisulphide, a coil of wire is wound around the glass tube and an electric current passed through the coil. When the current ceases the carbon bisulphide instantly loses its rotatory power. The operation is as follows: First the polarizer and analyzer are permanently set in the crossed position, so that no light emerges from the analyzer. A current is now sent through the coil on the tube. The plane of polarization is immediately rotated. This is equivalent to rotating the polarizer through a certain angle, and hence light now emerges from the analyzer. Break the current, the medium loses its rotatory power and there is again complete darkness. This arrangement makes an effectual shutter for the beam without moving any mass of matter.

The whole time of transmitting the phenomenon to the receiver may be thought of as consisting of three distinct operations, which occupy three successive intervals, as follows:

1. The interval due to change in the current.
2. The lag of the magnetic field in the solenoid behind the current which caused it.
3. The time occupied by the rotation of the plane of polarization, and the transmission of the light from the transmitter to the receiver.

If we consider these intervals in the inverse order to that in which they are enumerated, the time taken by the light in travelling from the tube to the receiver, a distance of perhaps a meter, is only 3.33×10^{-9}, or .000,000,003,33 seconds, a quantity a thousand times as small as the smallest that we have measured with our instrument. The other part of this interval, that of rotating the plane of polarization, we cannot speak of with the certainty of an experimental determination, for we know of no experiments that have ever been carried out bearing directly on this point, that is to ascertain whether the rotation of the plane of polarization takes place in unison with a change in the strength of the magnetic field, or whether it lags behind it, and if so how much. If such a determination were experimentally possible, it would seem that its answer would throw much light upon the connection between the ether and ordinary matter, now so much agitated. It may be considered as practically certain, however, that this lag, if any such exists, is of the order of magnitude mentioned above, and cannot affect any measurable quantity.

In taking the difference of two times this interval will vanish, as the times must be alike in any two instances.

The second interval, the lag of the magnetic field behind the electric current depends in part upon whether there is in the magnetic field any magnetic material. If there is iron present, this interval might have a decidedly important value, since it might not only have an appreciable magnitude, but most of all it might vary from time to time, depending entirely upon the past history of the iron as has been repeatedly and conclusively shown by experiment. But the case is different where no iron or magnetic material is used, for then the magnetic field is propagated into the space surrounding the solenoid in waves that travel onward with the velocity of light. So that within a few centimeters only of the solenoid the field is in perfect unison with the current. For these reasons there was no iron used in the space near the solenoid in these experiments.

The intervals involved in the last two operations may be counted as of no moment when compared with the first mentioned. The current always does take some time to decrease from its original value to zero, and the light is not put out until the current is zero, though it gradually goes out as the current diminishes. There is no fixed law of decrease of current in a circuit containing resistance and self-induction when the current is broken, *i. e.*, when the resistance is increased from its original value to infinity, or the conductivity is reduced to zero; for the current must depend upon the law of variation of this resistance. The resistance might be gradually increased, so that a comparitively long time is occupied by the current in coming to zero. The case of a "break" is apt to be sometimes confounded with one which is entirely different in its nature. When an electromotive force is suddenly removed from a circuit, *the resistance remaining the same*, the current is known to die away by a curve known as the exponential curve, and by this law the current reduces to $\frac{1}{\epsilon}$th of its value after a time T that depends only upon the resistance and inductance of the circuit. This T is known as the time constant of the circuit and is equal to L/R, the inductance divided by the resistance. This law has no application, of course, in the present instance and cannot be used; for here we actually let the constant electromotive force remain in the circuit, and, far from allowing the resistance to remain the same, we increase it to infinity. The process may perhaps be thought of as follows with advantage. When the circuit breaks, the resistance offered to the passage of the current becomes very great indeed in the gap formed. If the current is to obey Ohm's law it must quickly decrease to a much smaller value. The very act of decreasing the current sets up an electromotive force, called the counter electromotive force of self-induction, in the same direction as the current. The magnitude of this electromotive force depends upon the rate of change of the current, and also upon the inductance and it may therefore become very large. The induced electromotive force is in fact equal to $e = -L di/dt$. This electromotive force attains so high a value that the current passes right over the gap between the conductors and establishes an arc between the two severed metals, which accounts for the spark that is always observed when a circuit is broken. This arc lasts as long as the electromotive force is great enough to keep it up. It may be that the constant electromotive force acting in the circuit is large enough to maintain this arc, and we have an arc continually established, as between the carbons in an arc lamp. The moment when the terminals are so far removed that neither the induced nor the constant electromotive force nor their sum can bridge the gap, then the the current stops. Though we cannot hope to know the exact time which this arc occupies by any mere speculation, it has been experimentally determined in certain instances, and where certain metals are used as electrodes; and in general it should be so determined in each particular instance.

The foregoing considerations are useful however as a guide for the experimenter, to show him certain channels which it will be well for him to follow to attain the best results. We may be certain of one thing by referring to the expression for the induced electromotive force. We diminish the induced electromotive force just in proportion as we diminish the inductance of the circuit, for it enters as a direct factor there. This indication was followed in our experiments and the self-induction of the coil upon the tube of carbon bisulphide was made in four sections, so that they might all be joined up in parallel, and thus reduce the self-induction of the tube sixteen fold as compared with what it would have been had all the coils been connected in series. The more exact description of the apparatus is deferred until later.

Another point which may be noted is that the projectile mechanically breaks the circuit as quickly as it is possible to be done by any agency. But the exact influence of this is not so easy to predict, for, though it is probable that the current dies away quicker with a sudden break than it does with a very slow one which permits the arc to remain for some time; yet it is not proved certainly, for the more rapidly the break is made, the faster the resistance increases and therefore probably the rate of change of current, and with it the counter electromotive force increases. An increased electromotive force can bridge a longer gap. But a longer gap may be made in the same time that a short one is with a less velocity at the break. So it appears that these two considerations react on one another, and all depends upon which has the greater influence. The former consideration however seems to favor the view that the quicker the break, the sooner the current will cease.

The most important consideration of all in respect to this time interval, which is at the same time most fortunate, is that for taking differences of time these intervals are the same in all cases. For exactly the same circuit is used, and the inductance is necessarily the same, also the break is made at the same rate, (or approximately so) in all cases. This relieves us of any necessity of making two electromagnets exactly alike (as is required in the Boulengé Chronograph), and even if the magnets are exactly alike as to shape, it has been shown that two pieces of iron from a common original bar, depend for their action upon their past magnetic history, which may of course be entirely different in the two cases. There is no possible objection to our chronograph on the score that there are masses of matter which have to be moved or that there are iron cored magnets used in its operation, for there are absolutely none. This will hardly be claimed for any other chronograph with which we are familiar.

(b) *The Receiver.*

The receiver is that part of the chronograph which is susceptible of receiving the continuous record from the transmitter, and it also includes that part of the instrument which measures time. A receiver is a good one when the exact law of relative motion between it and the recording part of the transmitter is known, so that every point of the record of the receiver represents a certain definite known time. Different instruments may have different laws of motion, for instance one may be a falling body whose motion is uniformly accelerated, another may be uniform motion of translation, or again we may have a uniformly rotating receiver. There are various means of approximately obtaining these different motions; but let it suffice to describe the receiver used in our experiments. It consisted of a circular photographic plate upon a horizontal shaft in a dark box. An approximately uniform rotation was given to it by means of an electric motor, whose armature was coupled directly to the shaft. In order to accurately determine the angular velocity of the plate, whenever it is exposed, a tuning fork is placed so that the shadow of one prong is projected sharply upon it by means of a parallel beam of light from an intense source. The light from the transmitter, as well as the light from the tuning fork is admitted to the plate through a narrow horizontal slit. When the plate is in rotation, and the tuning fork is vibrating, the shadow of the edge of the fork describes a sinusoidal line around the plate. From a knowledge of the angle on the plate which a certain number of these waves subtend, and the time of vibration of the fork, the angular velocity of the plate at once becomes known. The real time measurer is thus a tuning fork, which is a most reliable method of measuring time. Moreover the speed is in each instance recorded upon the plate, so that the necessity of measuring the speed before and after the observation is avoided.

It need not be said that the various parts of both the transmitter and receiver might be constructed in other and better ways; and the manner of their use and operation modified in many particulars which it would be out of place to describe here.

III. DESCRIPTION OF APPARATUS.

The gun used was a 3.2-inch B. L. field rifle, No. 56, model of

1892, and the service charge of 3¾ lbs. of I. K. H. powder was uniformly employed. The projectiles were common shell, so selected that each weighed 13 lbs. 6 oz.

Length of bore of gun - - - -	25.2 calibers.
Travel of projectile in bore - - -	21.81 calibers.
Powder chamber capacity - - -	108.9 cu. in.
Density of loading - - - - -	0.95315.

For the gun two siege platforms were laid in prolongation and leveled, giving a suitable direction of fire out to sea. The firing was conducted without applying the wheel brakes, and the recoil was approximately constant at 48 feet total, or 28 feet on the platform and 20 feet on ground.

The arrangement of screens for this work possesses some interesting features. A skid *AA* (Fig. 1) 12″ x 12″ and 15′ long, was placed in approximate prolongation of the axis of the bore with the gun elevated at 3°, being supported by two solid upright posts *BB*. Beyond this, shifting planks were placed end to end, spiked together and supported by 2″ x 4″ scantlings set into the ground at intervals, as shown in the figure. Two large ballistic screens, shown at *C* and *D*, were erected, at distances respectively of 44 feet and 118.2 feet from the muzzle, for the use of the Boulengé chronograph (Bréger modification) for purposes of comparison.

A screen for these experiments which is but a foot wide, is shown at *E*, and is made by two strong upright pieces spiked to the sides of the skid. Along the straight edge of these pieces, on the side towards the gun, wire nails were driven in at close intervals and insulated wire wound around the nails and stretched back and forth, three times across being usually sufficient on account of the accuracy of the gun. The ends of each screen wire were attached to the line wires which were run along on either side of the trajectory, the insulators being shown at *FFF*. This method of making the screens near the muzzle a part of a heavy beam, placed end-on in prolongation of the axis of the gun, permitted greater accuracy in measuring the distances between screens by a steel tape stretched taut along the beam; and the whole arrangement, also, presented a minimum surface to the blast, the effect of which at first was much overestimated. The smallness of the screens, and the uniformity in the make-up of each, tended to reduce any error caused by the projectile not cutting the wires of each in exactly the same manner. During the progress of the experiments the screens were placed at various intervals, the final arrangement being five foot intervals up to 45 feet from the muzzle. The first screen was uniformly placed at a distance equal to the length of the projectile from the muzzle (0.69 foot). In some of the experiments the line wire was extended to the farther ballistic screen *D*, which was included in the circuit of the "transmitter." Between consecutive screens it was necessary to place a device which would re-establish the current which had been broken by the projectile cutting the wire of the previous screen. Although there are well known methods for accomplishing this object, yet with the interval between the screens so small as five feet, the necessity for *quick action* made a special arrangement necessary. An extremely simple means of accomplishing this, which was found to answer the purpose, is the following: Two brass springs about $\frac{7}{10}$ inch wide, $\frac{1}{20}$ inch thick, and 3½ inches long, were securely fastened to the sides of a small piece of wood, as shown in Fig. 2.

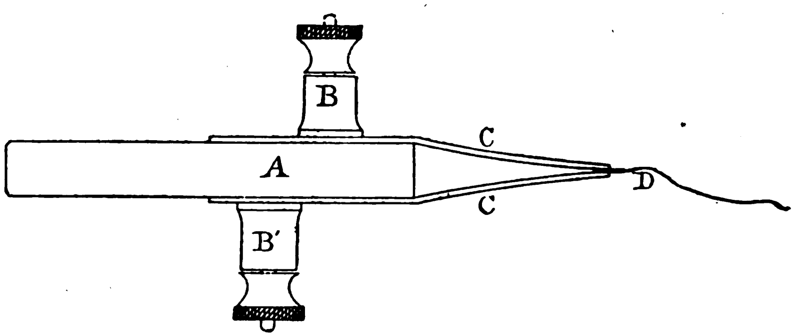


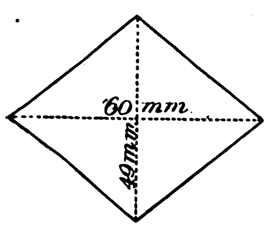
Figure 2.

A is the wooden body of the device, *BB′* binding posts for connecting in the line wire, *CC* the brass springs. The tapering jaws of the springs press firmly together, forming an electrical connection between the binding posts *BB′*. When, however, a minute insulating plug *D* is inserted between the jaws, *B* and *B'* become insulated from each other. A wire is attached to the insulating plug and stretched across the path of the projectile, to be mechanically pulled out by the projectile during its passage, thus re-establishing the current in the line wire and consequently through the next screen. Various insulating materials were tried in the search for one which would possess the requisite toughness to withstand the powerful shock caused by the projectile hitting the wire, and at the same time permit of being beveled to the minute thickness at its edge which was required for such *quick action.* Hard rubber, rawhide, and rubber belting were tried, but hard sole leather was found to work best.

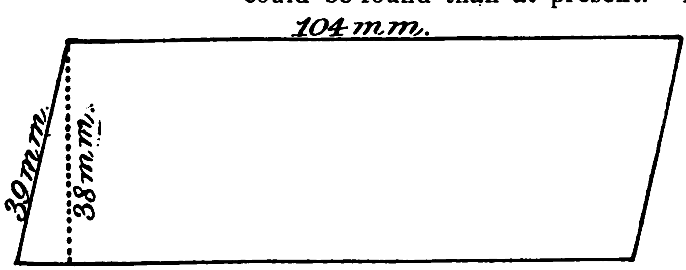
In addition to the necessary wires to the ballistic room for operating two Boulengé instruments, four line wires were run from the gun platform to the electrical laboratory, two for the primer circuit for firing the gun, and the other two for the chronograph "transmitter."

THE TRANSMITTER.

In Fig. 3 the transmitter is represented at *T*. It consists of a polarizer at *P*, which is a Nicol prism; and an analyzer at *A*, a Nicol prism like the first; and a glass tube *T*, wound with insulated wire, all mounted on an optical bench. The Nicol prisms used are two fine specimens belonging to Dartmouth College, and obtained at a time when larger specimens could be found than at present. Their



End.



Side.

Figure 4.

dimensions are shown in the accompanying diagram, Fig. 4. The tube was originally an ordinary chemical laboratory glass condenser tube of 3 cm. internal diameter and 45 cm. long, provided with ground ends upon which plane glass was fitted. The two smaller tubes *DD*, projecting from the side of the larger tube near either end, were placed in an upright position so that, when the tube was filled with liquid carbon bisulphide, any bubbles of air which might exist in the liquid would collect in the smaller tubes, thus not interfering with the passage of the light through the tube. The nature of liquid carbon bisulphide is such that it will dissolve ordinary substances such as rubber, leather and fatty materials which are commonly used to secure a perfect joint between ground and plane glass. It was found, after trials with a number of substances, that ordinary cane sugar, when melted to a candied condition, would make an impervious cement. The tube was wound with a No. 18 single covered magnet-wire in four equal separate sections along its length.

Resistance of 4 coils in series - - -	13.76 ohms.
Resistance of each coil - - - - -	3.44 ohms.
Resistance of 4 coils in parallel - - -	0.86 ohms.
Total number of turns on tube - - -	2900 about.
Number of turns on each section - -	725.

This tube was made of larger cross section than was necessary, and consequently consumed more power than would be required in another apparatus, but inasmuch as plenty of power was available this was not a matter of importance.

The four coils were usually connected in parallel in these experiments, with the object of reducing the inductance of the line, the inductance of the tube itself being reduced sixteen-fold by this arrangement. Since a given strength of magnetic field had to be attained, the line current was therefore larger than it would have been with the coils in series. The current which was ordinarily used was about 17 amperes, which makes about 4¼ amperes around each coil of the tube, and the amount of power therefore required for the transmitter was about 249 watts. It must not be inferred that these figures represent what is necessary, but they gave good results. From ten seconds to half a minute is approximately the length of time that the current flows around the transmitter during the taking of an observation, and when, therefore, this amount of power is being used.

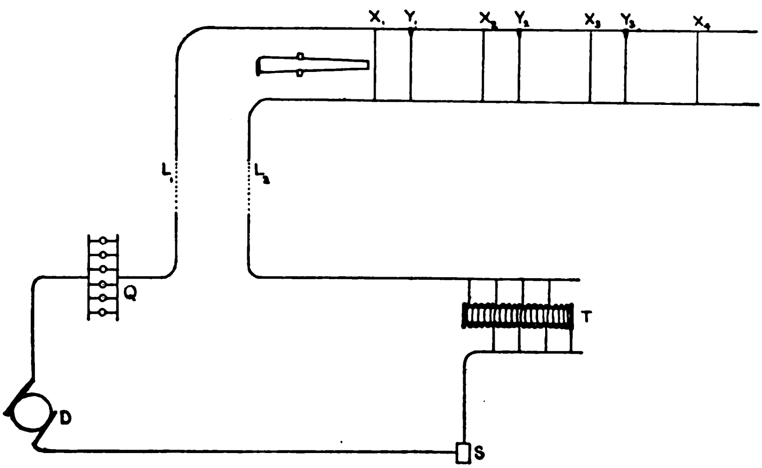


Figure 5.—Transmitter Circuit.

The diagram (Fig. 5) shows the transmitter circuit, including the tube at T with the four coils in parallel, a switch S, a dynamo D, giving constant electromotive force of 110 volts, a bank of incandescent resistance lamps Q, the line wires $L_1 L_2$, and the muzzle screen X_1. At $Y_1\ Y_2\ Y_3$ are represented the devices, previously described, for re-establishing the current. The line wires beyond are normally disconnected by the insulating plug inserted between the brass springs, so that the only path for the current before the gun is fired is through the screen X_1. The current is regulated by turning on or off lamps from the bank Q. The operation of the transmitter is as follows: When no current is flowing in the circuit, the polarizer and analyzer are permanently set in the "crossed" position for darkness, and then just before firing, the switch S is closed and the current flows through the circuit. This permits light to pass through the analyzer as long as the current is maintained. When the projectile arrives at the muzzle of the gun, the wires of the screen X_1 are broken and the current is completely interrupted. The disappearance of the light through the analyzer is simultaneous with the interruption of the current. When the projectile arrives at the device Y_1 it pulls out the insulating plug and re-establishes the current through X_2. Simultaneously with this, light is admitted through the analyzer, again to be interrupted when the projectile reaches the second screen X_2, and sc on. The light through the analyzer is thus intermittent, the transition from light to darkness being so instantaneous as to produce a sharp, well defined record on the photographic plate.

THE RECEIVER.

The receiver is a photographic means of recording the intermittent beam of light through the analyzer, and consists of a camera containing a sensitized plate, which is shown in position ready for use at *C* (Fig. 3). Detailed views of the camera are shown in Figs. 6 and 7. It is made of wood in the shape of a rectangular box, the interior dimensions being 10″ high by 10″ wide by 2.5″ deep. Figure 6 represents the front view of the camera-box *A* with the cover *B* removed, showing the small auxiliary dark chamber *C*, which contains the electro-magnetic device *D* with armature *E* attached to the brass spring *F* for releasing the camera-slide *G*. This slide is shown in the photograph, withdrawn from the grooves in which it normally slides by passing it through the opening at the top after removing the cover *H*. The narrow horizontal slit through which the light is admitted to the photographic plate is shown at *I*. The slit is constructed of sheet brass, the upper jaw being stationary, horizontal, and parallel to a radius of the photographic plate. The lower jaw *J* is a sector of sheet brass which slides between two guides, so that the lower edge of the slit is also parallel to a radius of the plate, and thus the slit is adjustable and is always a sector of the circular plate, the object being to obtain a uniform time of exposure for any part of the slit.

When the camera-slide is in position, the nail at *K* rests upon the top of the brass spring *F*, and the upper edge *L* of the lower screen of the slide covers the slit *I*. When the current passes through the electro-magnets by the binding posts *M*, the armature is drawn and the slide released. The slit is exposed only while the opening in the camera-slide is passing by.

When the camera-slide comes to rest, the upper screen *G* covers the slit and it remains so covered. The upper screen *G* is capable of adjustment along the brass rods of the slide, and the opening between the upper and lower screen of the camera-slide is thus adjustable, and the time of exposure of the slit under control.

When the cover *B* is in position, the space containing the slide and the release mechanism is a complete dark chamber in itself. A cap *N* in the cover *B* is removed just before the camera is to be used. The wires shown at *O* are for the purpose of producing on the plate reference circles by casting their shadows. The entire back of the camera is removable, and its outside face is shown at *P*. Through the center of the back a horizontal shaft *Q* passes, which revolves in the bearing *R*.

Figure 7 shows the inside of the camera; its body at *A*, the removable back at *P*, the slit at *I*, and the cover for the camera-slide at *H*. The slide is shown with the upper screen *G* removed. The inner end of the shaft is shown at *Q*, and the photographic plate *S* is mounted on this shaft. Suitable circular plates might easily have been obtained, prepared for mounting on the shaft; but, rather than order special plates, it was decided, on account of the limited time at our disposal, to adopt the following plan: Since the most sensitive plates were required, the Stanley plates (sensitometer 50) were used. The 8″ x 10″ size was cut into a circle 8 inches in diameter; and, because it is not easy to make a hole in a glass plate which must be manipulated in a dark room, the circular plate was divided along a diameter *T*, and from each half a small central piece was cut to admit the shaft. When these two halves were mounted on the shaft, care was taken to accurately fit them together so that the disadvantage of having two halves was in part overcome. An ordinary adjustable lens shown at *B* (Fig. 3) was used to condense the light which came through the analyzer upon the slit.

The tuning fork is shown at *F* (Fig. 3). A simple wooden rectangular frame was made, and the tuning fork screwed into the upper cross-bar, giving it an inverted position. The distance between the prongs of the fork is about three-fourths of an inch. Between these prongs a single magnet coil was secured to the frame by a cross piece. The clearance between the core of the magnet and either prong of the fork was just sufficient to allow the fork to vibrate without touching it. One terminal of the coil was connected directly to the binding post *H*, the other terminal to the fork itself at *F*, and the current would pass down through the fork and the flexible brass spring soldered to one prong. A platinum point, connected with the binding post *K*, was brought in contact with this spring, and the pressure was adjustable by a screw.

Wires were led directly from the binding posts *H* and *K* to some battery cells of the closed-circuit type.

The motor available for running the camera was not exactly suited to the purpose. Four storage cells were used to energize the motor, and greater uniformity in speed was obtained by placing a heavy iron-toothed gear-wheel as a fly-wheel on the motor shaft, as shown at *N* (Fig. 3). This wheel also served another purpose in offering a convenient and ready means of determining the proper speed of rotation for a given setting of the camera-slide. The wheel contained fifty-six teeth, and by simply holding on its periphery the edge of a card, with the motor running at an unknown speed, the corresponding note would be given out, and when this is compared with a tuning fork in the other hand of the observer, it indicated at once whether the speed of the motor should be increased or diminished. From the constants of the camera-slide, a curve was constructed showing complete vibrations given by the note on the fly-wheel as abscissae, and the corresponding opening of the camera slide in mm. as ordinates, so that if desired, the proper speed for any exposure becomes known, that is, a speed that will rotate the plate once during the exposure.

The gravity switch.—It was found necessary in the course of experiment, to have an accurate means of exposing the camera at just the proper time in relation to the firing of the gun, and, after some trials, the form of switch shown in Figure 3 at *G* was constructed with this object in view. It consisted of a wooden base with an upright brass rod in its center. On either side of this rod were two wooden uprights carrying the connectors *V V* and *UU*. To these connectors were attached wire springs bent inward toward the brass rod. The weight *W* was a cylindrical piece of brass four inches long, with a hole drilled through it lengthwise so as to permit it to slide freely upon the brass rod. The gun was fired by dropping this weight down the rod. When the weight arrived at the springs connected with *VV*, the electrical circuit was completed through *VV*, which operated the camera-slide, and upon arriving at the springs connected with *UU*, the primer circuit was completed and the gun was fired. The interval of time between making the camera circuit and making the primer circuit can thus be varied within certain limits, by dropping the weight from different heights. The curve of calibration of this switch was constructed, which gives this interval of time for any height from which the weight was dropped.

The complete arrangement of the electrical circuits used with the different pieces of apparatus is shown in the diagram (Fig. 8) in which *D* is the dynamo, *T* the transmitter tube, *S* a switch which completed the circuit of the transmitter just a moment before firing the gun to prevent heating the coils—L_1 L_2 the line wires leading to the proving ground; *Q* a bank of resistance lamps; $X_1X_2X_3$ etc., the screen wires shunted across between the line wires; Y_1 Y_2 Y_3 etc., the devices for restoring the current successively between the screens; and *L* and *L'* two 50-volt arc lamps in series which for convenience were lighted by the same dynamo. The electrical tuning fork is controlled by the cells *E*; *M* is the motor for running the camera plate; and at *O* are represented four storage cells for energizing the same. *G* is the gravity-switch for exposing the camera and firing the gun, and *C* the camera whose slide is operated electrically by the cells *I* from the gravity-switch at *VV*. The firing circuit contains the electric primer *P* at the gun, the line wires P_1 P_2, the dry cells *S'*, and the gravity-switch terminals *UU*.

IV. RESULTS.

During the brief two weeks, which because of other duties was the longest time that could be devoted to these experiments,

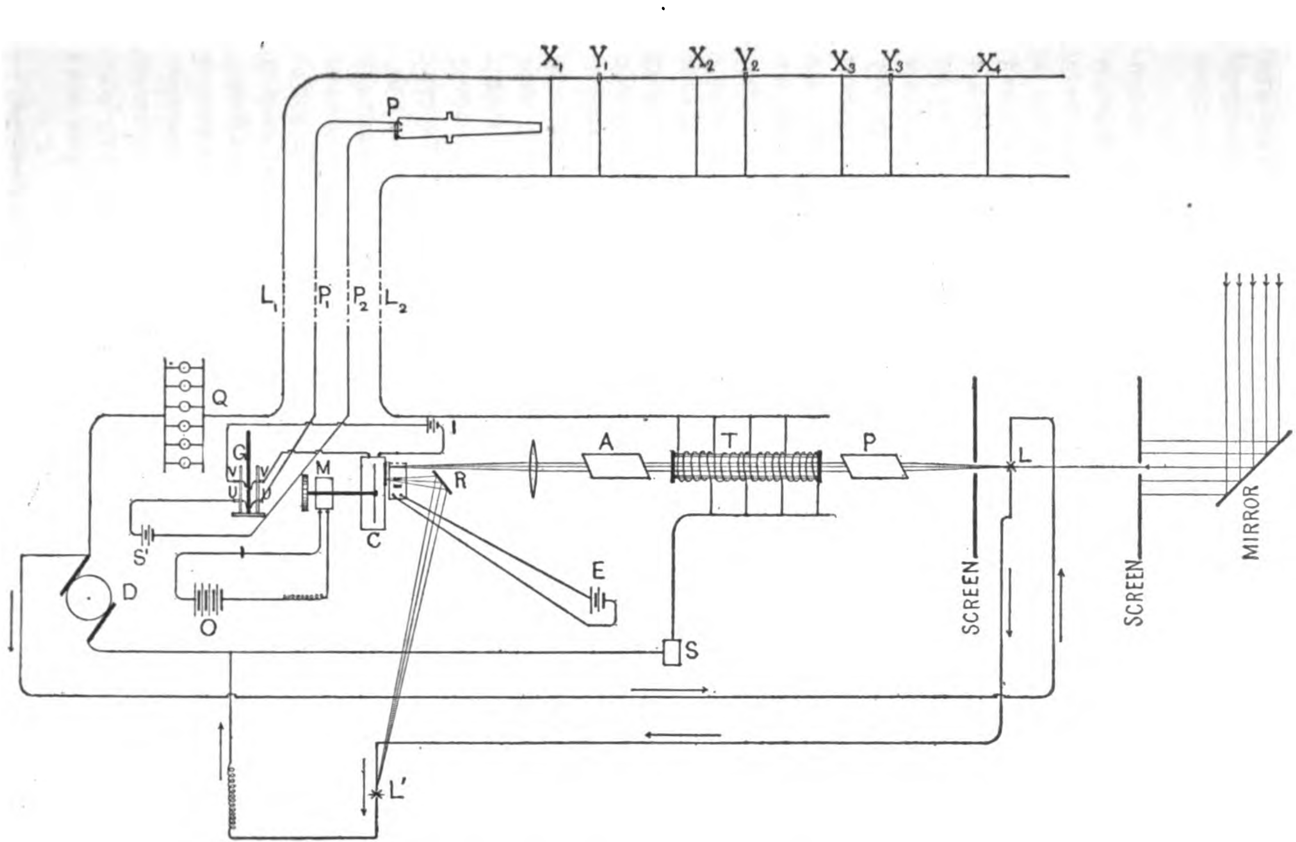


Figure 8.—Complete Arrangement of Electrical Circuits.

twenty-five negatives were obtained. A large portion of these were only of value in so far as they served as a guide toward the best practical method of obtaining results. They were of course necessary as a preparation for this end, as any one who has had any experimental experience is fully aware. It seemed as though the instruments were just set up, and sufficient practice in their use acquired to feel confidence in getting a result with every shot, when we were obliged to cease.

The construction of the camera used has already been explained. This design was adopted rather on the basis of expediency than because it is of the most desirable form. There is one important feature of the camera which was a decided disadvantage in experimenting, that would have been avoided by a different construction. We refer to the fact that the record must be made during a single revolution of the plate, and for this reason the whole time of exposure is but a small fraction of a second, about .066. The experimental difficulty introduced by this was to make the particular six hundredths of a second, when the plate was exposed, coincide with the time when the record is made by the projectile, so that the beginning of its record should fall near the beginning of the exposure. A certain unknown time elapses after closing the primer circuit before the projectile arrives at the muzzle of the gun. If the plate were exposed at the instant of closing the primer circuit, this interval is so long that the exposure is nearly over when the projectile arrives at the muzzle. This time interval might have been accurately ascertained if more time had been allowed for experiment, or if this had been the main object in view. The interval which the projectile occupies in passing through the bore of the gun could likewise have been found, and the primer interval being known, the time of ignition and combustion of the charge deduced. A knowledge of these intervals which together make up the "firing interval" of the gun, is of considerable importance, especially on ship-board, where shots must be fired when the vessel is rolling.

The camera is exposed by closing an electric circuit which releases the camera slide by means of an electromagnet. The slide has to fall a small distance, about 1.1 cms., before the exposure begins. The armature also takes a little time to act, so that here again is an uncertain interval to be determined by experiment. It was not known whether the camera interval or the "firing interval" is the longer, and this determines whether the camera circuit or primer circuit must be closed first. It turned out by trial that to bring the muzzle record near the beginning of the exposure, the camera circuit should be closed a small fraction of a second before the primer circuit.

To determine the "firing interval" above referred to, an experiment was tried as follows: A switch was used that would close the primer and chronograph circuits at approximately the same time. In Figure 9 let time be measured along a horizontal

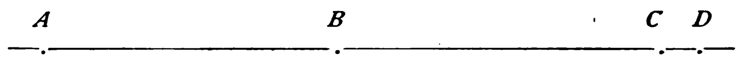


Fig. 9.

line, and let *B* represent the instant when both circuits are closed. An arrangement is attached to this same switch so that the camera circuit is made at some unknown interval previous to *B*, as at *A*. The beginning of the exposure of the plate occurs at some interval *A C* after *A*, and the arrival of the projectile at the muzzle at another interval *BD* after closing the primer at *B*. By reference to *Negative 8* (Fig. 10), obtained in one of the early trials with this object in view, it is seen that the plate is exposed first at *C*. There are two circles of light; the outside at *C* is the chronograph record, and the inside at *VW* is the tuning fork record. The inside edge of one prong of the fork gave the wavy sinusoidal line *VX*, and the outside edge the line *WY*. The plate was exposed until it revolved to *XY* when the camera slide cut off the light. Thirty-four complete waves may be counted on the plate, and as each wave occupies 1/509.46 of a second, the whole time of exposure is thus seen to be about .067 of a second. This interval will be found not to vary much in the different negatives. The line *LM* shows where the two halves of the glass plate come together. The radial lines *H, I, J, K*, were intentionally put upon the plate as lines of reference, though they proved to be unnecessary. To obtain them the camera was exposed in the dark room to an oil lamp when the plate was stationary, the slit being nearly closed for the purpose. This negative shows that the chronograph circuit was closed, and with it the primer made, at *B* some time before the plate is exposed at *C*, for the circle of light begins with the exposure of the plate. The light is cut off at *D* when the projectile cuts the screen at the muzzle of the gun, and the interval from *C* to *D* is approximately measured on the plate to be .041 of a second. This leaves us in uncertainty as to the whole interval *BD* because the interval *BC* is unknown. We can say however that the interval from the closing of the primer circuit to the arrival of the projectile at the muzzle of the gun, is certainly more than *CD* or .041 of a second.

Another trial made with this same object gave *Negative 13* (Fig. 11). It was attempted to bring the point *C* before *B*, that is, to have the camera exposed before the chronograph circuit is made; and at the same time care was taken not to shift its position so far that the point *D* would not be found on the negative. This negative shows that its position was not shifted quite far enough to bring *B* after *C* so that *B* would appear on the record; but the point *D* is observed to be nearer the end of the exposure. The interval from *C* to *D* is .051 of a second on this plate. It is therefore known that the "firing interval" is more than this amount. The point *D* on this plate is so near the end of the exposure, that by shifting it again the chances are that it would disappear before the record of *B* would become visible. It was then decided not to fire again with this object in view. The principal object however in determining this interval was already obtained. It was to bring the record of the muzzle screen on the plate, and both these plates show the record. If this can be shifted back near the beginning of the exposure, and some fixed arrangement adopted that will ensure its constancy of position on the plate, we are ready to take records of the projectiles.

A word may be added by way of digression as to the nature of the light used. The two sources of light in the experiments were sunlight and arc light. The sunlight could not be depended upon when it was needed, but when available gave a smoother negative than the arc, as the light is perfectly steady. The arc light was much more convenient as it was ready for use at any moment, but is not so steady as sunlight, or perhaps it ought to be said that the lamps we were obliged to use were not so. It was fortunate that the arc could be used at all. This was a point which had not been determined until these trials were made. *Negatives* 8 and 13 (Figs. 10 and 11) were made by arc light, and they show the variations in its intensity very distinctly, especially in the tuning fork record. At *VW* on *Negative 8* is a spot where the light was especially intense, and on *Negative 13* the radial streaks alternately light and dark are quite numerous.

The outside circle *CD* was made by light from the lamp *L* in Fig. 3, which passed through the transmitter. The tuning fork record was made by another lamp *L'*, the light being reflected once from the mirror *R*. Two of the circles of reference, made by the shadows of the wires across the slit in the camera cover, as shown at *O* (Fig. 6), are seen at *T* and *U* on *Negative 13*.

Inasmuch as the variations of the intensity of the constant current arc show so plainly in the negatives, it may be of interest to show a record of an alternating current arc taken with this camera. This is seen in Fig. 12, which shows that the arc goes completely out and appears again at regular intervals. Twenty of these light spots appear on this plate during the time of exposure, which was about .067 of a second, and two of these spots are made by one complete alternation of the current. Therefore the time of a complete alternation of the current is approximately $.067/10 = .0067$, and the number of alternations per second is the reciprocal of this, or 149 is the frequency of the current funished by the generator. It is noticeable that every other light spot is similar, but consecutive ones are different. The cause of this was a magnet held near the arc so that it was drawn out to the left when the current went one way, and to the right when it went the other.

The first trials to obtain a record of the projectile were made with an arrangement of circuits as in Fig. 13. It was intended to show the makes in the current, when the projectile passed between the pairs of points at *A*, *B*, *C*, *D* in succession. There was one screen X_1 at the muzzle to be used in the ordinary way as a break. It was hoped that when the projectile touched the pairs of points at *A*, *B*, &c., there would be time enough during the contact for sufficient current to flow to make its record on the plate, but on both the negatives 8 and 13 the muzzle record occurs and no trace of light is observed for the other points. To obtain the points for the projectile to bridge across, wire nails

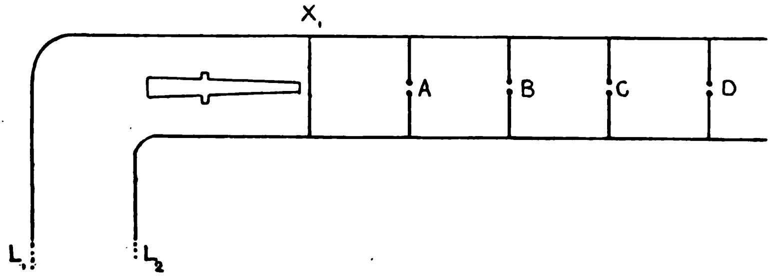


Figure 13.

were driven into the heavy skid *AA* (Fig. 1), about an inch apart, and the terminals of the 110 volt Edison dynamo connected to the nails. The pairs of points were placed at five foot intervals from the muzzle of the gun. Some of the nails were knocked out from the skid, but most of them were bent over outwards and forwards by the projectile. As no light spots appeared on these plates, it proved that the inductance of the circuit was too great to permit sufficient increase of current during the short time of contact to make a record. The inductance might have been reduced still more by the use of storage batteries instead of a dynamo, but these were not at hand. The inductance of the chonograph itself was decreased by winding the tube with several coils in parallel, instead of a single one in series.

The method of "makes" was finally abandoned for fear of losing too much time in experiment without obtaining any result, and the following plan adopted, when *Negative 10* (Fig. 14) was secured and with it the first measurement of the velocity of a projectile. This was obtained on Saturday, Jan. 5, 1895, after eight of the fourteen days had passed. The plan was to use the break instead of the make, and the arrangement of circuits was essentially as in Fig. 5, but two screens being employed. The first screen X_1, consisting of only a single wire, was placed at a distance of the length of the projectile from the muzzle. The second screen X_2, consisting of only five wires about an inch apart, was 40.13 feet beyond the first. The device Y_1 for re-establishing the current was at a distance of ten feet from the first screen. Negative 10 shows that the camera was exposed at C for the transmitter record, and at VW for the tuning fork. The muzzle screen was broken at X_1, the current re-established at Y_1, and interrupted again at X_2 when the projectile cut the screen X_2 (Fig. 5). Sunlight was used for this negative and the light appears of a uniform intensity throughout. The waves of the fork are clearly seen, and the suddenness with which the light is cut off at X_1 and X_2 permits accurate measurments to be made.

As the plate revolves at a uniform angular velocity ω, the angle θ between X_1 and X_2 may be expressed

$$\theta = \omega t$$

where t is the time occupied by the projectile in going 40.13 feet. The average velocity v of the projectile during the interval is then

$$v = \omega \frac{s}{\theta}$$

where s is the distance between the screens. In the present instance

$$\begin{aligned} s &= 40{\cdot}13 \text{ feet} \\ \theta &= 108^\circ\ 5'.815 \pm .444 \\ &= 108^\circ.0969 \pm .0074 \end{aligned}$$

The probable error is calculated from nine measurements of the angle, and shows that the angle θ can be measured with accuracy, the error being only .0068 of one per cent. of the whole, or again an error of only one part in 14,630. This is not selected as an especially good example of the probable error, but is a fair case by which to judge the whole. Of course the percentage of error depends upon the whole angle measured, but 40 feet is a smaller distance than it is customary to use with other chronographs. Thus far the value of v is

$$v = \frac{40.13}{108.0969}\,\omega = .371241\,\omega.$$

The angular velocity ω of the plate is obtained from the record of the tuning fork. The advantage of some method of this kind for recording time will be apparent when it is considered that now the whole record is on each plate, and we are not troubled to take the speed of the plate at the time of firing the gun. In the experiments were used two tuning forks manufactured by Koenig in Paris which were marked 1024 vs., that is 512 complete vibrations per second were used. These were, as nearly as could be detected by the ear, exactly in unison. One of these forks was mounted to run electrically as previously described (See page 427). After mounting it was found to beat with the other fork just one hundred times in 39.45 seconds, or once in .3945 of a second. This is the time which the other fork took to gain one complete vibration on the electrical fork, and in one second it would gain 2.535 complete vibrations on the electrical fork. As the higher fork makes 512 complete vibrations per second, the electrical fork therefore made $512 - 2.535 = 509.465$ complete vibrations per second. The accuracy of this method depends of course upon the determination of the absolute time of vibration of the fork. This has not as yet been made by us. Since it is not so important to determine the absolute velocity of the projectile in these experiments as it is to examine into the merits of the method, and see what might be done with a more perfect instrument, a determination of the period of the fork and consequently of the angular velocity of the plate, aside from that made by the makers, is not deemed to be necessary before publishing the results of these preliminary experiments. Fortunately, however, we need not know the angular velocity absolutely in order to determine the relative velocity of the projectile at different points of its trajectory. This will appear when later other negatives are described, by which the relative velocity may be found with considerable accuracy.

The angular velocity of the plate is found by the relation

$$\omega = \frac{\theta}{t}$$

where θ is the angle through which the plate turns in the time t. The angle corresponding to 34 complete waves on *Negative 10* is found by measurement to be 294.54 degrees. The time of a complete vibration of the fork is the reciprocal of the frequency or

$\frac{1}{509.46}$ of a second. The time corresponding to 34 waves is

therefore $\frac{34}{509.46}$ and the angular velocity

$$\omega = \frac{294.54 \times 509.46}{34} = 4413.42 \text{ degrees per second.}$$

This corresponds to about twelve and one quarter revolutions per second, or seven hundred and thirty-five per minute. By substituting this value of ω in the preceding expression for the velocity, we obtain

$$v = .371241 \times 4413.42 = 1638.5 \text{ ft. per sec.}$$

From the relations $v = \frac{s}{t}$ and $\theta = \omega t$ we may express the velocity as $v = \omega \frac{s}{\theta}$, in which form appear the three separate quantities that actually have to be measured to obtain the velocity. It has been shown that the angle θ can be measured with considerable accuracy, and with proper instruments it is evident that the angular velocity ω can be obtained with great accuracy. The distance between the screens can of course be found with some care to a high degree of accuracy; but when we attempt to express the distance by more than four or perhaps five significant figures, it is necessary to measure to a definite part of the wire of the screen. The uncertainty introduced here is caused by the conical point of the projectile striking the screens at unsymetrical places, so that the distance may be greater or less than that which is measured by a small amount. This fact makes it useless to express more than four or five sigificant figures in giving the distance. The cause of the greatest error in expressing the velocity is thus the factor s in the above, so that we may say it is not the time interval which is so difficult to measure, but it is the space passed over by the projectile during this time.

The velocity of this same projectile was measured independently with the Boulengé chronograph, and was found to be 1615.8 feet at a distance of 81.10 feet from the muzzle, this being the distance of the point midway between the two large ballistic screens, one at 44, the other at 118.21 feet from the muzzle. This velocity reduced back from the mean point to the muzzle by Ingalls' tables gives a muzzle velocity of 1628.2 feet per second, as compared with the value 1638.5 obtained by us.

Negative 16, (Fig. 15). The next purpose before us was the investigation of the *variation* in the velocity as the projectile leaves the muzzle of the gun, since our experience had taught us that the blast was not to be feared as much as formerly supposed. With this object in view the plan was to obtain observations at several points along the trajectory. But to accomplish this it was necessary to make sure that the muzzle record could be depended upon to appear near the beginning of the exposure. For this the gravity switch described on page 428 was constructed. There were then arranged four screens at fifteen foot intervals beginning with the muzzle screen. The muzzle screen was always placed in front of the muzzle a distance equal to the length of the projectile, so that the record would be made after the projectile is out of the bore. These screens were at distances 15, 30, and 45 feet respectively from the muzzle screen, and the arrangement of circuits similar to that in Fig. 5. Negative 16 was the first obtained with this arrangement, and arc light was used. The muzzle record at X_1 was delayed more than half a revolution of the plate; but the make at Y_1 and the break at X_2 were recorded. The make at Y_2 failed and consequently did all the rest of the record. The cause of this was found to be that the hard rubber wedge between the brass springs at Y_2 did not come out to allow the springs to come together. Although it was wedged in with only sufficient pressure to hold it and the attaching wire, yet the rubber was so brittle, the piece so thin and the pull so sudden, that it snapped off leaving a small piece between the jaws. Finally in trying different materials, instead of brittle rubber, hard sole leather was found to answer the purpose very well. The reason why the muzzle record occurred so late on the negative was decided to be due to the fact that the contacts in the gravity switch operating the camera rebounded from the weight as it fell, and thus delayed the exposure. This was remedied by fastening two flexible rubber cushions behind the springs to take up the rebound.

Thirty-two tuning fork waves on this plate correspond to 290° 25′. Therefore the angular velocity of the plate was

$$\omega = \frac{\theta}{t} = 290.416 \times \frac{509.46}{32} = 4613.0.$$

The angle between the breaks is 41°.938, and this corresponds to a distance along the trajectory of 15 feet. Therefore the velocity of the projectile is

$$v = \frac{s}{t} = \omega \frac{s}{\theta} = 4613.0 \times \frac{15}{41.938} = 1649.9$$

The Boulengé instrument gave a muzzle velocity for this shot of 1655 feet.

Negative 17, (Fig. 16). Upon this negative obtained with arc light it is noticed that there is a record of the four breaks X_1, X_2, X_3, X_4, as well as the makes Y_1, Y_2, Y_3, which were all the points prepared in this trial. The measurement of the tuning fork record shows that 34 waves of the tuning fork occupy 305.°442, and therefore the angular velocity is 4576.8 degrees per second. Measurements on the negative give the following angles between the breaks X_1, etc., corresponding to the distances.

s	θ
15	41°.213
30	81°.683
45	124°.267

Calculating the velocities for each point, using the muzzle screen as the first one in each case, we find

s	v
7.5	1665.7
15.0	1660.6
22.5	1657.3

The Boulengé record of this shot was 1655 for the muzzle.

Negative 18, (Fig. 17). It was then arranged to obtain points at ten foot intervals instead of fifteen, and negative 18 was next obtained with arc light. This shows the muzzle break at X_1, the first make at Y_1, the ten-foot break at X_2, the make Y_2 and the twenty-foot break X_3, but that is all. The reason why the rest of the record does not appear is supposed to be because the next make Y_3 came so late that the following screen X_4 was broken before the current was made, and thus there is no record.

This is seen to be almost the case at Y_2 where the make was only just in time to be recorded before the break X_3 came. From the result of eight different measurements of each angle on this plate, we find the following relation between s and θ:

s	θ
10	25° 33′.25
20	51° 30′.44

The angular velocity of this plate was $\omega = 4312.10$, an angle of 349°.1676 corresponding to 32 waves on the negative. If the velocity is measured by means of the muzzle and ten-foot screens, we have $v = 1687.4$ for a point half way between, or five feet from the muzzle. If we count from the muzzle to the twenty-foot screen we have $v = 1674.3$ for the velocity at ten feet. The velocity at fifteen feet may be obtained from the ten and twenty-foot screens. It is 1661.5 feet. We may tabulate as follows:

s	v
5	1687.4
10	1674.3
15	1661.5

This clearly shows a decrease in the velocity as we recede from the muzzle, but there is no indication to show whether the decrease began before or after the projectile passed the five-foot mark. The velocity is also so variable near the muzzle that it is not nearly correct to say that the average velocity between zero and ten feet is the actual velocity at five feet.

Negative 19, (Fig. 18). This same arrangement of circuits was tried again, except that the devices to close the circuit were brought forward and placed nearer to the preceding breaks. Arc light was used and the record gave every point complete, at intervals of ten feet apart except the last one which was only *five* feet, making in all six points in forty-five feet from the muzzle. The results of measurements on this plate is given in the following table:

s	θ
10	28°.098
20	56°.504
30	85°.016
40	113°.446
45	127°.793

As the tuning fork record on this plate is not distinct enough to read, we may assume that the muzzle velocity is as measured by the Boulengé chronograph, viz: 1628.2. The velocities are given in the following table, each value being calculated from the muzzle screen:

s	*v*
5	1628.2
10	1619.4
15	1614.6
20	1613.2
22.5	1611.3

It may be of interest to note that the radial lines *H, I, J* and *K* on this plate show the actual width of the slit used.

Negative 20, (Fig. 19). Screens were now placed at intervals of only five feet apart, from the muzzle to a distance of 45 feet, and also the further large ballistic screen was used. This negative showed that the make devices were not placed sufficiently in advance of the succeeding screen as the record shows only a few points, and then the current was just made in time. Although the devices were placed immediately after the preceding screen, yet the projectile would reach the next screen before the current was made. This showed that it took about .003 of a second, or the time it takes the projectile to go five feet, for the springs of the make device to come together. This time varies with the strength of the springs and the width of the insulating wedge. The light appears again at the make after the 45 foot screen, and the screen beyond was 118.2 feet from the muzzle, so that its record did not appear before the light was cut off by the camera slide at *P*. Sunlight was used for this negative.

Thirty-five waves on the plate correspond to 302°.10, and the angular velocity is therefore $\omega = 4397.4$. The relation between the space and angle θ are given in the following table:

s	θ
10	26° 3.'5
15	39° 1.'0
20	52° 10.'2

The velocities calculated from the muzzle screen are,

s	*v*
5	1687.5
7.5	1690.6
10.0	1685.8

This shows that there is an increase in the velocity indicating a maximum point somewhere between five and ten feet, but probably nearer five than ten.

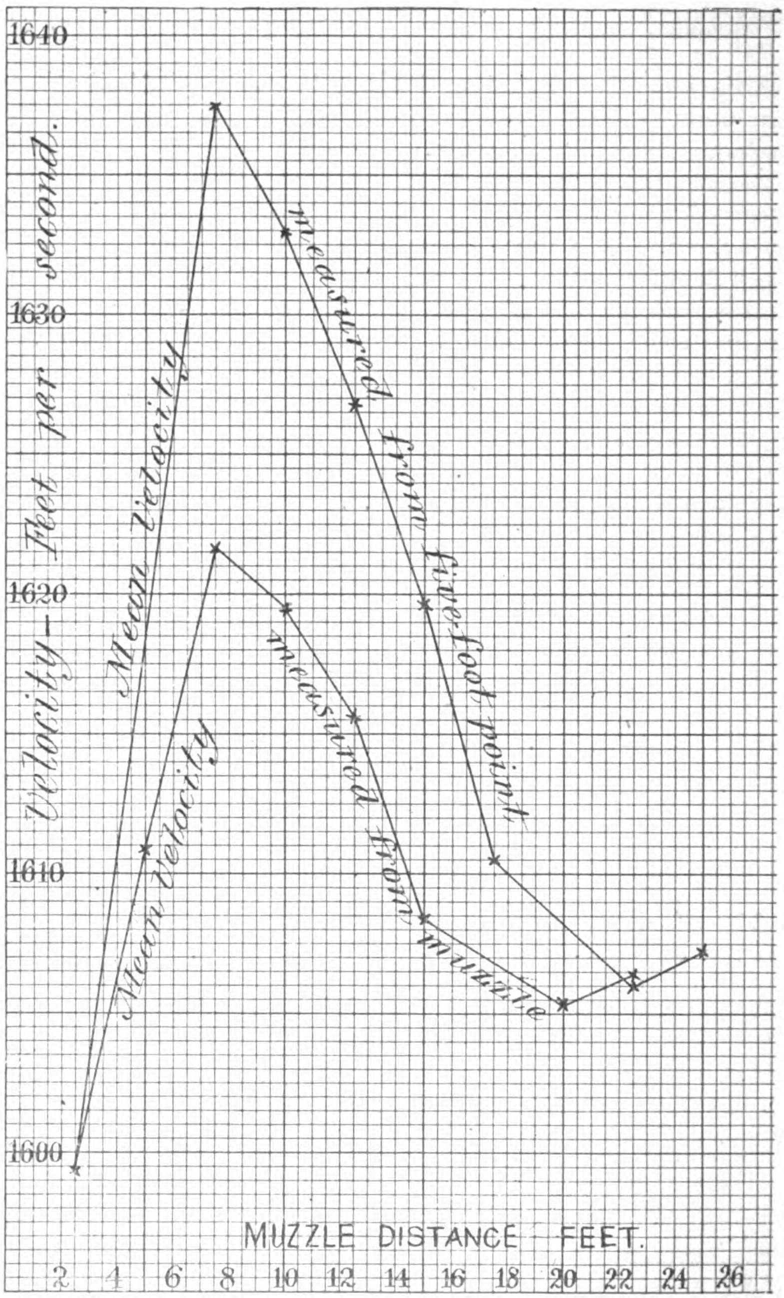
Negative 23, (Fig 20). The tuning fork record was not recorded upon this plate, so that the exact time of rotation is not known. This can of course make no difference in the relative velocities indicated by the relative spacing of the different breaks, and can only affect the absolute velocity about which we are not so much concerned. The Boulengé chronograph also failed to obtain a record of this shot. A very close estimate may be made however by comparing the dark space (or light space) on this negative with that on negative 20, since the whole time of exposure of each is alike. Such a comparison gives for the angular velocity of this plate 4421.3. The corresponding values of s and θ are shown in the following table. This is the first negative obtained in which all the points at five foot intervals up to 45 feet from the muzzle are recorded:

s	θ
5	13° 49′.29
10	27° 19′.29
15	40° 53′.79
20	54° 36′.00
25	68° 24′.83
30	82° 28′.25
35	— —*
40	110° 10′.46
45	123° 50′.88

The velocities found by considering the muzzle screen to be the first screen are shown in the following table:

s	v
2.5	1599.4
5.0	1610.8
7.5	1621.7
10.0	1619.5
12.5	1615.6
15.0	1608.3
17.5	——
20.0	1605.3
22.5	1606.5

* This record fell upon the cut in the plate and could not be accurately measured.



1640
1630
1620
1610
1600
Velocity - Feet per second.
Mean Velocity
measured from five foot point
Mean Velocity
measured from muzzle
MUZZLE DISTANCE FEET.
2
4
6
8
10
12
14
16
18
20
22
24
26

Figure 21.

This table is also exhibited graphically in Figure 21, and shows that the velocity suddenly increases within a distance of six or eight feet from the muzzle of the gun, and beyond that point gradually diminishes. The uneven appearance of the line is due to errors, not so much in measuring the record on this plate, as to the fact that the breaks of the circuit did not occur at exactly five-foot intervals since the point of the projectile does not strike each screen in exactly the same manner. The increase of the velocity after the projectile passes from the gun is so large however, that it is not hidden by errors. Every negative obtained shows an increase at the beginning of the trajectory. Since the velocity does increase for some distance from the muzzle, the average as measured from the muzzle screen must be less than if the point from which we measure were the maximum point. Let us therefore make a table of velocities, taking the five-foot screen as the first instead of the muzzle screen. The table of velocities calculated from the same readings as before is as follows:

s	v
2.5	1599.4
5.0	1637.5
7.5	1633.0
10.0	1626.8
12.5	1619.7
15.0	1610.5
17.5	——
20.0	1606.0
22.5	1607.3

This table is represented graphically by the broken line labeled "mean velocity measured from the five-foot point." This shows that the actual velocity at the maximum point must have been at least 1637.5, and this is considerable more than would have been assigned if the calculation had been made from the muzzle screen. It would in that case be only 1621.7 feet per second.

Negative 25, (Fig. 22). This negative was taken with sunlight, and besides being the last one taken, proved to be the best. It contains a record of the projectile at intervals of five feet from the muzzle to a distance of forty-five feet, and includes also a screen at a distance of ninety-five feet. At this stage in the experiments the apparatus was just getting into such shape that we could depend upon it to give results every time, when it became necessary to stop. Measurements on this plate are given in the following table. Each angle is determined from as many as eight measurements and the mean taken.

s	θ
5	13°.443
10	26°.525
15	39°.802
20	53°.123
25	——
30	79°.648
35	92°.940
40	106°.361
45	119°.827
—	——
—	——
95	253°.900

If velocities are calculated from the above table, regarding the five-foot screen as the first each time, we find the following table of velocities. The velocity at a distance of seventy feet is an exception to the above, the 45 and 95-feet screens being used for the 70-foot point.

s	v
2.5	1635.8
7.5	1681.0
10.0	1668.6
12.5	1662.8
15.0	——
17.5	1664.8
20.0	1663.6
22.5	1656.7
25.0	1653.7
50.0	1646.2
70.0	1640.2

This table is exhibited graphically in Fig. 23 and shows a distinct rise in velocity after leaving the muzzle, which gradually falls off later. The irregularities at the points are no greater than in *Negative 23*, but the correspondence between the two negatives is quite marked. The rise in velocity is nearly the same in each, and the maximum point occurs at approximately the same distance from the muzzle.

These results may be otherwise exhibited. If a curve is drawn representing the relation between the space and time (or what amounts to the same thing, the space and angle θ which is

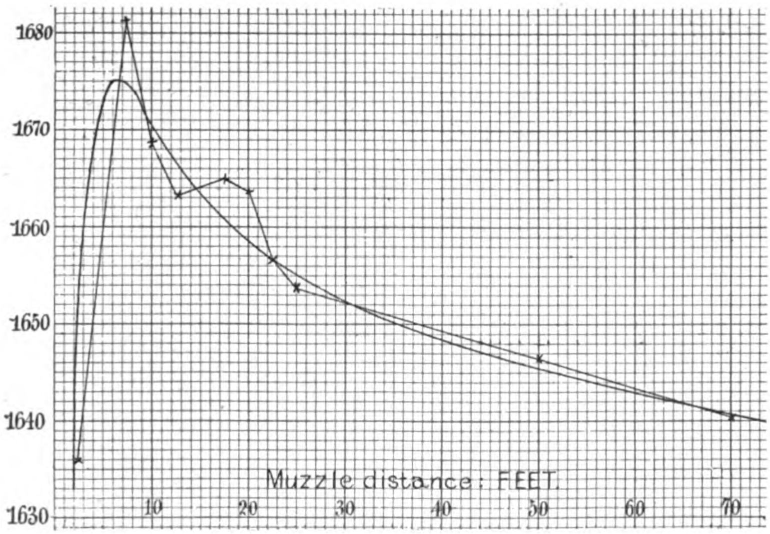
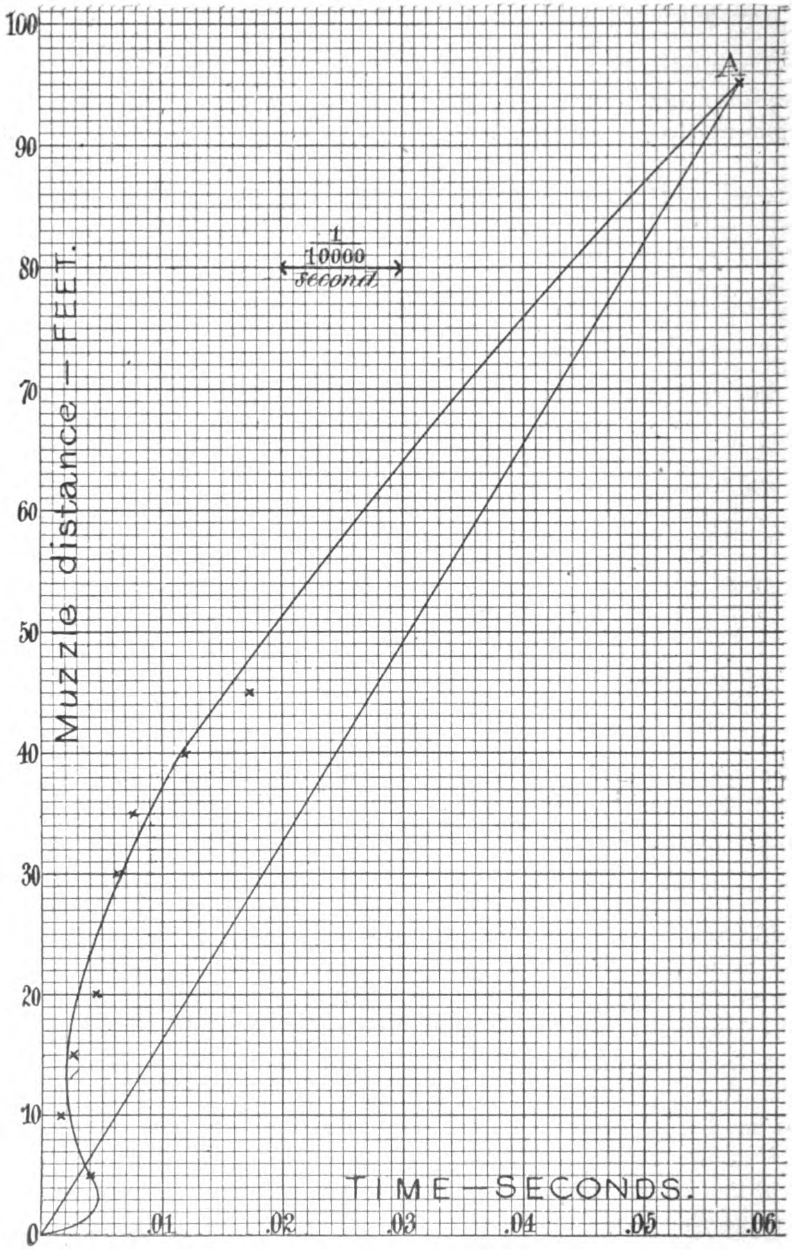


Figure 23.

proportional to the time) found in the table above, then we might find the velocity at any point by measuring the tangent of the angle which a tangent line makes with the axis of time because of the relation $v = \frac{ds}{dt}$. In Fig. 24, if the points given in the table are located according to the scale there indicated, they will be found to lie very closely upon the diagonal line *OA*. They do not, however, lie exactly upon it, and all the points beyond the first lie to the left of it. If the distances which these points are from the diagonal line are magnified one hundred fold (so that two large squares correspond to one ten-thousandth instead of one-hundredth of a second) the points will be located as they are in the diagram. For example, the point opposite forty-five feet lies about two squares to the left of the diagonal line, which means that the time in coming to the forty-five foot point was one ten-thousandth of a second less than it would have been if it



100
90
80
70
60
50
40
30
20
10
0
Muzzle distance — FEET.
A
1
10000
second
TIME — SECONDS.
.01
.02
.03
.04
.05
.06

Figure 24.

were exactly on the diagonal line. A curve is drawn passing within the limits of error through all these points, in such a manner that the tangent of the angle which the tangent line to this curve makes with the time axis when properly translated, represents the velocity in the former curve, Fig. 23. It is seen that the point of inflection in this curve occurs at the position of maximum velocity, and the velocity increases up to this point, and then gradually diminishes again as it is observed that the tangent then decreases.

The instrument used to measure the angles on the negatives is a large spectrometer, with a graduated circle reading directly to ten minutes of arc, and with the verniers to ten seconds. The two halves of the negative were fastened down upon a piece of plane glass, and the whole laid horizontally on the turning table of the spectrometer. The negative was supported upon blocks so that the light could be reflected up from below, and it was centered by means of the circles of reference on each plate. The settings were made by looking through a stationary telescope with cross hairs.

CONCLUSION.

The foregoing experiments described in detail justify one or two conclusions:—This chronograph as thus far developed, although home-made and hastily assembled, has clearly demonstrated its important field of usefulness for the accurate measurement of small intervals of time. The record made by a break in the current due to the passage of the projectile is sharper and more defined than we had anticipated, and this permits of an accuracy in reading the record even beyond that attainable in measuring the intervals between screens on the proving ground. A future working instrument designed upon this fundamental principle is capable of endless modification, and an instrument properly designed would be as simple in its operation as any of the well known chronographs now in use. The whole is manipulated by a single switch which fires the gun and obtains the record.

The adaptability of this instrument for obtaining observations at any number of points of the same trajectory and the nearness which these points may have to each other, make it admirably suited to the study of the law of change of velocity near the muzzle of the gun, and also to the systematic study of the law of the resistance of the air to projectiles of various forms; a problem which, since the advent of the modern high-power gun with its realm of velocities unthought of in the classic experiments of Bashforth, is at present of paramount importance to the science of *exterior ballistics*.

The principal ballistic result obtained from these experiments may be said to be the locating of a maximum point in the velocity curve outside of the gun. This maximum point is, in the case of the gun and conditions of loading described, at six or seven feet from the muzzle of the gun,—certainly more than five feet and less than ten—or about 25 calibres in front of the muzzle. The increase in velocity from the muzzle to the maximum point is large, more than 40 foot-seconds. The muzzle velocity being about 1600 feet, this increase is about 2.5% of the whole.

The decrease in velocity beyond the maximum point is comparatively gradual, obeying the true law of the resistance of the air so that the projectile must travel about a hundred feet before the velocity is reduced to that which it actually had at the muzzle.

This maximum point introduces an error in the present method of obtaining muzzle velocities in which the velocity is measured at a distance of one hundred to two hundred feet and reduced back to the muzzle by formulas.

DIAGRAM.

The direction of this error is shown in the above diagram. Supposing that the heavy line represents the true velocity curve, the part beyond the maximum point *M* would follow the law of the resistance of the air, and by reducing back by formula the law of air resistance is assumed to be continuous to the muzzle. This would extend the velocity curve corresponding to formula back of the maximum point, as indicated by the dotted line, to *A*. The diagram measures velocities from a horizontal axis much below the axis represented, the increment of velocity above the actual muzzle velocity alone being represented. The diagram shows that the computed velocity for the muzzle is greater than the actual muzzle velocity by an amount OA and also greater than the *maximum velocity actually attained by the projectile* at M by the amount AB.

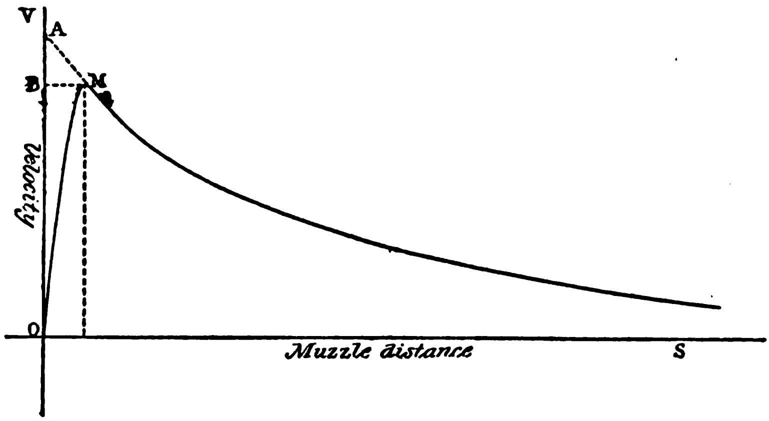


Figure 25.

The determination of the law of development of velocity inside the bore of a gun has been the subject of investigation by two general methods. The first is that originally employed in 1760 by Chevalier D'Arcy, and recently in Paris by Mr. L. V. Benet, an account of whose experiments is given in this *Journal.** Successive lengths are cut from the chase of the gun and the velocities measured for each artificial muzzle. The second method consists in piercing the chase at intervals and observing the velocities with a chronoscope such as Noble's. It need not be stated that any method which would permit reliable interior velocity curves being taken without the mutilation of the gun must surely be a distinct advance. Upon the data which such curves would furnish, rest not only the questions of gun construction but also the ready study of new powders and their adaptability to existing ordnance.

A few preliminary experiments were tried with a view of determining the value of this instrument for the measurement

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of velocities inside the bore, but any mention of them is withheld until further experiments can be made. The time at our disposal was so limited and so many dfficulties had to be overcome on account of the *most inclement* winter weather, and the necessity of improvising all apparatus on the ground, that it was decided to devote all disposable time to problems outside the bore.

We cannot close this paper without expressing our obligations to Lieutenant John W. Ruckman, 1st Artillery, and Lieutenant C. D. Parkhurst, 4th Artillery, for assistance rendered throughout these experiments.

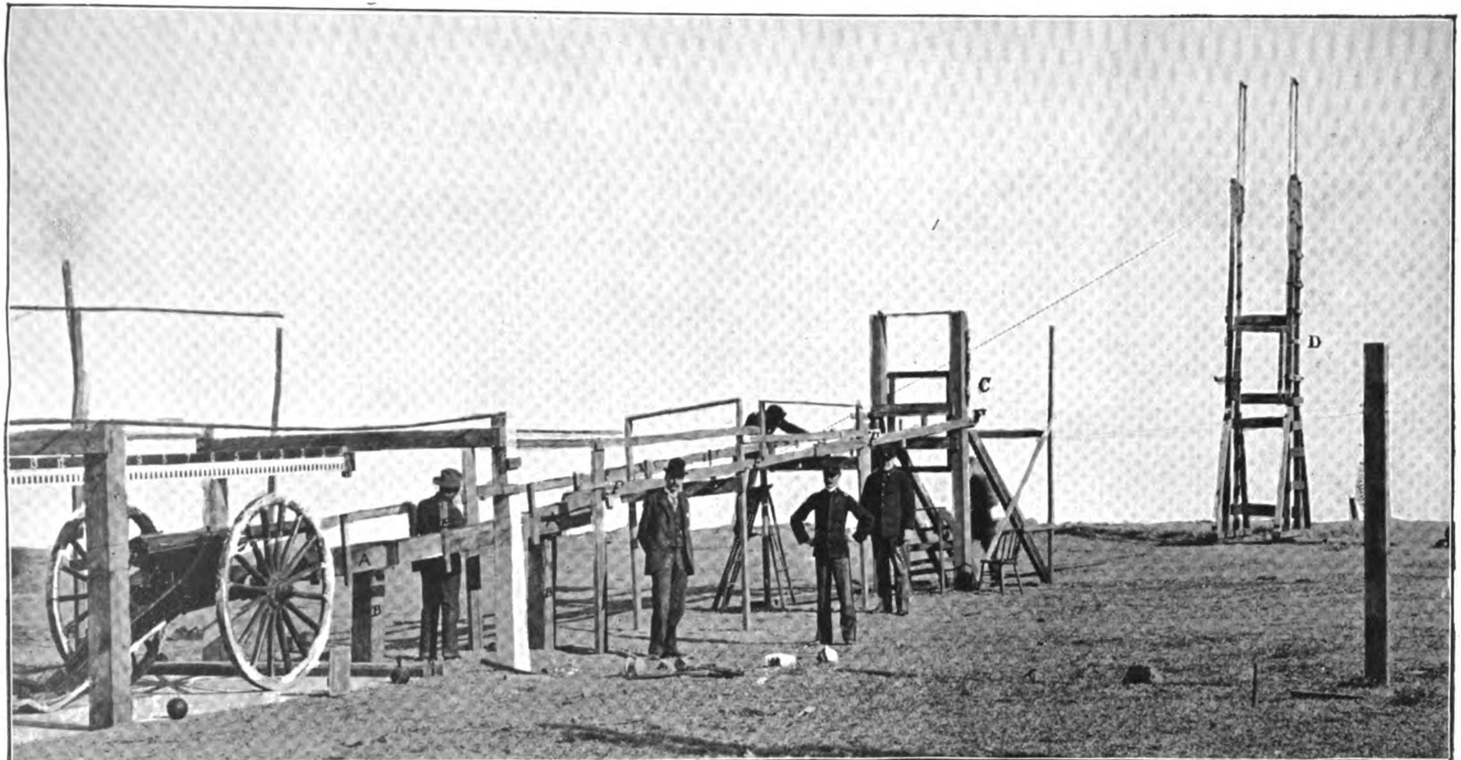


FIGURE I.

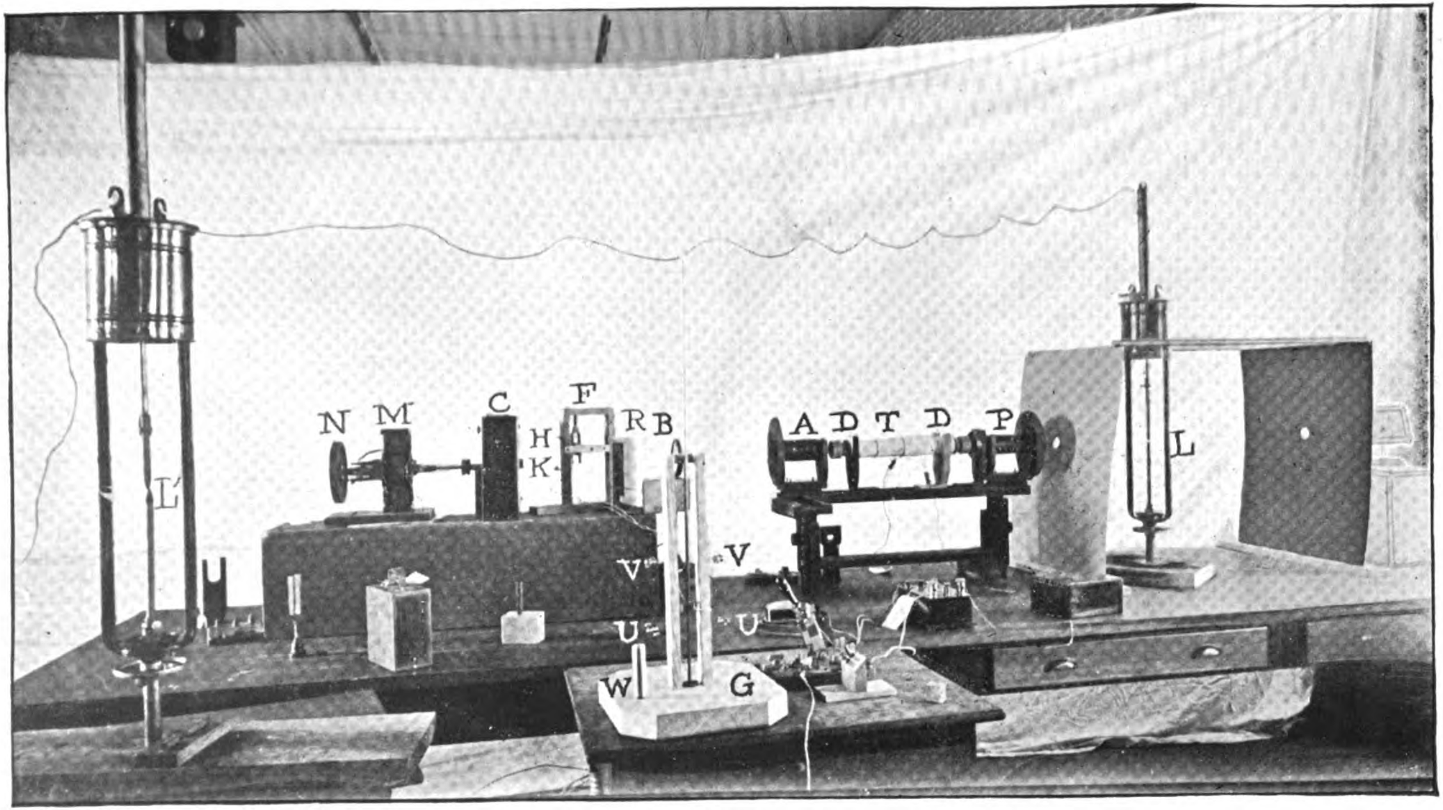


Figure 3.

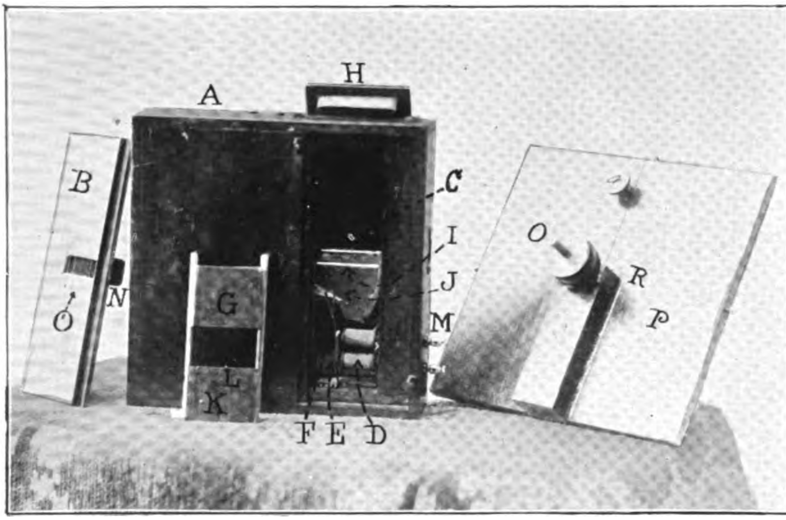


FIGURE 6. — *Camera, front view.*

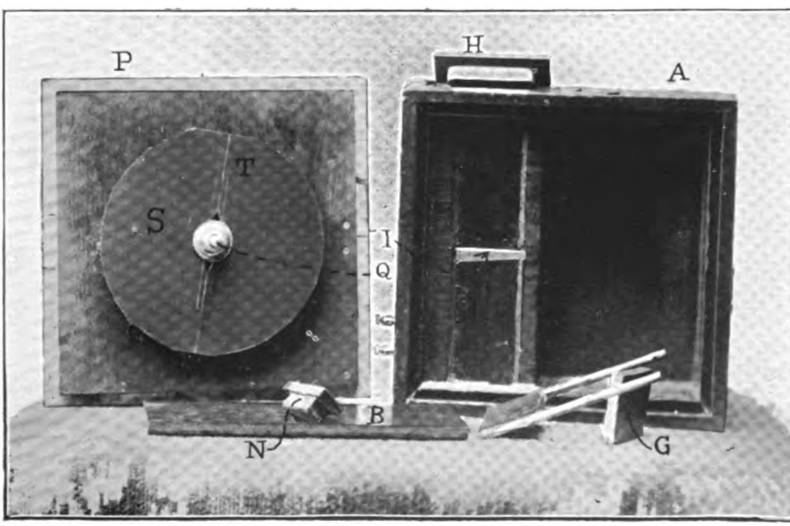


FIGURE 7. — *Camera, interior view.*

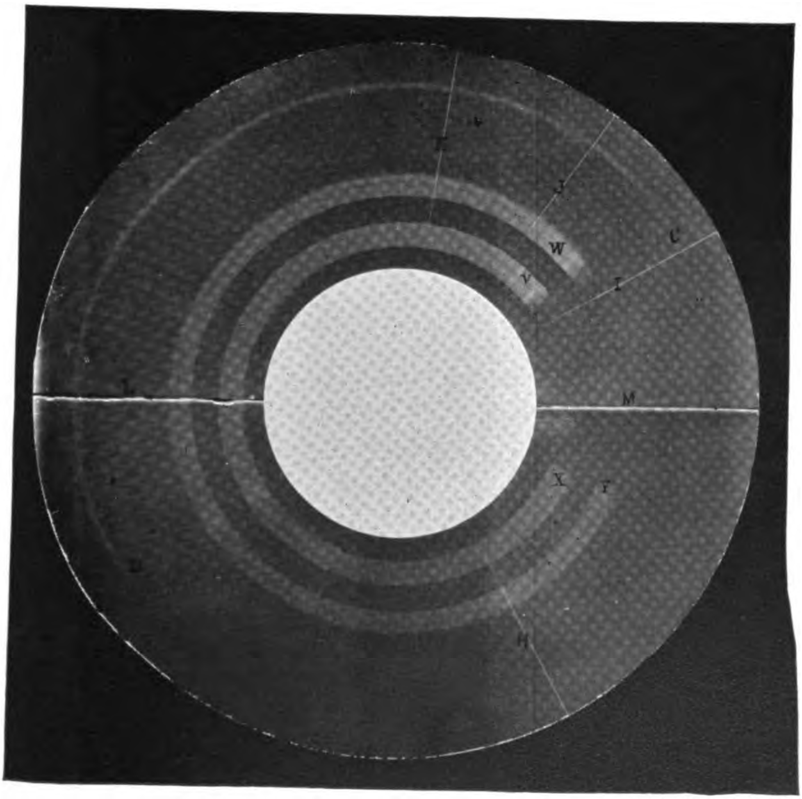


FIGURE 10. — *Negative* 8.

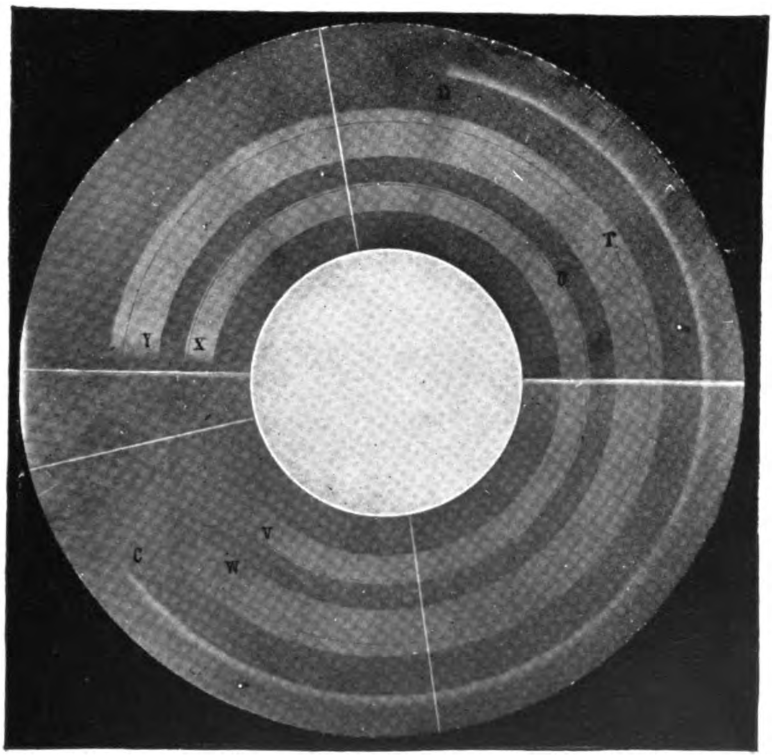


FIGURE 11. — *Negative* 13.

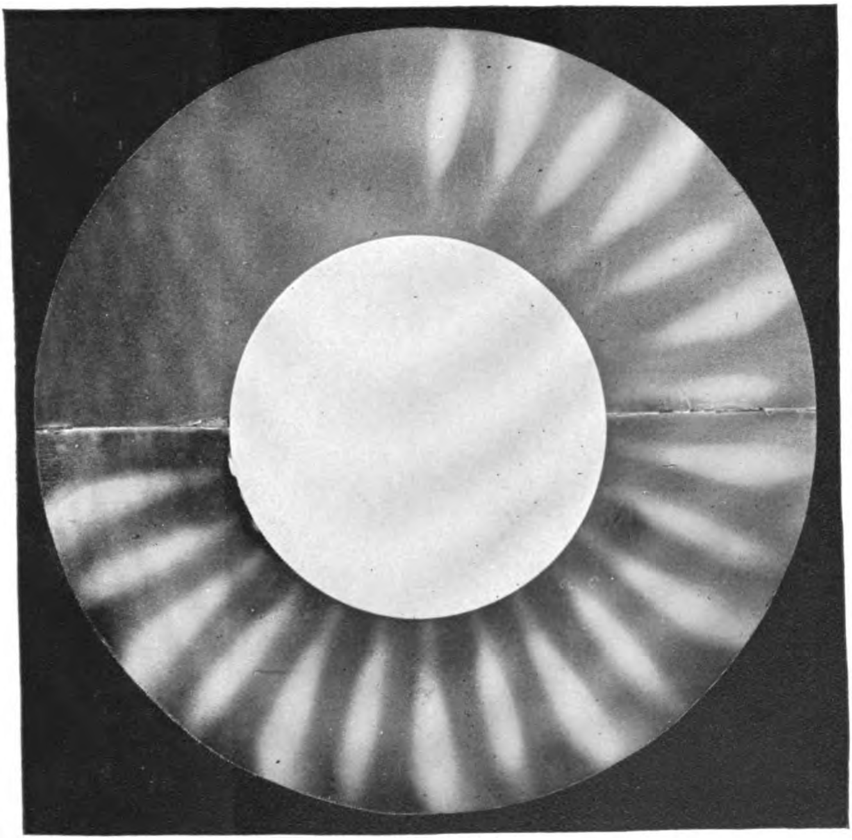


FIGURE 12. — Alternating current arc light.

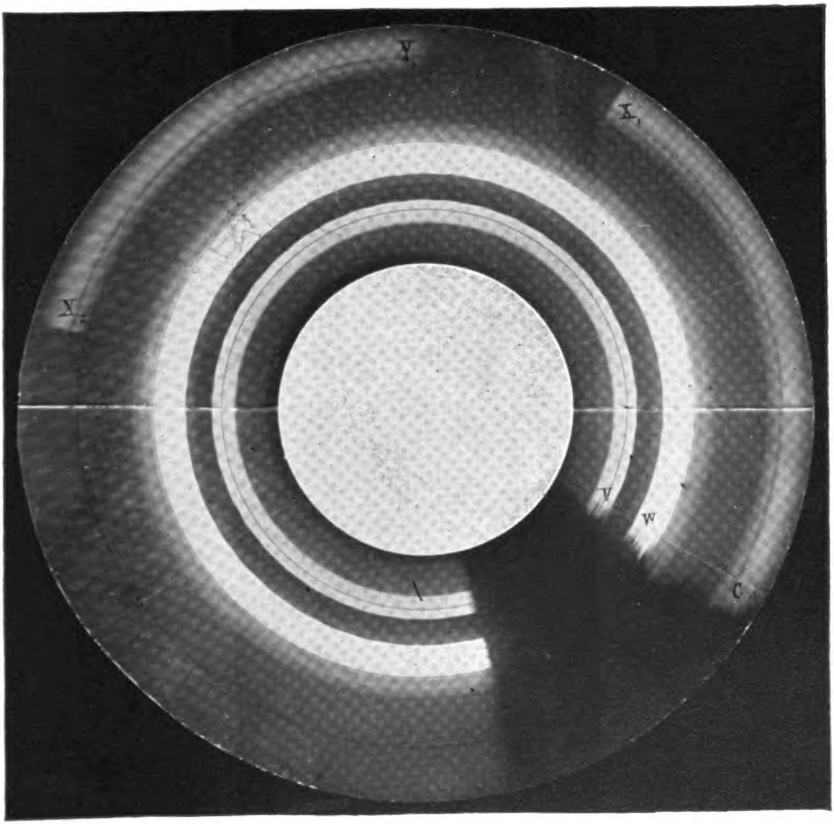


FIGURE 14. — *Negative* 10.

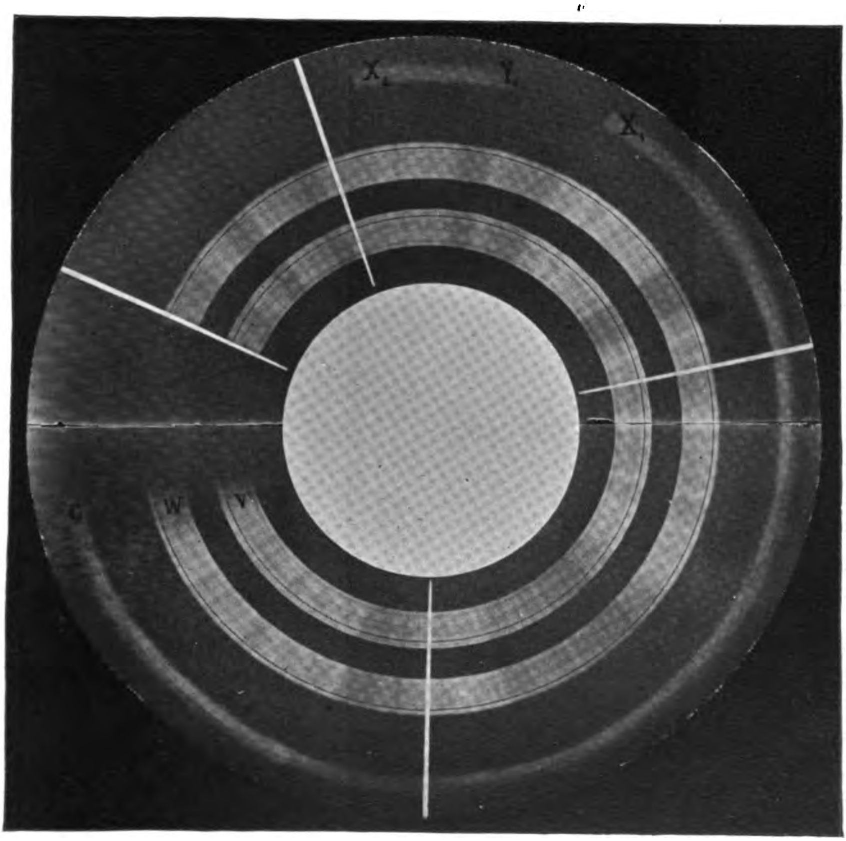


FIGURE 15. — *Negative* 16.

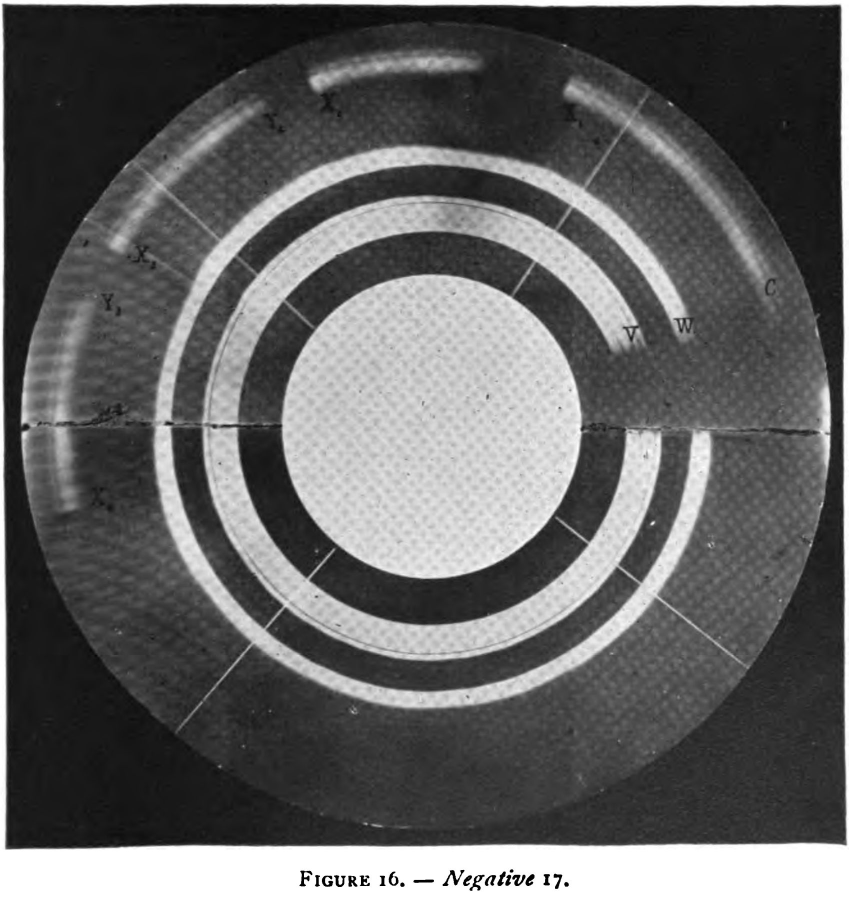


FIGURE 16. — *Negative* 17.

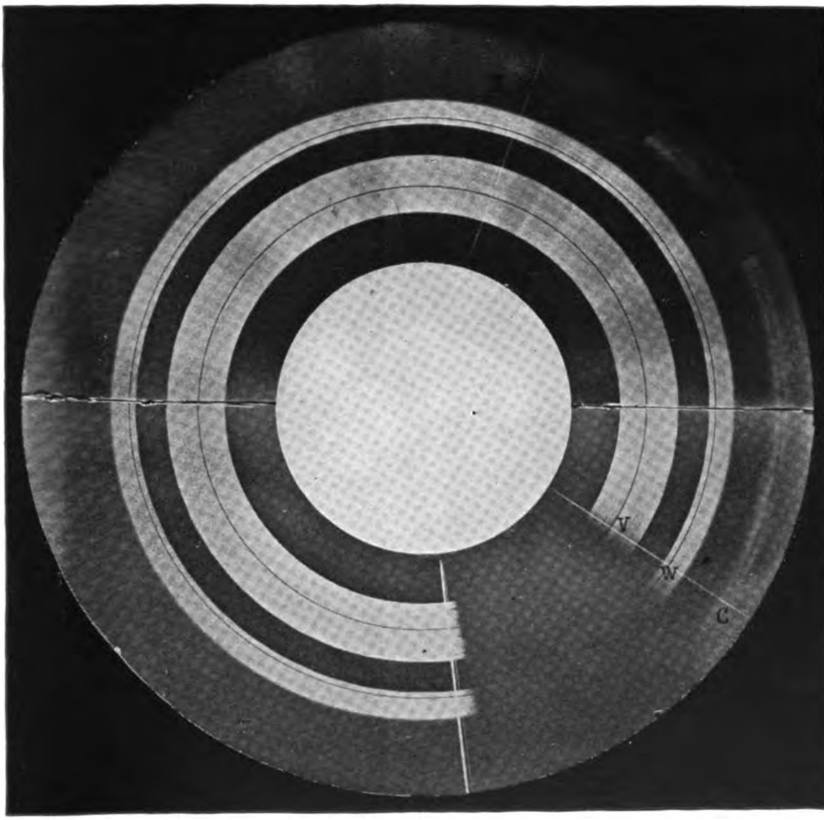


FIGURE 17. — *Negative* 18.

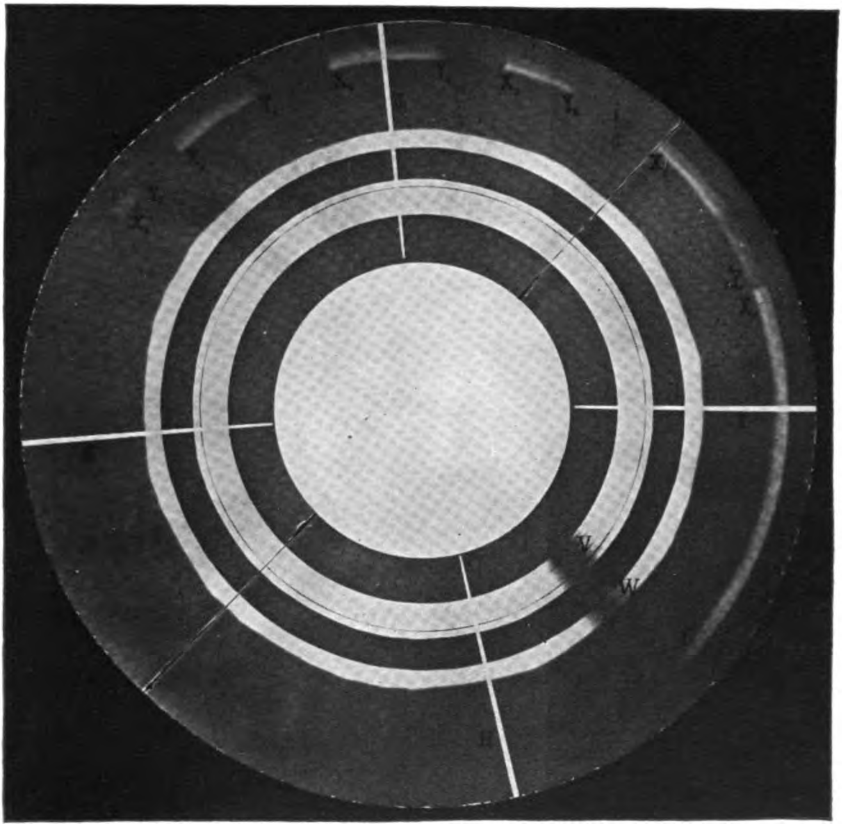


Figure 18. — *Negative* 19.

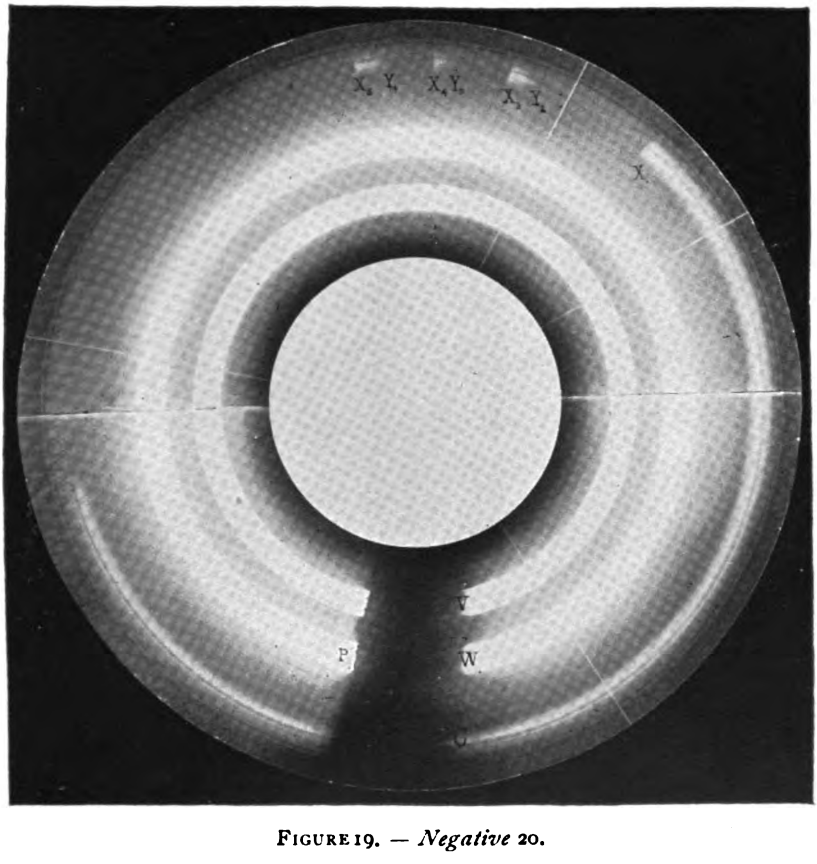


Figure 19. — *Negative* 20.

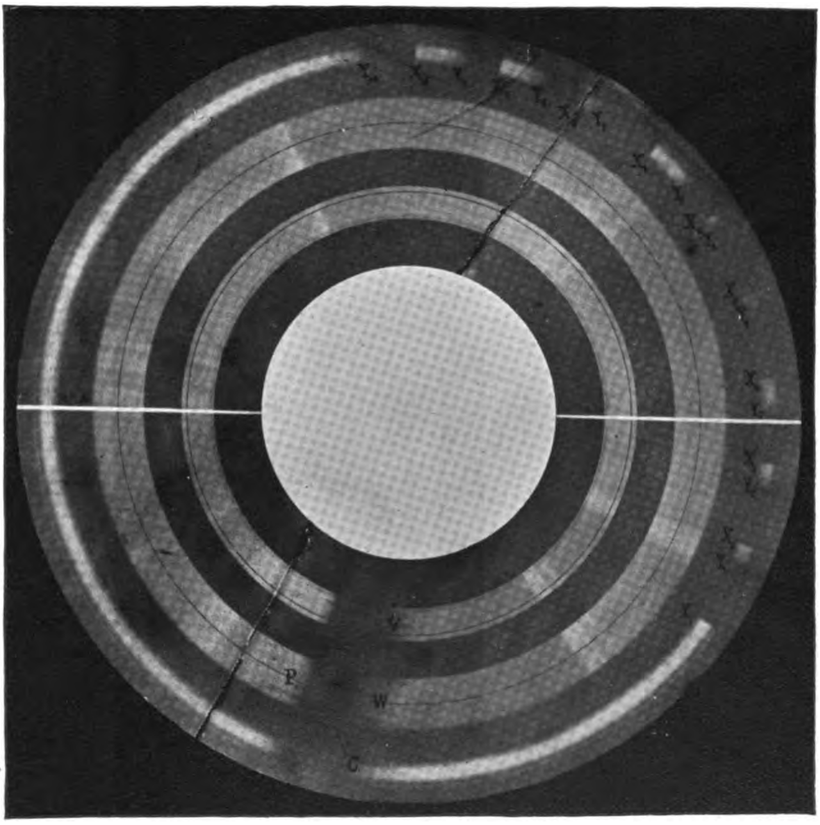


FIGURE 20. — *Negative* 23.

THE DEVELOPMENT OF A NAVAL MILITIA.

BY COMMANDER JACOB W. MILLER, I NAVAL BATTALION, NEW YORK.

The ex-naval officer approaches the subject of the development of a naval militia with much diffidence. His early training and association naturally lead him toward the naval view of the question, while contact with the merchant marine, and practical experience in the details of organizing volunteers tend to destroy some of his preconceived ideas concerning the scope of a state force. The interest which has arisen throughout the country in a naval militia is of such recent date, and the laws and conditions governing the corps in various localities are so different, that it may be scarcely time as yet, to lay down any positive rules concerning the future of the movement. I can therefore only present the subject as viewed from the New York standpoint, prefacing my remarks with a general statement of the underlying principles which should govern the relationship between the civilian sailors and the United States Navy.

The type of mind developed by military education is naturally prone to think that action by the central government should always precede local action. This trend of thought is increased in naval circles from intercourse with foreign countries and personal knowledge of monarchial methods. One of the strongest factors of our institutions however, is the spirit of local autonomy, with its competitive and individual rivalries, working both for good and evil; and no project can become a national force until it has fought its way to success through the stress of primary discussion in the hamlet, the city, and the state.

This evolution is nowhere more apparent than in the rise of the militia of the United States. Immediately after the Revolutionary war a National Guard was proposed, under direct government control. The name alone remains to-day; all the steps which have been made during the past one hundred years having been on state lines, until, from the various inefficient "trained bands" of the past have grown the well equipped and disciplined bodies which are fast approaching an army standard.

The growth of a National Naval Militia, or as it is generally called, a "Naval Reserve", would naturally be slower. Physical conditions separate the seafaring man from the landsman and delay essential cooperation, while the occupation of coasters and fishermen make them a race apart from their fellows on shore. Geographical and political reasons have also retarded the spread of the movement, individual and corporate effort having been turned, during the past thirty years, away from the sea towards the development of the interior. Many other reasons go to show how difficult it has been to focus the small seafaring population into any body for national defense; and it was, therefore, natural that all attempts from Washington and Jackson to Whithorne should have resulted in failure. Such a body will ultimately be formed, but not until a revived merchant marine shall have grown into larger proportions: commercial ships and crews will then be united with the government non-combatant marine forces, by some wise legislation which the navy and the general government shall evolve. Even so great a nation as England with its extensive fleet and seafaring population, has not as yet perfected an efficient "Reserve," and it is scarcely to be expected that the United States can for a long time solve the problem.

The question then arises: Can we enlist the interest of the states in a movement looking to the protection of their own immediate coasts? This question was no sooner asked, some six years ago, than it was answered by the enlistment of some 3000 men in the various battalions which now form the naval militia of nine states. The success of the movement was due to its local characteristics as outlined above, as well as to the fact that the building of our new fleets had kindled a sentiment which is already spreading beyond commonwealth lines towards broader national patriotism. Experience has more and more forced upon the mind of us, who had the honor of being in the navy, that our earliest conception of forming at once a school of education for the "forecastle" was erroneous and a waste of effort tending to jeopardize the movement.

The results, even of the first cruises, in 1891, were more direct and tangible from a state than from a navy standpoint, for while a close and most friendly relation was developed between the officers and men brought in contact, the regular service as a whole was naturally skeptical of the future usefulness of raw recruits, whose main claim to recognition was enthusiasm and a certain longshore knowledge. The direct and immediate need of the navy at that time was an increase of foremast hands, and the composition of the battalions was not thought to be capable of supplying deep-sea sailors; — a criticism which in its direct application was perhaps just, and subsequent years seem to have only enforced this naval opinion. Indirectly, however, the naval militia was building up a sentiment which was of far more value than an increased complement, and its influence was the more felt because the personnel was of a type taken from the higher walks of life; experience in the state land forces having proved that the example of a high grade of privates, in crack regiments, permeates at once to those composed of the lower orders. Furthermore the original battalions are an officers' school for future ones, which will eventually be formed from the longshoreman and sailor class, a type preeminently fitted for emergency men-of-warsmen. The natural and laudable ambition of the regular officer to reach the ultimate rank in a profession which in time of peace gives slight hope of promotion, should never be checked by the chance of outsiders coming between him and high position in time of war. The duty of the militia officer therefore should be limited to his state, and his pleasure unlimited in advancing unselfishly the interest of the naval service.

The immediate outcome from the state point of view was more direct. The favorable comment which the first cruises obtained begot in the commands a resolution to supplement enthusiasm by discipline, while the example set by the crews of the white squadron developed a capacity for work which has rarely been surpassed by volunteers. The spirit was reflected throughout the state, producing a result at Albany in a liberal appropriation. In order to continue this good will the naval militia had to show a definite aim, based upon state defense, and that aim had also to bring it into close touch with the national guardsmen without interfering with their finances or recruiting. The early difficulty was to learn exactly how and where this dividing line should be drawn while keeping up a relationship with the navy. The feature which largely determined the problem was the geographical characteristics of the state, with its extended water front on the lakes and the ocean.

It had been remarked that the naval militia could never occupy the same position towards the navy that the land militia does towards the army; the two latter could combine more readily as the differences between them are only in degree of discipline, both acting on the land; whereas the naval militia, in addition to discipline, was compelled to master the intricacies of a sea duty, foreign to its civilian and shore habits. It was manifestly impossible to accomplish this in a five years enlistment, in addition to the requirements of general headquarters, as the actual experience of life on board ship was necessarily limited to a week's annual cruise. In default therefore of attempting to create a man of warsman from the citizen sailor, what was the best practical result to be attained? Evidently, with our environment and limitations, to perfect a thorough knowledge of the coast and waters of our commonwealth, and to act as an amphibious connecting link between the navy, as a first-class line of defense at sea, and the army and national guard on shore. A glance at the state of New York will show how essential it is to have a force of this nature, and a little reflection will convince the most doubtful that there is sufficient work to be done to occupy a volunteer body for years to come. It has been the definite aim of the naval militia of the state to follow this policy during the last four years. Three annual cruises of short duration have been made with the navy, their object being to perfect gunnery practice, to obtain a general idea of modern naval methods and of the rudiments of ship life; but these tours afloat have always been within state waters. One independent cruise was made as a preliminary study of a portion of Long Island Sound, in order to crystalize the command into a self reliant body. Expeditions of several hundred miles were taken last summer, to familiarize the men with littoral navigation and to create in them handiness in the management of small boats. The results of the expeditions have been tabulated, and the Naval War College at Newport has been furnished with information concerning the eastern end of the sound, which had never been before prepared for war purposes by men who had made a study of definite and specific localities.

Great stress has been laid upon signal work, as practiced both by the national guard and the navy, as well as upon all other duties essential to prompt communication between land and sea forces. Permanent signal stations have been established upon the coast after a personal examination of their necessary characteristics, lists of available craft for transportation and torpedo-boats have been prepared, and while all these activities were being perused during the summer, against the time when some foreign war might arise, the winter months have been utilized in perfecting a system which might meet this remote emergency, and also make the naval militia effective in the much more immediate and pressing problem of domestic disorder arising near the water front.

The organization of a state marine force must be modeled on naval precedent, hence the terms and titles employed have been those of the service. The "Divisions" when united are analogous to the crew of a modern ship; when subdivided, each smaller portion, as well as the individual, readily falls into place on board a man of war. The "quadrantal" or "quadri-sectional" system was adopted, even before the navy officially recognized its superior merits. Space will not permit a description of that system, but through it, the transition from sea duty to coast work, and thence to co-operation with the land forces, has been rendered simple, the battalion organization giving equally good results, whether it be temporarily on board a cruiser manipulating great guns, or near shore protecting a dock as light artillery; and each division whether manning tugs, or acting simply along the water front, has within it all the requisites essential for such detached duty. No expert class, except such an one as can be developed within the division, is allowed, it being the intention that the unit shall ultimately contain the required percentage of signalmen, torpedoists, engineers, messmen and local pilots necessary for independent action.

Such in brief has been the aim and effort of the New York Naval Battalion during the past five years. It has not attained perfection even in state work; but it has labored conscientiously and with due regard to the helpful appreciation received from the people and the government.

Having established intimate and cordial relations with the navy on one hand and the national guard on the other, the next step, of making some practical combination between the different militant forces, follows as a natural sequence. A beginning was made in this direction last year, when the navy, the artillery and the militia of two states communicated by signal from Block Island to Fort Trumbull. A further amplification in the way of joint maneuvers could be easily accomplished. It so happens that a large fleet will be in this vicinity during the coming summer, and that it will be commanded by an admiral anxious to cooperate with the other branches of the service. The President of the War College at Newport is, moreover, now engaged upon the problem of the defense of the coast. The Adjutant General of New York has also lately issued an order that certain regiments may perform duty in the field, in lieu of the ordinary camp routine at Peekskill, while the numerous army posts between New York and Boston are in a position to assist. A little energy on the part of the various officials could bring these commands together at that most vulnerable point, the eastern end of the Sound. The proposed plan does not involve the mobilization of large numbers; a detail of two regiments of national guardsmen, the naval militia and a few regulars would be sufficient, the numerical force, both land and sea, being based upon a general percentage of one hundred to one. Keeping this latter point in view the fleet could be divided into two squadrons, one representing the attack and the other the defense. Five hundred national guardsmen by taking a transport in the afternoon would reach Montauk early on the following morning, acting there as the enemy's troops and landing under cover of the guns of the fleet; another regiment to go by rail down

Long Island, the naval militia becoming its flankers on the sound and on the bays of the south shore. At Gardiner's Bay they would unite with the squadron of defense, the home forces and the enemy meeting on the main line near Sag Harbor, where a series of tactical and strategical movements could take place. The addition of a small *cadre* of Connecticut and Rhode Island militia would materially assist in signal work across the race, and in manning light artillery and placing mines near Greenport. Five days of such a campaign would cost no more than a week at the state camp, and would be as interesting as it would be instructive, serving also as an object lesson for civilians who know too little of what is being done by the military and naval contingents. The most important result, however, would accrue to the various forces participating, each learning from the other the defects which undoubtedly exist to-day to prevent successful results in case of a war emergency.

It may be well to note these defects, or rather differences between the various arms of the service. The army has recently adopted a small arm of different size bore from the navy; the militia has other guns and their calibers are not identical. If, therefore, ships and troops were massed to-morrow at the intersection of the three states, near the mouth of the Thames river, and an action occurred, it might be lost for want of a common ammunition. The forces would also be without a pre-arranged signal system. The army and the national guard use the "Morse" and the navy the "Myers'" Code, while the naval militia, in its province as a connecting link, endeavors to learn both, but only with doubtful success. The "wig-wag" should be as familiar as the mother tongue, and no two sign languages can be equally mastered.

The navy also has a distinctive set of sea signals known as the "Navy Code." This code is printed in a large volume which consists of two distinct parts, embracing the system and the vocabulary. Flags and lights of various sizes, shapes, and colors are hoisted to denote certain meanings. The principles given in this code are not in any sense an index to the vocabulary, nor does the drill concerning the arrangement of the symbols serve as a guide for their interpretation; and yet the Navy Department, with a conservatism which may lead to dire results, looks with extreme disfavor upon any State organization having access to its "Signal Book"; the reason being given that the messages printed therein would become common property. The self-evident and immediate answer to this objection is that an expert hostile signalman could master the vocabulary within a few hours, and that no admiral would be worthy to command a fleet in time of war unless he used a cipher, and changed that cipher daily. The Navy signal book should at once be printed in two parts, the first part containing the principles involved as well as all other data, except the actual numbers denoting certain messages. These latter should be in a separate volume, while the first part should be placed in the hands of all the naval militias, so that any off-shore action may not be jeopardised for lack of prompt transmission of orders between land and sea. Pre-arranged combinations and permutations are easily and quickly arranged, but practice alone will create exact manipulation of the symbols used.

One other cause which exists and prevents effective coalition is the lack of modern instruction books dealing with long-shore work. The recently adopted small arms have necessitated many changes in the tactics, and the army and the navy have drifted apart, the navy using certain land methods in their drills, while discarding others, until to-day the "Instructions for Infantry and Artillery" are so full of errata that a new addition should be printed. The same neglect of keeping other text books up to date is noticeable, and it is impossible for the militia to drill properly until the bureaus at Washington can promptly supply late and standard publications; even the antiquated "Ordnance Instructions" cannot be had, and no late edition of the torpedo drill book is accessible. The "Navy Regulations," although revised some two years ago, cannot be obtained in sufficient quantities to meet even the requirements of the service: no pamphlets are issued showing the new uniform, adopted by the board of officers appointed for that purpose; no station bills are published for the latest type of cruiser, while it has been reserved for an officer of Massachusetts to make the first compilation of departmental circulars relating to great gun exercises. Numerous public documents are scattered by Congress broadcast over the land, only to be thrown into the waste paper basket, while students of naval subjects have their applications for books returned from Washington with the endorsement that "none are on hand" in the navy.

These patent defects are referred to not in any spirit of hypercriticism; equally grave ones perhaps exist in the army and should be treated by some one more closely allied to it than the writer; they are mentioned only to be remedied, and certainly should not discourage the effort for a closer alliance between the State and Government forces. On the contrary, the different branches of the service should be brought practically together, in some small way, at the earliest opportunity, and thus learn through existing discrepancies the lessons of future success. Until this next, and most important, step is taken there is little use in attempting to form a national reserve. It takes years of buffeting on the seas to create the Anglo-Saxon sailor, and it would be effrontery for the naval militiaman to suppose that a few short cruises could fit him for the position of an American man-of-warsman. The few navy men who think that such is the aim of the volunteers belittle the men who serve in the forecastle and are unappreciative of the possibilities of their profession. The larger number of officers have understood the true scope of the naval militia as well as the dignity of their own calling and have thus materially assisted the small, but zealous corps, in its efforts to learn its duties in shallow waters before venturing upon the intricacies of deep-sea navigation.

At the close of the first four years of its existence, the naval militia shows an increasing membership and vitality. It has decided what are its immediate duties; and is studying its future ones. Its next steps should lead it towards some combination with the departments controlling the municipal tugs, so that these small vessels and their crews could co-operate for a few days during the year with the militia. There should be allowed to each naval battalion an engineer with a few petty officers under him, and these men together with the engineers of the tugs would form a nucleus which could be easily exercised in naval duties and increased by the addition of firemen and coal heavers when necessity demanded.

After the organization has proved its staying power, inducements should be held out to the Corinthian yachtsmen to join a navigating or torpedo corps. Small steamers flying the naval reserve flag of the State would thus be added to the naval brigade and would be of much service in creating a force whose duty it would be to assist in collecting coast information and giving facilities for torpedo exercise.

With these aims realized, the time shall have arisen for creating a national reserve embracing merchant vessels and ther crews as well as the collateral marine interests; but this plan can never be practically successful until the whole country has awakened from its present dormant condition concerning all maritime affairs.

EXTRACTS FROM THE JOURNAL OF 2nd LIEUTENANT JOHN WILKINSON, 6th ARTILLERY, SERVING WITH LIGHT BATTERY "H," OF THAT REGIMENT, FROM OCTOBER 1st, 1897, TO OCTOBER 1st, 1900, AT FORT RILEY, KANSAS.

October 1st, 1897.—I arrived to-day at my new post. It is a far cry from my last station, Washington, but it seems to be a good place for a light battery. There are 21,000 acres in the reservation, comprising all kinds of ground: a river bottom, flat as a floor; low rolling hills; deep ravines; and bluffs difficult of ascent in many places. There is a magnificent target range practically unlimited in extent. Thousands of acres of pasture land afford grazing for a great part of the year, and during many months the forage allowance is reduced on account of the horses being grazed. So much I have already learned of the post. As to the battery, I have seen something of it. I strolled down to the stables about the time for afternoon grooming, and was surprised to find that the members of the guard were attending to the horses, watering, bedding down, &c., and that there was no grooming. The captain, who happened to be there at that time, told me that, except after marches or some especially hard exercise, he omits afternoon grooming. He says one grooming a day is plenty, with thorough rubbing down after drill or exercise. The horses are not fat, in fact some of them look almost thin. The captain says he does not believe in fat horses, but he gives them enough to eat to keep them in good working condition. They appear, tough and well-seasoned, the result, I am told, of frequent marches. I asked about the riding horses and the captain told me I could choose any horse I pleased, except, of course, one ridden by a senior, but that probably I would like best the one used by my predecessor. I looked at the animal and found him very fair, as are all of the officers' horses. The captain says he makes a point of getting good horses for his officers, as he wishes them to be the best mounted men in the battery.

As we stood talking, three men came in who had been out for a pleasure ride. I asked if the men did not sometimes ride their horses too hard. The answer was that they did, but not often, and that any man who misuses a horse loses the privilege for three months, and the captain said he had never known any man to repeat the offense. His theory is, to make the men as contented as possible with the service. He gives them all the privileges consistent with proper discipline and military efficiency, and has absolutely no restrictions for the mere sake of restraint. The pass system is unknown except when a man wishes to be absent from some duty. He works his men, works them hard, but he never nags them. It is the same with regard to the officers; except the one on duty they are free to go and come as they desire. Altogether, it appears to me that the service at this post is destined to be very satisfactory.

October 16th.—To-day I finished my first week as battery officer. I have been during that time, practically executive officer of the battery. Of course, as I am new at the business the captain has been around a good deal, but the idea is to have, so far as possible, all routine duties carried on under the orders of the battery officer, general instructions only being given by the battery commander. I have, of course, had charge of the grooming and care of the horses, and have had supervision of the stable guard. Nightly inspections of the guard are not required, but enough during the week to keep the men up to their work. Sometimes the guard is visited three nights in succession, then again the inspection is omitted for several nights. During the week I have frequently been in the blacksmith shop to observe the shoeing. There is a head shoer for the post who is an expert. He gives the artillery post two days out of six, when the battery smiths are instructed. By watching the shoeing from time to time, I expect to become acquainted with the proper methods. In addition to the shoeing shops there is one shop for general work, where there is a mechanic able to do all ordinary repairs to guns and carriages. Very seldom is it necessary to have any repairs done at the arsenal. I have also made frequent inspections of the kitchen and dining-room. So far I have confined myself to simply observing. Later on, I am informed I will be put in charge for a month, when the whole management will be in my hands.

November 2nd.—A horse which has been sick for some time died to-day. At one o'clock the post veterinary came and made a post-mortem. All the officers and non-commissioned officers of the artillery post were present. The cause of the death of the horse was shown, and the surgeon then went on dissecting, and showed, in a much better manner than could be learned from books or diagrams, the internal structure of the horse. This course is always pursued when an animal dies, and also when an operation is performed, and in consequence, the officers and non-commissioned officers know something about the horse in addition to what is learned from the outside of him.

January 10th, 1898.—To-day I finished my month as battery clerk. Every officer coming to the battery is required to become familiar with all company papers by actually making them out for a month. This is not expected, however, if the officer has had similar training at another post. During this month I have made out every paper required in the battery, from a guard detail to a quarterly return, but where duplicates are required the copies have been made by the regular clerk. Of course it is drudgery work, but I suppose there is no better way to learn about the papers.

January 15th.—We held a council of war this morning after inspection. This is a custom in the battery. The captain believes in having as few secrets as possible, and the work of the battery is freely discussed, the battery commander, of course, deciding as he sees fit in any matter, even if the judgment of all the others is against him. The appointment of non-commissioned officers, the work for the ensuing week, suggestions on personnel or equipment, and many other points come up at these weekly councils. They are wholly informal and no record is kept. Mere discussion for discussion sake is discouraged, but all ideas advanced in good faith receive most careful attention. The captain says that many very valuable ideas have been developed in this way.

February 15th.—I spent the afternoon in looking over the last proofs of the *Light Battery Handbook*, which has been in preparation by the officers of the battery for some time. It is a small book of a size to be conveniently carried in the pocket. It contains all the drill regulations necessary for a non-commissioned officer to know; description and nomenclature of gun, carriage, caisson, harness and battery wagon; range tables; instructions for digging gun-pits; notes on treatment of the horse in sickness and health; a few simple tables giving weights of various articles, as rations, forage, &c., in use in light batteries. So far as possible, nomenclature is shown by plates with names of parts printed on them.

March 12th.—As the spring comes on we are beginning to have outdoor drills. There have been indoor exercises of some kind all winter: setting up drill in barracks, and riding team or section drill in the riding-hall. Just now we are having the simple marching drills laid down in the drill regulations. These exercises are now very sensibly restricted to the movements for marching a battery to and from stables or park. During the next few weeks the minor drills will be worked up fully, so that by May 1st, at the furthest, battery drills can commence.

June 15th.—We have now had six weeks of battery drill, five days in a week, for about an hour and a half each day. The preliminary training was so well brought up during the winter and early spring, that the battery is now thoroughly drilled. During the earlier part of the six weeks the drills were on smooth ground, but lately we have had them on every kind of ground on the reservation. The regular drivers have had the horses so far, but from this on, it is the intention to put cannoneers on some of the pairs, so that every man in the battery will become at least a fair driver.

July 15th.—I got back to-day from a week's march with a platoon. Ever since I came, last October, hardly a week has passed without one or more marches, varying in length from ten to thirty miles, but we have always come back to the post at night. This time, however, it was a regular field march. We made in the seven days 175 miles. This is a big distance for the time, and would have been practically impossible had the horses not been kept in training by the single marches I have spoken of. On this march there were six horses to each carriage, and the chests were loaded with ammunition. As the weather was quite warm the marches were made early in the day, and twice they were made at night. As opportunity offered, there was practice in digging gun-pits. The men had had some instruction in this at the post during the spring, and on the march we put what they had learned into practice. A certain position was indicated at which to put the battery under cover, and the kind of pit designated. The sergeants gave all other directions and superintended the work. We also had occasional target practice, finding a few places where it could be safely carried on. We had no regular targets, but made use of prominent objects, stones or a hillside, &c. Twice during the march we forded streams, in one case the water being over four feet deep. By attending to the breech mechanism immediately after fording, no injury was done. We went over all sorts of roads and some horses got sore necks, but no serious damage was done, the men giving the animals prompt and intelligent care. There were some small breaks in parts of the carriages, but they were mainly repaired after the day's march by the mechanics. These breakages showed the weak spots in the construction, and the captain will forward a list of them at once to the arsenal that the faults may be corrected. As this was my first regular field march, the captain accompanied me, but only in an advisory capacity, all orders being given by me. In future on platoon marches I shall be alone.

October 31st.—To-day we fired the last shot of the annual target practice. This has been prosecuted in all weather except absolute downpours of rain. We have had two days of each week since September 1st, the other two batteries having the rest of the time. The practice has been at both known and unknown distances, and has taken place at all times of the day. In the unknown distance firing range finders were used, and the range was also found by trial shots. No great advantage was gained by the former method, either in time or accuracy. The guns were used some days when the dust was blowing and at other times in light rains, but by careful and immediate cleaning no material damage was done. All the men showing any aptitude were practiced as gunners, and we now have eight or ten privates in addition to the non-commissioned officers, who are excellent gunners. In all the practice the guns, limbers and caissons were disposed as they would be in actual service, some firing being done from gun-pits. The War Department is now very liberal in the supply of ammunition, and while none was wasted, we have not been at all cramped in its use. No attempt was made for record firing, the practice being for the instruction of officers and men, and not to send in a "spread-eagle" report to headquarters.

December 12th.—We got in to-day from a very disagreeable march. We were out but four days but it rained nearly the whole time. We started out, all three batteries, to make a two day march, by three different roads, and rendezvous at Wamego, thirty miles distant, at three p. m. on the second day. We all got there on time, but it was tough work on men and horses. Culverts were found washed out, gullies furrowed out on the side-hills, mud-holes in roads a foot deep. But the men did excellent work. By their native ingenuity (they are nearly all Americans), difficulties seemingly insurmountable were overcome; temporary bridges built, carriages worked down steep hills, and many other hard jobs showing the "get there" spirit of the American soldier. The captain says that while he did not expect this bad weather, he is by no means sorry that he encountered it, for there could be no better training for some kinds of campaigning.

February 6th, 1899.—To-day there happened to be some stock and flat cars on the side-track at the railroad station, and advantage was taken of the fact to have some practice in loading cars. All the horses and carriages were loaded in two hours from the time the order was given at the barracks, and without a regular loading platform. Temporary ramps were made with ordinary planks, rough side rails being put up for the horses. Of course, the work could be more quickly and easily done with a regular platform, but this is not always available.

March 9th.—This morning all the battery tentage was got out and the men spent the forenoon in tent drill. This exercise is held as often as once a month when in garrison, tents being regularly pitched, camp-cooking utensils set up, and at least one meal cooked thereon. In the afternoon a wagon was obtained from the quartermaster and loaded as for the field with tents, mess-chests, rations and other things authorized carried. The captain says he doesn't intend to be caught napping with an order to take the field.

May 8th.—Lately we have been having mechanical maneuvers at battery drill. The men have had some practice at the gun-sheds, but now it is applied in the field. The officer in charge of the drill calls out "such a wheel disabled," and at once the proper cannoneers put the spare or limber wheel, as indicated, in its place. Or he says "such a horse disabled," and at once a led horse is brought up and put in the team, or the horse and his mate led to the rear, and a caisson team put in their places. Or a carriage is declared out of action. The gun is dismounted, slung to a limber and taken off the field, the carriage being left. It is astonishing how much interest the men take in these exercises and how expert they become in performing them.

August 3rd.—For a couple of weeks we have discarded the caissons, mounted the cannoneers, and had horse artillery drill. Some of these drills have been in conjunction with a cavalry squadron, and there are mighty few places it has gone that we have not followed. Of course there have been some breakages, but these must be expected at horse artillery work.

September 30th.—This year the target practice has been delayed for a month, September being given to combined movements. Two regiments of infantry were brought up from Little Rock and the Territory, and the maneuvers of a brigade were had, the general commanding the department being in charge. There has been actual field service, all living under canvas, and at times in bivouac. There were formations for battle, night marches, sudden attacks, in short everything that can be done in time of peace. The last three days the brigade made a forced march, covering in that time 100 miles. Not all the men made it, but most of them did.

January 15th, 1900.—I got back to-day from a week's service on a horse board. A cavalry officer and a veterinary surgeon were the other members. We bought 50 horses in all for various organizations at the post. I have seen enough of the light artillery service to have a very fair idea of the kind of horses wanted, and I think we got a very decent lot. We may have been cheated on one here and there, but it there were any defects they were very skilfully concealed.

September 30th.—To-day I complete my three years. This last year's work has been to a great extent in practical command of the battery during my weeks of duty. All the minor work has been done by the non-commissioned officers. The captain has been away a great deal of the time, but even when present, he usually gave all orders through the executive subaltern. I believe that I am as competent now to command a light battery as I ever shall be. I do not know of any one thing in the way of instruction that has been omitted. It is true, I have not put the battery through many exhibition drills, but Battery "H" is not that kind of battery. With the present undress uniform for all purposes, and the abandonment of the fancy part of the drill regulations, a battery is not a circus any longer. Indeed, in the movements now laid down, absolute precision is not insisted on as it used to be. It has been discovered that there are things more important than the countermarch. Nowadays the idea is to "get there," to get there quickly, shoot straight when you are there, and not get hit yourself any more than you can help.

In the above extracts from Lieutenant Wilkinson's journal, of course not all things practiced in a light battery are adverted to, but the portions printed were selected as bearing upon the more necessary work of this very important branch of the military service.

A PROPOSED MODIFICATION OF THE FIELD GUN SIGHT.

By First Lieutenant EDWARD E. GAYLE, Second Artillery.

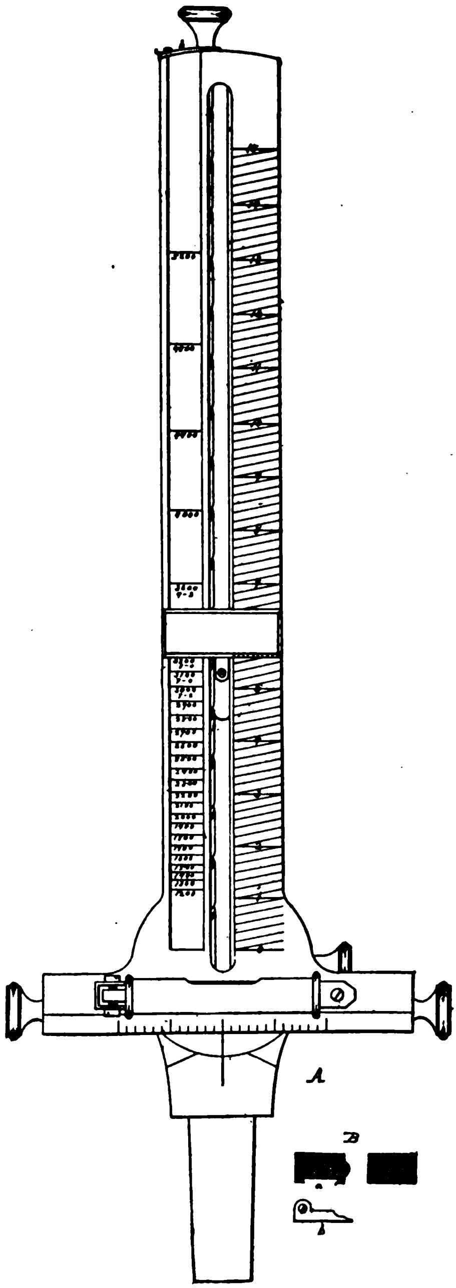
Any one who has had practical experience with field artillery—even that afforded by the short tour of instruction required by regulations—will admit that to obtain the best results in actual service, that is, to fire with the greatest accuracy in the shortest time, our sights must be so arranged that changes in elevation may be rapidly made for corresponding changes in range.

It is thought that no system will more nearly fulfill all the conditions than a graduation of the sight in yards. The advantages of such a system are apparent; our ranges are determined in yards either by estimation or range-finder; and, when known, the sight could be instantly set by the gunner without the additional trouble and inconvenience, to say nothing of the frequent impossibility, of consulting a range-table for the corresponding elevation in degrees and minutes. Again, our drill regulations for the firings could be accurately and quickly complied with; whereas, with the present graduation, when the commands (§ 108), 1. *range*, (so many) *yards*, 2. Load, 3. Fire, are given, each gunner must either trust to his memory for the degrees and minutes corresponding to the number of yards indicated, or he must have at hand a range-table from which he may get them. Neither condition is likely to obtain. On the target range, where time is not the most essential element, the advantages of such a system are not so significant; but, in active service, where circumstances frequently demand rapid fire, the necessity for some means of aiming rapidly and accurately becomes manifest. The prescribed rate of *ordinary fire* is one shot in twenty seconds. Whether with the present sight this range, to say nothing of *rapid fire*, could be maintained with accuracy is extremely doubtful. This opinion is supported by actual experience. During the target-practice season of 1892 at Fort Riley, Kansas, Battery "F," 2nd Artillery, firing over unknown distances, when the element of time entered into the efficiency of the practice, fired by piece, fifty shots in 34 minutes and 36 seconds, or one shot in about 40 seconds, which is double the time of *ordinary fire*. The time consumed in changing position is not considered, nor that for the *first* setting of the sight at the different ranges. During this time, elevations were changed throughout the battery fourteen times, and that these changes were not made at random is clearly shown by the uniformly excellent results obtained. Since accuracy was of the first importance in this practice, a great part of the time was undoubtedly consumed in consulting the range-table and interpolating for the *degrees and minutes* corresponding to the changes in range. This was with shell; and had shrapnel been used, additional time would have been consumed in calculating time of flight and cutting of fuse. If the sight had been graduated in yards, the elevation could have been instantly given; and, with some device which would, *at the same time*, indicate the proper cutting of fuse, the interval between shots would have been materially reduced. In a word, the gain in time presents itself as the greatest of the many advantages of such a system.

On the other hand, there are many perplexing obstacles in the way of such a graduation, no better evidence of which can be offered than the experience of the light artillery battalion at Fort Riley in the three target-practice seasons of '91, '92 and '93; during each of which, for a given range, a different elevation was used, which in turn differed from those given in four range-tables officially furnished. This variety of elevation was due to a corresponding variety of powders, variation in weight of projectile, and local conditions different from those for which the several range-tables were computed. If we could have a uniform weight of projectile and but one kind of powder which would not deteriorate, the sight, graduated in yards only, would answer all practical purposes; but as this does not obtain, and is not likely to in the near future, the device herein proposed is offered as a solution of the problem under existing conditions. By means of it we have, with a slight change in the construction of the present sight, one graduated in yards, which can be prepared and used whenever a range-table can be computed.

The following are the proposed modifications: The face of the sight opposite that upon which the present graduation is marked is made the same width, one-half inch, as the latter; throughout its length is cut a groove the shape of which is represented in cross-section at *a*, Fig. B; in width its smaller dimension is $\frac{5}{16}$, its larger $\frac{7}{16}$ and its depth $\frac{1}{20}$ of an inch. The bottom of the groove corresponds with the zero of the present scale; the top is closed by means of a device *b*, represented in the drawing, and the slide is lengthened to correspond with the increased width of the face. In the groove it is proposed to insert, what may for convenience be designated, a *range slip* made of aluminum, bristol board or heavy drawing paper. It is prepared as follows: a strip is cut of such width that it may easily slide in the groove, care being taken that after insertion it rests squarely on the bottom of the groove. A range table previously computed with elevations in degrees and minutes corrected for "jump" is then referred to the slide set of elevations corresponding to the different ranges, and lines drawn on the slip, using the lower edge of the slide as a straight edge. The range in yards is then written, stamped or cut, according to material used, under its corresponding line; and on the back of the slip, near the top, is recorded the initial velocity, weight of charge, weight and kind of projectile, etc., indicating the ammunition for which it is to be used. When prepared for use with shrapnel, as is indicated in the drawing under the ranges 3000, 3100 and 3200 yards, the time of flight, corrected for proper time of "burst" expressed in seconds and sixths (the smallest division of the fuse scale), is also written with each range.

For every powder and projectile designed for field service, metal range-slips could be prepared under normal conditions, and when these conditions change, other slips could be readily prepared from bristol board, which is an exceptionally favorable material for the purpose. They should be lacquered to prevent the absorption of moisture. The figure represents the sight as it would appear with range-slip in place and elevation set for


A
B
a
b

3200 yards, the corresponding degrees and minutes being 5° 36′.

It is believed that this device fully answers all objections heretofore offered to this system of graduation, while it possesses the advantage of extreme simplicity, the capacity to prepare the slip being measured only by the ability to set the slide for a given elevation, and to draw a straight line with a pencil along a straight-edge held mechanically in place. Since the adjacent intervals on the scale are practically equal, it possesses the additional advantage of readily setting the sight for intermediate ranges without the inconvenience of interpolation from the range table, which the average gunner is not capable of doing. In short, it is a working range table attached to the sight, easily constructed, at hand when wanted, and capable of being used by any one of ordinary intelligence.

COAST ARTILLERY FIRE INSTRUCTION.

First Lieutenant John A. Lundeen, Fourth Artillery.

VESSEL TRACKING.

Instruction given to the non-commissioned officers and some of the privates of Battery "L," 4th Artillery, during parts of September and October, 1894, at Fort McHenry, Maryland.

What follows is merely a brief account of my experience in instructing enlisted men at this post last autumn in *vessel tracking*, and, as it is the first attempt at this work that I have undertaken or seen during my service as an artillery officer, I have considered it worth while to record what was accomplished with the means at hand, and how it was done.

It was seen at the outset that there were two things, in addition to the rapid and accurate taking and reading of the angles at the two observing stations, that were essential in order to make vessel tracking even a possibility; one, the rapid transmission of the angles to the plotting station as soon as taken, and the other, the "laying off" of these angles on the plotting board, more rapidly than can possibly be done by means of the protractors furnished us by the Ordnance Department.

The first of these might have been accomplished, I suppose, if we had had telephones or dial telegraphs at our disposal; for the ordinary telegraph or the signal flag is entirely too slow to use in transmitting the angles.

As we had neither a telephone nor dial telegraph at the post, I devised a simple system of *visual signals*, consisting of sets of large figures, each one painted in *white* on a *black* tin plate, as white figures on a black ground can be seen farthest and most distinctly. These figures were hung on large blackboards placed near each observing station, and facing the plotting station, so that the figures could be easily distinguished from the latter station, either with or without a glass, depending upon the size of the figures and the distance.

The figures were arranged to be hung in two lines on the board, the upper for the degrees and the lower for the minutes of the angle, and two men were assigned to each board, one to put up the degrees and the other the minutes of the angle as soon as the observer read it.

In addition to this, there was a place in the upper left hand corner where another symbol could be hung up, as for example *T* for target and *S* for shot, when this system of signaling the angles was used in target practice.

I am thus particular in describing this simple apparatus, because it can be made and used at any post, the figures varying in size according to the distance at which they have to be read; and, in the absence of something better, they answer the purpose very well for "peace practice."

We found this system of signaling the target and shot angles very simple and reliable during our mortar target practice here last summer. It was ascertained to be both rapid and accurate.

For the purpose of rapidly *plotting* the different positions of the observed object, two arcs were constructed on the plotting board, each with the plotted position of its observing station as a center, and a radius of thirty-six inches, as this was the largest radius that could conveniently be used on our board. The arc was divided up into degrees and subdivided into 5′ spaces, which could be even further subdivided by the eye.

Fine silk cords were then attached to small screws, one at each of the stations, one of the cords being *black*, the other one *red*, and the degrees, etc., on the corresponding arcs were also numbered in the same two colors to avoid mistakes when rapidly laying off the angles.

Owing to the limited water-front facing the channel, the longest base-line that could be conveniently used for this work, having both ends accessible was 280 yards, and this was carefully measured, its ends being permanently marked and plotted on the drawing board. The positions of the principal guns used were also located on the board.

In order to train the observers, the azimuth circles were first set up near the barracks twenty-eight paces apart, and with the plotting board between and a little in rear of them, so that the work of the observers and plotters could be readily supervised.

A man was then sent out with a staff to move along the sidewalk in front of the officers' quarters about 120 paces away, moving when signaled and halting every ten paces. The object of making the man move in a straight line at first and planting his staff at equal distances apart, was to readily check the accuracy of the work of the observers and plotters; plenty of time being also at first given them to take the observations and transmit the angles to the board. Quite a number of different men were in this manner trained to observe and plot, the work being done during the regular drill hours and some additional time.

After a few drills the stops were made shorter, and the man with the staff was made to take unexpected and devious courses.

Before the preliminary training was finished, a number of the observers could take and transmit to the board a series of observations a minute apart, each one being plotted in time for the next one and with very few breaks.

Actual vessel tracking was then undertaken, the azimuth circles being placed over the ends of the base line—280 yards apart—where a vessel passing in or out along the channel could be readily seen and followed with the instruments. For convenience, the plotting board was placed near enough to one of the stations to hear the angles called directly by an extra man; the angles from the other station being transmitted by the numbers hung on the blackboard previously described.

The first difficulty encountered here was how to signify to the two stations, quickly and in a simple manner, what object was to be followed and "tracked." as there were boats of all kinds passing in and out along the channel, and even across it.

A signal flag was used at the plotting station for this purpose, with another at the further station to repeat the signal to show that it was understood. A circular wave of the flag around the head like the old "numerals follow," was used to denote "a tug going out," two waves for a "steamer" and three for a "sailing vessel." For a tug, steamer or sailing vessel coming in, the corresponding number of "waves" was followed by "front."

This was found to answer very well unless there were several of the same kind of vessels coming in or going out at the same time, when it was found necessary to designate the particular one that was to be "tracked." A more comprehensive and at the same time simple and rapid system of signals can be readily devised for this purpose, or the one that I have suggested added to as required. In order to take the distance to certain stationary objects visible from the two stations, lists of them by number were made out and furnished the observers and plotter, and then they were called for by their number.

The azimuth circles being placed and oriented, the blackboard in position at the further station, the numbers being placed conveniently for picking them up and the plotting board prepared, with the full complement of men at their different stations, we were ready for the business in hand.

A vessel that it was desired to "track" was coming in or going out, the proper signal was made by the signalman near the "board" under the direction of the officer in charge, and repeated at the further station to show that the message was understood. The flag was then raised to indicate "ready" to the two observers who were to take the angles. After giving about ten seconds time, the officer commands "*take*," when the flag is dropped; and at this instant each of the observers takes the angle of the vessel, immediately reads it, and transmits it to the "board"—the near observer by word of mouth, and the farther one by calling it out to the men at the "blackboard," who immediately put up the corresponding numbers, one man putting up the degrees and the other the minutes of the angle. As soon as the angle is read, the numbers are taken down and placed in their proper places, to be ready for the next observation. At the plotting board, the signal man calls out the angle put up on the blackboard; the recorder stands ready and records "time," "angles," "distances" and "rate," as given him; two men hold the ends of the silk cords fastened to the two stations, and as soon as the angles are received each one stretches his cord in the proper position. The intersection of the cords is then marked by the "plotter," who marks the number of the observation and immediately swings the scale around to this mark and measures the distance from the guns, which is at once recorded by the "recorder" on his tablet.

Meanwhile, the officer in charge (or time-keeper), at the end of a minute from the first observation, calls out another "take," which is taken, transmitted and recorded in the same manner as the first one, the distance between the two positions of the vessel also being measured.

In this manner a service of observation on a vessel, at intervals of one minute, are taken, and its speed in miles per hour ascertained by dividing the distance in yards passed over in a minute by 29⅓ (or by 30, which for practical purposes is near enough). For artillery purposes it is more important to know the variation in the distance to the vessel per minute in *yards* than in *miles* per hour, so that this conversion is unnecessary.

After some practice with my best observers—who were all enlisted men—it was found that the angle from the near station reached the board 8 or 10 seconds after the signal "take;" and from the farther station, where the numbers had to be posted, in from 18 to 25 seconds; and that the location of the vessel was plotted and range measured in 50 to 60 seconds from the time of the signal. With a slight modification in marking the arc, there would be less delay in stretching the strings to the proper angular point, and I think that this last time can be shortened by 10 seconds or more.

As the observers and plotters that I had were by no means perfect, sometimes a "hitch" would occur and we had to throw out or skip an observation; but this seldom occurred after each man had been taught to attend to his own duties exclusively, and to those of no one else. If any one man failed to do the work assigned to him promptly, of course our machine would fail to work, and we would either be delayed or even have to "drop" an observation, and pass on to the next one.

I did not at that time attempt to "predict" the position of the vessel two or more minutes after the last observation, so as to send this predicted range to the guns, as I intended to do that later, and to combine it with serving and aiming the guns; and then to compare the actual with the predicted position of the vessel.

LIGHT ARTILLERY TARGET PRACTICE.*

By First Lieutenant ERNEST HINDS, Second Artillery, U. S. A.

All of the principal military nations of the world have an authorized Artillery Firing Regulations. These regulations include an elementary course of instruction in gunnery; a description of the sights and other instruments used in firing, and rules for their use; a preparatory course of instruction in sighting, &c., for recruits; and a special course for the more advanced men; as well as general rules to be observed by platoon, battery, and battalion commanders in field work. We have no such text-book. Our Artillery Drill Regulations do not lay down any course of training for gunners. Under the caption "Artillery in the Field" are given general rules governing the employment of the arm in the field; but much detailed instruction must be given before reaching this point in order that the battery may prove an effective weapon on the battle-field. Modern shrapnel fire is exceedingly deadly, provided the shrapnel be burst exactly at the proper point; but this is difficult to attain even in deliberate practice on the target ground. How much more difficult the problem becomes when all the disturbing influences of battle are brought to bear upon it can readily be imagined. But this is the problem that is presented for our solution.

A battery may be so thoroughly drilled as to execute all the evolutions of the battery, mounted and dismounted, before the Inspector General, without noticeable error, and its captain be highly commended therefor, while its practical efficiency if tested on the battle-field might be far from satisfactory. Our inspectors not infrequently pay too much attention to beautifully kept company records and showy drills, and do not delve sufficiently into questions of practical utility.

Hohenlohe says:† "The artillery must make its chief aim to

*Read before the Artillery Officers' Lyceum at Fort Riley, Kansas, February 21st, 1895.

† Letters on Artillery.

fire well." Again, he says: "What we require of it can be summed up in very few words. The artillery should strike the enemy, then *strike the enemy* and again STRIKE THE ENEMY. Under this heading is included all that concerns the accurate service of the pieces, the most exact observation of results, and the most rational method of obtaining the range and regulating the firing." It has been said that we are too prone to accept the doctrine of the Germans without inquiring as to its truth. However this may be in general, we will all agree with Hohenlohe that *to hit* is the *raison d'être* of light artillery.

Our target practice is the culmination of our year's work, and by it that work should be judged. A certain amount of squad drill, standing-gun drill, and battery drill is necessary, both as a requisite to the attainment of good discipline and as a means to the proper training of the battery for target practice. But the fact should never be lost sight of that these are only the means and not the end to be attained. Our light artillery is just beginning to awaken to the importance of this fact. We have been in an undeveloped stage for some time past, so that an experimental study of the best methods of target practice has not been possible. For some years the Ordnance Department was experimenting to obtain the best gun possible; then came the search for a projectile; and we are still looking for a powder. But I do not criticise the Ordnance Department for our lack of *matériel*. We must go to the fountain-head of the trouble. Our most urgent need now is an increased ammunition allowance; but if Congress in its wisdom deems it best to withhold the funds for a proper and reasonable amount of ammunition, we must make the best use of the small amount allowed us, and, by a critical study of the subject, endeavor to find out the best methods of using it when under the enemy's fire. This study is the more important and necessary because the modern shrapnel has never been thoroughly tested in battle.

AMMUNITION ALLOWANCE.

The light artillery is a more expensive arm than the cavalry—much more so than the infantry—and it seems that it would be reasonable to increase our money allowance for ammunition in like ratio at least. Yet our allowance is less than that of the cavalry—scarcely more than that of the infantry. We are allowed per battery 75 shrapnel, which at $4.12 per round complete, cost $309; and 25 common shell, which at $2.32 per round amount to $58; giving a total of $367, or $4.89 per man.

The latest information that I have been able to obtain in regard to the annual allowance of ammunition for target practice in the German army, gives it as 356 per battery.

In England the average allowance per battery is about 300 projectiles (issued at the rate of about two common shell to three shrapnel) and the allowance of batteries not practicing may be authorized to be used by those which do practice. Projectiles may also be interchanged at cost price. At Okehampton the allowance is 640 per battery—280 common shell, 345 shrapnel, and 15 case.

Fort Riley should be made our Okehampton, and for this purpose our ammunition allowance for the batteries stationed here should be largely increased. This is probably the best post in the United States for the attainment of ideal target practice conditions—more than thirty square miles of territory with every variety of ground; and the authorities should afford us every facility in their power for making the most of our natural advantages in this respect.

In this connection I will remark that because this is our best light artillery station, I think it would be well to limit the tour of batteries here to three years at most, and have no two batteries from the same regiment. This would give all batteries in the service a tour of three years here once in ten years. As it is now, these batteries have been here for nearly six years where every condition is favorable for target practice, whereas some batteries in the service have been so situated that they could have none at all.

This increase of the ammunition allowance I regard as the first requisite for the improvement of our firing efficiency. And a considerable increase might be obtained despite the economical ideas of Congress, were authority granted for the use of the batteries stationed here of the ammunition allowance of those batteries which have no annual practice.

A GRADED SCHEME OF INSTRUCTION.

The next thing necessary, in my opinion, is a graded scheme of instruction extending from the squad drill to the annual target practice. Such a scheme is necessary to achieve the best results in target practice, because we have but a limited time in which to train officers, non-commissioned officers and privates for their various duties ; and if no scheme be followed, hap-hazard work is the outcome, which always results in a minimum of progress and efficiency.

Instead of having the officers detailed for a tour here join on October 1st, it would be a better plan if they were to join January 1st, since January 10th is the beginning of our school year at this post. By joining at any other time, they arrive and the officers who are relieved go away while we are just in the midst of some work whose continuity is necessarily broken into by the exchange of officers at that particular time. It disarranges matters very much to have these changes occur during the annual practice ; neither can the best results be obtained when it takes place immediately after the arrival of the officers of the new detail. Were the details made to take effect January 1st, we could reckon upon seven months for our scheme ; that is, from April 1st until November 1st, when the combined maneuvers usually begin. For the present, however, we will have to allow but six months—April 1st to October 1st.

I do not mean by a graded scheme that the tasks for each day should be laid down six months in advance. But I do mean that the scheme should be progressive, covering every essential subject pertaining to the work of the arm, and that both officers and non-commissioned officers should know at least one day beforehand exactly what movements will be given at the next drill in order that they may thoroughly inform themselves as to their duties, and this should be required of them. But they—the non-commissioned officers especially—can not be held to a strict accountability in this respect when they have to study the whole of the school of the cannoneer or battery or driver each day. It is said of General Upton, the author of the infantry tactics, while Commandant at West Point, that he invariably studied the drill for the day before going out to drill the battalion of cadets.

The value of drill to all—officers and men alike—is enhanced just in proportion as all are kept interested. Without interest a minimum amount of good results. It needs no argument to show that more interest is taken in their work by both officers and non-commissioned officers, when they know exactly what is required of them and can prepare themselves accordingly. And when the officers and non-commissioned officers are interested, so will the men be—at least, much more so than they otherwise would be. Take two company commanders, one enthusiastic in the performance of his duties and the other perfunctory, and the difference is always shown in the drilling and discipline of their commands.

A scheme can easily be devised by taking an average of the number of drills for two or three years past, without considering unusual circumstances, such as the trip to Chicago during the labor riots of last year. This average would give a fair basis for a division of time among the different subjects embraced in the scheme. In this scheme there would be included, in addition to the regular drills provided for in the drill regulations, range finding and the estimation of distances (which it has not been possible for us to include heretofore, not having the proper instruments), and a more elaborate scheme for the training of gunners.

If possible the following subjects should be disposed of before April 1st: Harness drill, pistol and saber drill, packing equipments and ammunition for field service, the elementary principles respecting the care of horses, the elementary principles of gunnery, sight setting, fuze cutting and the school of the soldier mounted (in the drill hall). One or two lectures should also be given during this time on the use of artillery in battle; the various kinds of projectiles in service, and under what circumstances each would be used; the methods to be used in finding the range, length of fuse, &c. Every man upon the completion of his three years' service should carry away with him correct general ideas on these subjects firmly impressed upon his mind.

As a tentative division of time after April 1st, I would suggest:

For mounted drills.

April 1st to May 15th—School of the driver in pairs, teams, sections and platoons.

May 16th to July 15th—School of the battery, including selection of positions, sub-division of the battery for action, etc.

July 16th to July 31st—School of the battalion. (During August the mounted drills will probably be suspended on account of the excessive heat.)

For dismounted drills.

April 1st to May 15th—School of the soldier dismounted, school of the cannoneer, and saber and pistol drill.

May 16th to July 15th—What I will denominate school of the gunner.

July 16th to August 31st—Range finding, estimation of distances, construction of hasty intrenchments, etc.

September 1st to September 30th—Target practice.

October 1st to December 20th—Brigade drills with the cavalry, marches, combined maneuvers, camping, loading batteries on cars, fording rivers, crossing ravines, etc., during the forenoons; school of the soldier mounted, during the afternoons.

If the officers join on January 1st, target practice should be extended to October 15th.

It will be observed that I have devoted a considerable portion of time in this allotment to the school of the driver. I have done so because this is the time to train the drivers, and not during the school of the battery, which, as far as work on the drill ground is concerned, should be made a school mainly for the training of officers and non-commissioned officers. I have moreover devoted little time to the school of the battalion for the reason that it is a school for officers only—principally for battery commanders—and little time is needed.

During a part of these battalion drills the captains should be required to drill the battalion, and the lieutenants the batteries, since officers are supposed to fit themselves for the higher commands, which would certainly fall to them in the event of war.

Proficiency in all of the subjects enumerated is necessary for the attainment of the best results in the field; but those of most importance as bearing directly on my subject are, the school of the gunner, range finding and estimation of distances, and target practice proper. These will now be considered in their order.

SCHOOL OF THE GUNNER.

The preliminary training of the gunner should be as complete and thorough as possible before the annual practice begins. Therefore this school should include a thorough and systematic course of instruction in reading and setting the sight, both for elevation and direction; laying at different kinds of targets, stationary and movable, under various weather conditions; indirect laying on disappearing and invisible targets; fuse cutting; the illustration of the results of errors most commonly made in laying and fusing; and practice firing with the sub-caliber apparatus.* For practice in fuse-cutting the Ordnance Department should provide a dummy fuse, the holes of which could be filled with putty or clay so as to give actual practice in this work.

The gunners should first be taught individually to lay regularly, that is, always in the same way; then with uniformity throughout the battery; lastly, with rapidity. They should be taught that with a target of broad front, direction is of small moment; and the Nos. 3 should be taught to lay for direction from the end of the trail handspike, so that for instance, in firing at a long line of troops, the gunner need lay for elevation only. Similarly in firing at a deep target, it is not necessary to waste time in refinements of laying for elevation.

In the heavy artillery we have a scheme for the examination and grading of gunners, and badges are furnished those who qualify as first or second class gunners. A similar method should be adopted for the light artillery. It is done in England, France and Germany, the only foreign armies about which I have information on this point. This would tend to stimulate the men themselves to qualify, and the officers to devote more attention to this important subject.

* A Springfield rifle centered and held in position by disks in the 3″.2 gun. The Ordnance Department sent one here for trial last year.

There should be in each section, besides the chief of section and gunner, at least two privates qualified as gunners, and with proper instruction there should be at least four.

The scheme for the examination to determine the qualifications of light artillery gunners should include estimation of distances; laying, on both stationary and moving objects; fuse cutting; and firing as many as four shots by each competitor at a fixed target, if the extra ammunition could be obtained; if not, then firing at stationary and moving targets with the sub-caliber apparatus. With a proper allowance of ammunition the gunners' competition might take place during the preliminary practice of the battery.

RANGE-FINDING AND ESTIMATION OF DISTANCES.

The artillery drill regulations require that "all the non-commissioned officers and some of the most intelligent men of each section should be practiced in the use of the authorized range finder; those that show the most aptitude should continue the practice until they become expert; from these last a range-finding party can be permanently detailed when the battery takes the field.* Instruction should also be given in judging distances by sight."

The ability to estimate distances correctly and rapidly I regard as of great importance. We must be the first to get the range if we are to make sure of winning. And the necessity for this may be increased by the introduction of fixed ammunition and smokeless powder. It is claimed for the Nordenfelt Quick Firing Field Gun that twelve aimed shots per minute can be fired by it. With a third of this rate even, a six-gun battery, having the range and firing twenty-four shots per minute, leaves an opposing battery commander who cannot estimate the range closely at a glance and who has not the range, but one thing to do—seek cover until the range is measured. The more destructive the shell, the more imperative it becomes to obtain the range quickly. It will therefore be more important with the larger 3".6 shell than with the 3".2.

*We have no authorized range-finder yet. But a board consisting of five artillery officers was recently convened at this post for the purpose of testing such range-finders as may be sent by the War Department. Two kinds have thus far been sent out for trial, and four other kinds will be sent soon.

The value of estimating distances rapidly and accurately is also plainly shown in our work with the cavalry here, where more frequently than otherwise there is no time for range-finding. A troop of cavalry appears and is exposed to fire for two or three minutes, and then disappears behind a fold of the ground. If the officers of the battery are able instantly to closely approximate the range, they may be able to get in two or three shrapnel and thus badly injure or demoralize the troop. Again it comes into play where an opposing battery, knowing the range, opens fire from a position concealed under cover. If the battery commander can at a glance closely estimate the range, his adversary will have but slight advantage.

As a rule, range-finding can be done only when there is plenty of time. Because of the great value of every minute under modern shrapnel fire the range should be measured wherever possible; but half of the time perhaps (even more in the case of horse artillery) the range will have to be estimated—and in these cases the gunners must never wait on the range takers for a moment. In my opinion a considerable part of the value of range-finders will be found to consist in their use in training officers and non-commissioned officers in estimating distances.

The necessity for this training has been made evident to me personally during the combined maneuvers at this post. The estimates of a certain range by the officers of one battery in 1893 varied from 700 to 1500 yards; and last year another battery firing at unknown distances began with an elevation for 3000 yards, but had to come down to about 1700 before getting on the target (the range was obtained however within the time limit—five minutes). Such estimates might produce disastrous results in the face of a well trained enemy.

TARGET PRACTICE.

The annual target practice should be divided into preliminary practice and service practice.

PRELIMINARY PRACTICE.*

This should be known distance firing at various kinds of

* See page 23 "Order of Firing. 1st, &c."

targets and should be deliberate. Its object is to complete the training of the gunners; to observe and point out errors; to test the projectiles, powder, fuses and range-tables; to give practice in the observation of the effects of fire, and to train the *personnel* in fire discipline.

Being deliberate, this practice might also be taken advantage of to make a special study of any question which it may be thought desirable to investigate. For example, the practical determination of the cone of dispersion of our service shrapnel, so as to know exactly at what point it can be burst most effectively at various ranges.

The bursting point of each shot or the point of impact, and its effect on the target, should be signaled in to the firing point before the next shot is fired. The marking should be most carefully done in all of this practice, and for this purpose there should be two officers detailed in order to have a check upon the estimate—especially upon that of the height of the point of burst, which it is difficult to estimate accurately. Because of this difficulty, no attention should be given at the firing point to the estimate of the height of the point of burst unless it is manifestly abnormally high or low, and after the length of fuse is once established no change should ever be made in it, on the basis of an estimate made on a single shot alone.

To assist the markers poles twenty feet high and ten yards apart should be placed parallel to the line of fire and at a short distance from it, extending from about 200 yards in front of the target to 100 yards behind it.*

In this practice all officers should be required to take notes of errors made, unusual occurrences observed, and suggestions that may occur to them and hand them in to the adjutant. Many good suggestions which occur to an officer during the firing if not noted down are soon forgotten.

SERVICE PRACTICE.

The preliminary practice of all the batteries should be concluded before any one begins its service practice. In this

* Method in use here for two years past.

practice everything should be conducted as nearly as possible under the precise conditions of actual service. The targets should be placed in various positions, a new one being chosen for each target. (At this post this can be done readily since the reservation is more than thirty square miles in extent.) They should be placed in those positions which would most likely be chosen by an opposing force; should represent in succession the various phases of an action; and should be placed at such distances from the position of the battery as would be most likely to occur in practice, in the open and behind hasty intrenchments so as to represent an enemy both on the offensive and on the defensive.

Our ammunition allowance will not allow each battery to fire at a sufficient number of targets to represent all desirable schemes. But target records of the service practice for purposes of comparison of the work of different batteries is of questionable value. I would therefore suggest that, until we have an increased ammunition allowance, the batteries should each* take up the general scheme where the preceding one left off, instead of all following the same scheme. By this means we could include in our scheme both offensive and defensive tactical ideas, as well as firing at both stationary and moving targets, which scheme could not be completed by each battery without a large increase in the ammunition allowance.

In all the service practice there should be a time limit† for finding the range and also for the subsequent shrapnel firing. This limit will depend upon the tactical conditions, but it should be prescribed in the firing order, otherwise there is always a tendency to take too much time. The drill regulations prescribe the rate for "ordinary fire" only, the rate for "slow fire" and "rapid fire" being left to the judgment of the battalion or battery commander. But whatever may be the time limit, the rate of fire at any one target should be uniform.

The battery which is to fire should know nothing of the position of the target until it, as well as the approximate position of the battery is pointed out by the battalion commander. There

* There are three light batteries stationed at Fort Riley.

† See Memorandum Circular, No. 29 of 1894, Light Artillery Battalion, pages 23-24.

should be a tactical idea to be carried out in the practice, and this should govern the battery commander in his method of attack. He, accompanied by the range-finding party and the trumpeters who are used as mounted orderlies to communicate with the battery, should precede it in order to make a reconnaissance of the position to be occupied and that of the target representing the enemy. If the scheme allows time for deliberate work, the battery should be halted, if necessary, under cover while the range is being found. It is then brought into position and fire opened as quickly as possible. Should the ground, or the tactical idea, not permit of the range being measured beforehand, the distance should be estimated while the battery is being brought into position and the range at once announced. The range-finding party should be at work meanwhile, and if they succeed in obtaining the range before the firing is begun their range should be used if the estimate is not sufficiently close; or, if they do not obtain it in time for this, it may be used in correcting the range where the first elevations are seen to be considerably in error.

Only the approximate position of the battery should be indicated, and the battery commander should be held responsible that the best position is selected, that it is not discoverable by the enemy because of any premature and unnecessary exposure of the range-finding party or the battery, and that during the practice nothing is done in violation of the requirements of the tactical idea.

In the firing the elevation should be given for a range slightly shorter than the estimated range. For the next shot, increase or decrease the range one-tenth, according as the shot fell short or beyond. If by this second shot a bracket is established, halve the difference in range as a correction for the third shot, and so on until the range is found to within twenty-five yards; then fire an additional shot, or more if necessary, as a verification; then change to shrapnel.

Our two projectiles should be identical in weight and shape. As they are now furnished, the range as found by shell does not give accurately the elevation for shrapnel, nor can we readily and satisfactorily pass from the one elevation to that for the other projectile. With the projectiles as made at present, the ranging for shrapnel fire should be done entirely with percussion shrapnel, except where the conditions require a greater volume of smoke to mark the point of impact.

Because of our limited allowance of ammunition, we have heretofore almost invariably made the mistake of making our changes in elevation for corrections in range too small. We may save a shot or two in this way, but it is not the method we would use in actual service; and I would insist upon our service practice being carried out as nearly as possible under service conditions and requirements. We will derive more benefit from firing at two targets in this manner than in firing at four, where those conditions and requirements are violated.

Fire discipline should be rigidly insisted upon in all firings. Every man should be required to do his duties and his only. No greater amount of noise than is necessary in the rapid execution of the work should be allowed. The men should be required to preserve their calmness and military bearing, and no conversation among them should be permitted. If this be not required the repetition of commands will be necessary, and this is bound to give rise to more or less confusion and excitement. The battery commander should pay no attention to the details of the firing—those should be looked after by the platoon commanders. He should occupy himself entirely with the observation of the effects of the fire, and the correction of range, deflection and fuse.

A majority of light artillery officers, I believe, favor a sight graduated in yards.* The time required for finding the proper elevation would be reduced and the problem of laying greatly simplified thereby. The English now use aluminum strips on which the graduations (in yards) are stamped, and which slide into grooves in the sight, new range slips being supplied when changes in ammunition great enough to require it are made. Were this done the battery commander would announce: "Range (so many) yards;" or, with time shrapnel: "Range (so

* New breech sights just received (April, 1895) from the Ordnance Department are so graduated.

many) yards; fuse (so many) seconds;" and no time wasting reference to range-tables would be necessary.

The lieutenants should be required in turn, during a part of the practice, at least, to act as battery commanders, having entire charge while firing at the designated target.

With respect to taking down firing data, notes, &c.: The officers in charge of the firing during the service practice should have nothing of the kind to do. Service practice firing data is not worth anything for ballistic purposes, and the data *required* to be kept, such as elevation, number of shot fired, &c., can be kept by the officers not firing, or by intelligent men detailed for that purpose. The necessary forms should be prepared beforehand, so that the matter is a very simple one. But however simple it may be, it should not be imposed upon the officers and men who are firing. So far as it is possible they should have nothing whatever to do that they would not have to do in actual service. In accordance with this idea, casualties should be practiced during this work. Men, horses and carriages should be replaced from the reserve. *In short, the idea should always be kept in mind that we are supposed to be facing an active enemy, and not so many silhouettes and dummy guns.*

In this, as in the preliminary practice, all officers not firing should be required to make notes of observations, suggestions occurring to them, errors noted, &c., and hand them in to the adjutant. Those criticisms and suggestions which are deemed of sufficient importance might be published in orders to the command.

After the series of shots at a target is completed, the marking should be done at once and the results signaled in to the firing point before the battery begins firing at the next. It adds to the interest in the work to know what results have been obtained. The markers should make no note of the total number of hits made during this practice, but should note merely the number of men, horses, &c., disabled. Anything more is a waste of time. Since the first bullet disables it is useless to count 75 other hits.

In all targets consisting of more than one line or rank, I would suggest the use of inch boards for all except the rearmost rank, otherwise the record will show too great a proportion of men disabled, owing to the fact that a single bullet may pierce several figures. As a rule all direct bullet hits will cause dangerous wounds, and every figure so hit should be reckoned *hors de combat.* Smaller fragments may, or may not be dangerous. Whether or not they are so reckoned may well be left to the judgment of the officers marking. This method of marking would save much time and would afford a practical measure of the firing efficiency of the battery.

Such a system as I have outlined will require more time and labor than if the firing were all conducted on the same target range; but I am convinced that not only will it repay us in experience for the extra trouble and labor involved, but that it will conduce both to good discipline and greater efficiency from the fact that both officers and men will take greater interest in the work than where it is executed always on the same ground, and in consequence becomes more or less stereotyped in character. Discipline is always improved when officers and men are kept deeply interested in their work, and greater efficiency will result from a closer approximation to battle conditions.

All systems have to be built up gradually and perfected from experience. My purpose in preparing this paper has been to offer some suggestions which I think are worthy of consideration in building up a system of target practice for our light artillery. I have gathered them from the English, French and German firing regulations; our own artillery drill regulations; U. S. ordnance notes; Artillery: Its Progress and Present Position;* Circular of September 17th, 1894, Headquarters Department of California (prepared by Lieutenant-Colonel John I. Rodgers, 2nd Artillery, Inspector of Artillery); current military literature; the light artillery battalion orders and verbal instructions of the battalion commander, under which our target practice has been conducted for three years past; suggestions by artillery officers at this post, and experience derived from participation in the target practice of the light artillery battalion during the last three years.

* * * * *

* By E. W. Lloyd, late Commander R. N. and A. G. Hadcock, late R. A.—J. Griffin & Co., Portsmouth, 1893.

ADDENDUM.

As artillery officers throughout the service will perhaps be interested in the work done at Fort Riley, I append, through the kindness of Major W. F. Randolph, 3rd Artillery, Commanding the Light Artillery Battalion, the order under which the practice of last year was conducted :

LIGHT ARTILLERY BATTALION,
FORT RILEY, KANSAS, October 18th, 1894.

MEM. CIRCULAR, No. 29.

The annual target practice of this command will begin on the 22nd instant, and continue until completed.

Batteries will fire successively in the following order:

1. Light Battery "F," 4th Artillery,
2. Light Battery "A," 2nd Artillery,
3. Light Battery "F," 2nd Artillery.

ORDER OF FIRING.

1st. Twelve shrapnel at 2000 yards. Canvas target 10'x60'. At this range it is intended that the firing shall be deliberate—a test of the guns, ammunition, range tables, etc. The position of burst and effect of shrapnel will be signaled after every shot and before the next is fired.

2nd. Twelve shrapnel at 2500 yards. Invisible target (huddled group of 50 silhouette standing figures representing infantry under hot fire, rushing to cover in natural depression of the ground). Time limit, six minutes.

3rd. Twelve shrapnel at 1750 yards. Target—infantry skirmish line (50 silhouette standing figures in one line at two paces interval). Oblique fire (about 30°), time limit, six minutes.

4th. Twelve shrapnel at unknown distance. Target—dummy platoon in battery. Rough representation of guns with normal interval, limbers, horses and drivers constructed of boards, with silhouette standing figures to represent chief of platoon, chiefs of section, cannoneers, etc. Front fire. Time limit, six minutes. Battery to trot from park to firing position (about three miles), [and begin firing immediately.]

5th. Twelve shrapnel at unknown distance. Target—infantry in column of fours (silhouette standing figures, ten fours, distance between fours 44" + 12" = 56"). Oblique fire (about 45°). Time limit, six minutes.

6th. Fifteen shrapnel at unknown distance. Target—infantry in column of platoons (silhouette standing figures, four platoons in single rank of twenty-five men each). Front fire. Time limit, five minutes.

7th. Unexpended percussion shell at unknown distance, long range. Canvas target 10'x20'.

RANGE FINDING.

At unknown distances percussion shell will be used to determine the range. Allowance: three shell, to be fired within five minutes after the guns are unlimbered to fire.

MARKING, RECORD AND PLOTTING.

Marking will be done under the supervision of officers detailed from day to day, who will see that the targets are set up properly and repaired after each firing, and will turn in to the battery commander concerned a rough plot (outline to be prepared beforehand) showing accurately the hits of shots, bullets and fragments Each shot will be recorded in the "Record Book of Artillery Firing," furnished by the Ordnance Department. The target for each range will be separately plotted so as to show the range, as "——yards," or "unknown distance, estimated at ——yards;" number and kinds of shots; striking points of shots; hits of bullets and fragments, etc. The finished plots will be turned in at this office.

REMARKS.

The firing will be divided equally between the lieutenants present for duty with the batteries.

Battery commanders will have their range tables prepared independently of each other.

Details of firing and instruction of officers and men will be so regulated by the battery commanders, that the fullest benefit may be obtained from the limited amount of ammunition, and the greatest care will be taken to prevent accidents of any kind. It must be borne in mind that the adjustment of sights and laying of guns pertain exclusively to the gunners (corporals and acting corporals); and while it is the duty of instructors to insure that the prescribed elevations are given, and that the guns are properly loaded and accurately pointed, under no circumstances will officers do more than see that required corrections are made by the gunners.

BY ORDER OF MAJOR RANDOLPH:
(Signed) ELI D. HOYLE,
1st Lieutenant, 2nd Artillery,
Adjutant.

RESULTS.

The results obtained were as follows:

First.—Light Battery "F," 4th Artillery, Captain S. W. Taylor, 4th Artillery, Commanding:

Known Distances—October 22nd, 1894.

First target. —	1st shrapnel	0	hits.	Burst in gun.
	2nd "	251	"	
	3rd "	0	"	Stripped or burst in gun.
	4th "	25	"	
	5th "	96	"	
	6th "	146	"	
	7th "	7	"	
	8th "	45	"	
	9th "	43	"	
	10th "	41	"	
	11th "	37	"	
	12th "	205	"	
	Total	896	"	An average of 75 per shot.

Second target.—Invisible; 2 men hit; all except two shots went over before bursting.

October 23rd, 1894.

Third target.—Known distance; 31 men hit out of 50.

Unknown Distances.

Fourth target.—Estimated range, 2025 yards; hits, 21 men out of 24, 13 horses out of 17; both guns and both limbers hit by fragments of shells.

Fifth target.—Estimated range, 2200 yards; 42 men hit out of 45.

Sixth target.—Estimated range, 2350 yards; 71 men hit out of 100.

Seventh target.—Ten unexpended percussion shell at estimated range of 3200 yards.; one hit. All other shots went over.

Second.—Light Battery "A," 2nd Artillery, Captain G. S. Grimes, 2nd Artillery, Commanding.

Known Distances—October 24th, 1894. Weather conditions fairly good.

First target.—	1st shrapnel,	57	hits.
	2nd "	35	"
	3rd "	23	"
	4th "	4	"

5th shrapnel,	9	hits.
6th "	24	"
7th "	10	"
8th "	36	"
9th "	0	"
10th "	48	"
11th "	111	"
12th "	40	"
Total,	397	" An average of 33 per shot.

Second target.—Invisible; 31 men hit out of 50.

Third target.—At 1775 yards; 33 men hit out of 50.

Unknown Distances—October 25th, 1894. Weather conditions very unfavorable. Thick dust storm, variable winds of 15 to 30 miles per hour.

Fourth target.—Range estimated at 2450 yards; hits, 20 out of 26 men, 14 out of 17 horses; 1 gun and 1 limber struck—probably put out of action.

Fifth target.—Range estimated at 2150 yards; 37 men hit out of 45.

Sixth target.—Range estimated at 2575 yards; 99 men hit out of 100; dust storm very thick at this time.

Seventh target.—Range estimated at 4100 yards; dust storm had so increased in violence that the target could scarcely be seen at all through the sights. Little judgment could be formed of distance of point of impact from target, even with best field glasses. The ten remaining percussion shell were fired at 10'x20' canvas target.

1st shot,	20 yards over.
2nd "	60 " "
3rd "	130 " "
4th "	140 " "
5th "	100 " "
6th "	55 " "
7th "	75 " "
8th "	70 " "
9th "	Range correct—struck a few feet to right.
10th "	35 yards over.

Only those who have had the experience of a Fort Riley dust storm, can fully appreciate the adverse conditions under which this day's firing took place.

Third.—Light Battery "F," 2nd Artillery, Captain W. P. Vose, 2nd Artillery (1st Lieutenant L. H. Walker, 4th Artillery, temporarily in command).

Known Distances—October 26th, 1894.

First target.—	1st	shrapnel,	43	hits.
	2nd	"	26	"
	3rd	"	28	"
	4th	"	0	"—over
	5th	"	314	"
	6th	"	0	"—over
	7th	"	89	"
	8th	"	148	"
	9th	"	65	"
	10th	"	51	"
	11th	"	45	"
	12th	"	252	"

Total, 1061 " an average of 88+ hits per shrapnel.

Second target.—44 men hit out of 50.

Third target.—40 men hit out of 50.

Unknown Distances—October 27th, 1894.

Fourth target.—Range estimated at 2300 yards; hits, 11 men out of 27, 15 horses out of 17; 2 guns; no limbers.

Fifth target.—Range estimated at 1700 yards; 43 men hit out of 46.

Sixth target.—Range estimated at 2250 yards; 86 men hit out of 100.

Seventh target.—Range estimated at 2000 yards; 10 unexpended percussion shell fired at 10'x20' canvas target.

1st shot	125	yards	over.
2nd "	100	"	"
3rd "	15	"	short.
4th "	15	"	"

5th shot	100	yards	over.
6th "	50	"	"
7th "	25	"	short.
8th "	10	"	"
9th "	40	"	"
10th "	50	"	"

The target was hit by 17 shells and fragments of shells, three shots apparently piercing the target before impact. The ground in rear of the target sloped down suddenly a few yards behind the target to a level of about 15' below that on which the target was placed, gradually rising to a level with it about 150 yards back. The second, fifth and sixth shots probably struck the target. The distances of point of impact were estimated only.

Although this was our second year's work with shrapnel, the methods employed were highly satisfactory and the results obtained were extremely gratifying to all the officers participating. The time limit imposed was the most important feature and added more than anything else to the value of the practice.

A few shrapnel burst prematurely, otherwise no important defects were developed in guns, ammunition or equipments. The fuse gave good satisfaction.

Taking into consideration all of the conditions under which the firing was carried out, the results were, I believe, as good at least as any ever attained in the U. S. Army; and judging by our peace practice, the light artillery in future as in days gone by will not be found wanting if ever called upon to face the enemy.

GERMAN FOOT ARTILLERY WITH HORSED GUNS.

TRANSLATED FROM THE *Revue Militaire de l'Etranger* BY FIRST LIEUTENANT T. BENTLEY MOTT, FIRST ARTILLERY, U. S. A.

The *Révue Militaire de l'Etranger* has already several times drawn attention to the maneuvers of the German foot artillery, which, it would seem, have for some time past been directed into entirely new paths.

In 1892 they had received a special extension, and we were lead to conclude that the German Staff meditated some important transformation for the foot artillery which would not be long in appearing. This expectation has been verified; in fact the object of these maneuvers was to prepare the way for the creation of batteries of foot artillery with horsed guns; and the organizing of these batteries, destined to introduce a new element into the battles of the future, is now an accomplished fact. We propose in what follows to give some information with regard to this *fourth arm*, whose special tactics are not yet well known, and in order to present the matter with more method, we will first try to briefly point out how the Germans have arrived, little by little, at this new idea. We will then see what rôle is probably intended for these batteries in future wars.

In 1891 the Minister of War asked the Reichstag for an appropriation of $27,700 for the purchase of eighty-eight heavy draught horses as an addition to the strength of two battalions of the train.

This request (which was favorably received) was explained as follows: "During past years, in order that the foot artillery might be made to take part in the maneuvers with their heavy caliber guns mounted on wheels, we have been obliged to hire from private parties heavy draught horses, as those of the battalions of the train were found to be entirely unfit for this service. During the maneuvers the carriages have been driven by civilian drivers, and many inconveniences have resulted.

* * * * *

In order that trials of this kind may be made, two battalions of the train will each receive forty-four heavy draught horses, which during the course of the year will be lent to the foot artillery for its maneuvers."

The two battalions selected by the Minister were the 14th and 15th in garrison at Carlsruhe and Strasburg.

This is the first mention made in an official German document of foot artillery with horsed guns; however the organization of this fourth arm follows out an idea which is not new, for it was advanced in Germany immediately after the last war. In fact, some time after the end of the campaign, the Germans began to think of providing means for quickly reducing *forts d' arrêt*, and with this intention, they organized two small siege trains, each comprising fifty 6-inch pieces (15 centimeters) served by two battalions of foot artillery. To each of these trains was attached a supply column of forty carriages with the necessary personnel. These trains were to be transported by rail; they could, however, in case of necessity be moved on wagon roads.

This organization held until 1880. At this time the adoption of new guns and the progress made in fortification, induced the German staff to reorganize the small siege trains. They created therefore, two *special* siege trains, each comprising forty guns and four supply columns; one regiment of two battalions of foot artillery was attached to each train. These forty guns were divided as follows:

20 short 6-inch guns.
12 heavy 4.7-inch guns.
8 8.3-inch mortars.

But this organization could only be temporary, for it did not answer all the requirements. Fully persuaded that existing fortresses with their disconnected garrisons and their surrounding forts separated by several miles from each other, could be taken by more rapid means than those formerly employed, the Germans felt the need of still further lightening their special siege trains, or rather of transforming them in such a way as to bring them more closely in touch with the field troops.

The necessity for this transformation became still more evident after the adoption of smokeless powder and magazine rifles. They thought in Germany that the modifications in the infantry arm were all to the advantage of the defensive, and they concluded from this that they must counterbalance these advantages by giving the attack more powerful means of action than those it possessed up to that time.

Moreover the opinion is generally admitted on the other side of the Rhine, that with the present arms, future wars, or at least those which more particularly interest the Germans, will present some very special characteristics. During the first operations, permanent fortification will play a very important rôle. Moreover, the difficulties inherent in the handling of large bodies of troops will frequently cause commanders of armies to take position upon ground chosen in advance, and there fortify themselves more or less strongly, so as to receive the attack of the enemy under favorable conditions. "An unprepared field of battle" say certain writers "will become more and more rare." The battle will last, apparently, several days ; it will present the aspect of a veritable siege, with the difference that the phases will succeed each other more rapidly. It is, then, indispensable that the artillery should be furnished with a means of action in accord with this new evolution of tactics. For this reason the Germans have sought to lighten their siege train and have ended by creating batteries of foot artillery with guns on horsed carriages. The request of the Minister of War in 1891 for an appropriation, seemed to indicate, in spite of the brief statement of the reasons, a full intention of giving a wider range to the maneuvers of foot artillery serving guns of heavy caliber on horsed carriages.

There are as yet, it is true, no regulations fixing the nature and order of these maneuvers; but in the absence of official information, we may try to find out with the aid of contemporary military publications what end the German staff has in view in putting heavy draught horses during time of peace at the disposal of foot artillery.

Among these publications there is one of great interest from our particular point of view. It is a pamphlet published in

Berlin in 1892 by General Wiebe of the artillery entitled, "Participation in the grand maneuvers by the foot artillery serving heavy guns." General Wiebe is an old foot artillery officer; during his whole career he has diligently studied the questions which bear upon his arm; he then, more than anyone else, is in a situation to give his advice in the present case.

After affirming that the importance of the foot artillery becomes greater each day, that the occasions in which it will be used as an attacking arm are more and more numerous and that particularly in the rapid attack of fortified positions, it is called upon to play a preponderating rôle, the General thus expresses himself:

"The most efficacious means of increasing the opportunities for the useful employment of the foot artillery is to form out of its materiel and personnel, heavy mobile batteries, and to attach them to the field artillery for the attack and defense of fortified positions. In order to make this combination possible, these batteries should be able to follow the campaigning troops in all sorts of country in order to be ready to take post in the line at the moment and at the point where they are needed. Now this result will certainly be attained if they give the foot artillery a light and mobile material as well as sufficient means of transport. Besides, that this arm should fulfil the hopes that have been placed in it, it is indispensable that it should be exercised during time of peace in the various kinds of service which it will be called upon to perform in time of war. The heavy mobile batteries of the foot artillery ought therefore to know thoroughly all the details of field service."

In conclusion, General Wiebe asks that a certain number of teams be permanently placed at the disposal of the foot artillery in order that it may take part every year in the grand maneuvers under favorable conditions, and on the same footing as the other troops.

General Wiebe's pamphlet, without a doubt, represented quite accurately the ideas which were accepted at this time in Germany, for, a little while after its publication (October 20th, 1892), the Chancellor of the Empire presented to the Reichstag his military bill in which, along with other new schemes, he asked for the equipment of seventeen groups of teams destined for the service of the foot artillery. "As the foot artillery," said the bill "ought to be employed in the future along side of other troops in the field, it should not be deprived of the transport which is necessary to it."

Each of the seventeen groups asked for in the bill was to consist of 1 officer, 42 non-commissioned officers and privates, 12 saddle horses and 44 heavy draught horses. Now if it is remembered that the foot artillery comprises 38 battalions, of which 36 are grouped into 17 regiments, it will at once appear that the German staff contemplated attaching one group of teams to each regiment.

The Reichstag modified this government bill, however; the seventeen groups of teams were cut out, and the foot artillery has actually at its disposal, it appears, only the eighty-eight heavy draught horses that were attached to the 14th and 15th battalions in 1892. * * *

The existence of batteries of foot artillery with horsed guns being known, the question now is to learn for just what purpose they were organized, and to discover the part they are expected to play in future wars. Before answering this question, it is indispensable that a few words be said as to the material with which these batteries are provided, since the details of the construction and organization of this material, the character of the guns and the weight and composition of the loads, will furnish valuable indications of the ideas animating the German staff.

The armament of the heavy batteries, which we will henceforth call *batteries d'armée*, following an expression now much used in the military journals, comprises three distinct natures: the 4.7-inch (12 cent.) gun with steel tube; the 6-inch (15 cent.) howitzer; and the 8.3-inch (21 cent.) mortar with steel tube.

The heavy 4.7-inch gun is of hardened bronze with a tube of nickel steel. This tube has lately been added to strengthen the resistance of the gun against the destructive effects of a torpedo shell (*obus torpille*) bursting in the bore. The piece weighs 2860 lbs.; it has a cylindro-prismatic wedge generally similar in its arrangement to that of the field gun—model of 73/91.

It shoots two kinds of projectiles: a torpedo-shell weighing about 35 lbs. and containing a bursting charge, and a shrapnel weighing 42 lbs. and containing 592 bullets of hardened lead. These two projectiles carry combination fuses. The normal charge for the piece is 3 lbs. of smokeless leaf powder (Geschütz Blättschen Pulver) with a priming charge of ¾ oz. of musket powder. This is equivalent to a charge of 7.7 lbs. of prismatic powder.

The gun is mounted on a wheeled carriage weighing about 2400 lbs. The limber weighs 900 lbs. Thus the gun and limber complete weighs not less than 6200 lbs.

The 6-inch howitzer which has lately replaced the 6-inch mortar and the 6-inch short cannon in the armament of the foot artillery serving horsed guns, is a new steel piece. It is furnished with the flat wedge system of fermeture, and fires a shell weighing about 88 lbs. with combination delay-action fuse. This shell probably has a bursting charge; there is as yet no adopted shrapnel. The normal charge for the piece is 27 ounces (750 grammes) of smokeless powder in cubes .08 inch on the side, with a priming charge of 15 grains of musket powder. This normal charge is arranged in four separate charges weighing respectively 400, 200, 100 and 50 grammes. In certain exceptional cases the normal charge can be raised to 850 grammes by the addition of one of the elementary charges. The charge, and hence the range and angle of fall, can thus be modified very easily.

The howitzer weighs 2400 lbs.; it is mounted on a wheeled carriage of metal provided with two breaks, an hydraulic break for firing and a rope break for the road. The carriage weighs about 1800 lbs. and permits of elevation between 0° and 65°.

It thus appears that adding to the weight of the piece and carriage that of the siege limber similar to the one for the 6-inch gun, we have for the weight of the whole equipage about 5100 lbs.

The third piece is the 8.3-inch bronze mortar with steel tube, which weighs about 6800 lbs. and fires a shell weighing 320 lbs.

This shell has a delay-action percussion fuse and probably contains a large bursting charge.

The normal charge for this piece is 5.3 lbs. of powder in cubes .08-inch on the side, with a priming charge of 150 grains of musket powder. This normal charge is arranged in six separate charges weighing respectively 800, 500, 400, 400, 200 and 100 grammes, or a total as above of 2.400 kilogrammes or about 5.3 lbs.

The carriage is of iron and rests on rollers or small wheels, the whole weighing about 5500 lbs. On the march the rollers are replaced by wheels similar to those for the 6-inch howitzer carriage. For transportation the piece is removed from the firing carriage to a special carriage (*porte-corps*), which itself weighs no less than 2860 lbs. The accoutrements and accessories are carried on the carriage with the piece.

The firing carriage is attached for the march to a siege limber by means of an adjustable trail.

It thus appears that the 8.3-inch mortar on its travelling carriage represents a weight to be hauled of 9900 lbs. at the very least; the firing carriage and limber 6160 lbs.

For batteries of such guns as these, transport of ammunition platforms, etc., must be provided. The Germans have made use of old model wagons, suitably lightened and changed for their new purpose. These wagons serve indiscriminately to carry ammunition, wood for platforms, or the various spare parts which the batteries may need. They are sufficiently light to be be able to follow the field troops without too much difficulty.

The preceding details will give some idea of the work intended on the battle fields of the future for the batteries of heavy guns which the Germans intend to carry thither; and while no official document, as yet, lays down this rôle precisely, a glance through the military journals will probably give us an idea sufficiently close to the reality.

* * * * *

It is certain that the present organization of the foot artillery for field service agrees, in part at least, with the ideas advanced by General von Sauer some years ago in the *Rêvue Militaire de l'Etranger*, and all others who have written on this subject have merely followed in his track. The solution adopted is evidently less radical than the one which he advocated, as he desired to have two batteries of howitzers permanently attached to each division of infantry, but it is none the less true that henceforth guns adapted to high angle fire will be found on the battle field by the side of field pieces with flat trajectories. Such at least is the hope of the Germans, and if we examine more closely the characteristics of the three pieces of which we have spoken above, we will see very clearly what rôle is intended for each.

The batteries armed with the 6-inch howitzer will probably play the most important part. This piece seems naturally for the use of the offense. It can on a pinch be hauled by six heavy draught horses, at least on paved roads and at slow gaits. It fires a powerful projectile which would be very effective against field works; it therefore answers very well the desiderata of General von Sauer and his successors.

If the 6-inch howitzer is not sufficient to destroy the works of the defense and thereby shake their nerve, the 8.3-inch mortar must be called in, which being much less mobile, cannot be employed except in a narrower sphere. As we have seen, this mortar on its travelling carriage weighs 9900 lbs., which gives us in a six horse team 1316 lbs. per horse, a load which excludes any march at all long, or any movement except on paved roads, unless additional teams be placed at the disposal of the batteries.

There remains the heavy 4.7-inch gun whose uses are rather difficult to lay down in the present connection. The fact is worthy of remark that none of the German military writers speak of the eventual use of this gun. They all occupy themselves with the pieces for curved fire, and insist upon the necessity of having them on the field of battle, but they say nothing of these guns for direct fire. It is possible, we believe, to fill the gap, and without pretending to actually divine the intentions of the Germans, a very plausible explanation can be given for the existence of this piece in the armament of the *batteries d'armée*, alongside of the 6-inch howitzer and the 8.3-inch mortar.

We cannot be very far off in believing that the heavy 4.7-inch gun is intended mainly for use on those occasions when the German army will itself be obliged to take up a defensive position. If we remember, indeed, that the German military writers consider high angle fire as above all useful to the offense, that they call attention, and with reason, to the fact that the defense cannot make much use of this kind of fire, because they particularly must direct their fire against moving objects; that against such objects direct fire alone is effective; we may conclude that the heavy 4.7-inch gun will be chiefly employed in the defense of fortified positions.

We will now endeavor to find out the conditions under which these *batteries d'armée* will be used on the field of battle, and the measures which must be taken to insure their coming up in time to be useful. General Speck has published an elaborate article upon this subject, wherein he suggests that these batteries be not attached ordinarily to the army corps, but remain collected and under the orders of the commander-in-chief of the army, who will direct their use as he may see fit.

We must not forget, moreover, that the German field batteries already possess the means of reaching an enemy behind a parapet. Their shell with a very wide cone of dispersion is especially designed for this use, and it will frequently happen that the *batteries d'armée* will not be called upon, and then only when the field batteries have shown themselves powerless to overcome the guns of the enemy and prepare the way for the assault. * * * *

The great proportion of howitzers as compared with mortars in General Speck's estimate (12 batteries of howitzers to 4 of mortars) is thus very rationally explained by that officer: "A line of defense, even when prepared in time of peace, will have only its *points d'appui* and its principal intermediate works strongly fortified; the rest of the line will be merely field works. It will be sufficient, therefore, that an army undertaking the attack of such a line have a small number of large caliber mortars and a great proportion of howitzers." We may notice that General Speck says not a word of the heavy 4.7-inch gun, and this silence confirms what we have said above as to the possible employment of this piece.

* * * * *

Nothing has been given out as to the composition of these batteries, but we venture to supply the gap.

The batteries of howitzers will doubtless be regular six-gun batteries. Allowing the same weight behind the teams for guns and ammunition wagons (5100 lbs.), and supposing the empty wagon to weigh 2420 lbs., we make the weight of projectiles carried in each wagon 2480 lbs., or, let us say, 30 shell. With 12 caissons per battery, each piece would thus be provided with 60 rounds. Adding the forge, wagons for platforms, baggage, etc., we may lay down the following as the composition of the battery:

Guns	6
Ammunition wagons	12
Platform wagons	6
General service wagon	1
Forge	1
Baggage and provision wagons	2
Total	28

General Speck gives the idea that each battery of howitzers will have attached to it two ammunition columns. Placing the number of wagons in each column at 20 and the number of rounds per wagon at 30, we get a total of 260 rounds per piece.

We may venture the following as the composition of the mortar batteries:

Pieces on travelling carriages	4
Firing carriages with limbers	4
Ammunition wagons	12
Platform wagons	6
General service wagon	1
Forge	1
Baggage and provision wagons	2
Total	30

As the mortar shell weighs 300 lbs., each wagon could barely carry more than ten rounds, and with four pieces to a battery the twelve ammunition wagons would furnish about thirty rounds per piece for immediate service. Allowing three ammunition columns with twenty wagons to a column for each battery, this allowance would be raised to 170 rounds per piece.*

On the march the *batteries d'armée* would follow the trains of one of the corps. Their ammunition columns would follow the last battery at about one day's march at the most.

General Speck states that on good roads with grades no steeper than 8°, the howitzer batteries would be able to keep up with the infantry; but he does not pretend that they could do so on poor roads.

The difficulties which the howitzer batteries, and still more the mortar batteries, would encounter as soon as they leave the highways, are fully acknowledged, and these difficulties would enormously increase as the position of the enemy is approached and the front of march contracted. And yet it is just at this point that the heavy batteries must be pushed to the heads of the columns, by hard marches along the cross roads.

That the confusion incident to such movements may be made a minimum, General Speck insists that minute reconnaissances should be made of the roads to be taken by the batteries, and their march regulated with every care. The loss of time incident to such reconnaissances is sufficiently evident.

When an attack upon a fortified position is decided upon, the *batteries d'armée* must be brought up. The nature of the works will decide their kind and number. If the works have been constructed since the war began, the howitzers should be equal to the task; if they are permanent works, mortar batteries must be sent forward with the columns which are marching to the front of the position.

An easy calculation will make it evident that the presence of the *batteries d'armée* lengthens the column of a corps by a long day's march; there is therefore another strong reason why the corps to which these batteries are attached should march on parallel roads, and that the best should be given to the batteries. Moreover, as batteries offer an excellent target and can make no reply, and as their effect is enormously increased when operating by surprise, every effort should be made to bring them into

* The original reads, for the three ammunition columns, "600 rounds, or 100 per piece." Evidently the error arises from overlooking the composition of the mortar battery given, viz:—four pieces to a battery.—T. B. M.

position under cover of the ground. This will be facilitated of course by the fact that they can fire over obstacles, but owing to their lack of mobility, their position should be carefully chosen sc as not to be changed.

General Speck wishes to have sixty infantrymen attached to each battery, to keep the alignment of the pieces following different roads, remove obstacles, repair the roads and lay platforms.

As these really siege operations cannot be carried out under the enemy's observation, the infantry force must meanwhile have driven in the outposts and strongly occupied the ground, so that no return attack may interrupt the planting of the heavy batteries.

We may say therefore, that granting all of this to be accomplished during the evening, the *batteries d'armée* cannot possibly be ready to open fire before the next morning; the employment of these heavy batteries therefore, will occasion a decided delay in the movements of the assailant, and this delay the defense will without doubt make use of to strengthen their works and bring up reenforcements. This disadvantage General Speck does not make of much account, for here, as elsewhere, he greatly overrates the superiority of the offense over the defense. This optimism is well shown in the following passage: "The measures taken by the enemy in time of peace to protect his artillery and infantry, the arrangements for flank defense, etc., will be known before the opening of hostilities, and will enable the assailant to determine the kind of artillery which he must put in line. As without doubt all the guns of the enemy which bear upon the ground of attack will open at the moment the assailant approaches, their nature, caliber, and, for guns of direct fire, their situation, will be disclosed." This hardly seems a true picture of what will actually take place, and if the defense is at all active they should be able to seriously interrupt reconnaissances and delay the arrival of the *batteries d'armée.*

The above would seem to forcibly point out the importance to the defense of holding on to the ground exterior to their works, and of making the enemy deploy and fight before he is able to attack the works.

Without insisting too much upon the advantages of fortification, we see from the above that the defense should not remain inactive behind their works. Detecting by means of cavalry the early movements of the marching column and taking the offensive at opportune times, the defense may greatly delay the operations of the heavy batteries; and when these batteries are in place, their curved fire is of little use against moving bodies of cavalry and infantry, which may, if active, seriously endanger them.

Thus from these published ideas of General Speck, General von Sauer and others, we get some idea of the new elements which the Germans hope to introduce into the attack of fortified places. They are more than ever convinced in Germany that pieces for high-angle fire are going to make fortifications untenable in a relatively short time, and the creation of foot batteries with horsed guns is intended to furnish the means.

Considered from the point of view of siege warfare, the new organization is perhaps an advance upon the old; but in field warfare we believe that the management of these batteries of heavy guns will always be surrounded by serious difficulties, on account of the weight of their material. The efforts required of their personnel, the numerous precautions which must be taken, the slowness of their movements, are all points of which the defense is sure to take good advantage.

PROFESSIONAL NOTES.

A. ORGANIZATION.

(a) The Reorganization of the Turkish Army.

Thanks to its organization of 1893, the Ottoman Empire can count on 18 army corps in case of war, duly organized into three armies, and this without taking into account the troops of occupation (Tripoli, Yemen, etc.). The following is the method of recruiting and the organization of these 18 army corps.

Recruiting goes by districts. It extends over thirty million inhabitants; the other ten million (non-mussulmans and certain classes of mussulman) being exempt from military service. These thirty million furnish about 120,000 men each year for the recruiting lists, that number reaching their twentieth year. On the average about 25,000 of this number are found unfit for the service, and 30,000 others are released on account of being the support for their families. These thirty thousand constitute the "second category." The remainder of the yearly contingent, about 65,000 men, is divided by lot into two parts; the first division, of 40,000 men, serve from three to four years; the second division serve less than a year (six to nine months). The men of the "second category" (released as support for their families) are drilled once a week for eight months.

The active army, or "*nizam*", is made up of the last six annual contingents. The active army will thus consist of six "first divisions" of 40,000 men each, forming the best drilled part; of six of the "second divisions" of 25,000 men each, forming a part passably well drilled; and finally of six "second categories," of 30,000 men each, who are employed in auxiliary service.

These six annual contingents theretore bring the army 225,000 well drilled men, and 130,000 passably well drilled, to which is to be added the list of officers of 25,000, making in all 380,000 men. To this must be added the 150,000 men of the "second category," employed as auxiliaries; the total is 530,000 men.

The Army of the Reserve, or "*rédif*", includes the eight annual contingents immediately preceding the six of the active army. These eight contingents represent 570,000 effective soldiers, of whom 280,000 have had military training corresponding to the "first division" of the annual contingent.

Such in a summary way is the division of the fourteen contingents which in time of war feed the eighteen corps which the Turkish army can mobilize to an effective strength of 600,000 well drilled men, and 430,000 men fitted for auxiliary service, making a total of more than a million men.

In peace the Turkish army is divided into seven army corps of the "*nizam*" or active service. The Yemen corps is made up solely of active troops, but the other six corps are capable of giving birth to two new army corps by calling upon contingents still of the active army, and upon the *rédifs* or reserve. They can also give rise to a fourth corps of militia called "*mustahfiz*." Besides these six active corps which are made up of 34 battalions, 10 squadrons and 12 batteries, and which on a war footing include 40,000 men each, or 240,000 in all, we must also take account of the seventh corps, composed of the troops of occupation.

The infantry, considering it by itself, is made up of 282 battalions. The peace strength of the battalion varies from 550 to 300 men. The cavalry includes 197 squadrons; the peace strength of the squadron varies from 100 to 50 men. The artillery includes 231 batteries: the peace strength of a battery varies from 100 to 60 men. The engineer troops constitute 23 companies, each company varying from 150 to 110 men.

Such, in a general way, is the present military organization of the Ottoman Empire, thus formed in 1887 in imitation of the administrative regulations of Germany. The application of these was fully realized in the course of the year 1893.

The arrangement of the battalion plays the chief part in the organization of the reserve troops. It contains approximately 7000 men from 20 to 40 years of age, professing the mussulman religion. It is by battalion that the men are called together for periods of instruction. At the headquarters of each battalion is the depot of arms, clothing and equipment for the active list and for the reserve when they come together for maneuvers or mobilization.

The muster rolls of the fighting men of the active army and of the reserve are kept by each battalion commander, and by each battery commander of the *rédif*, or reserve. A man who has completed his period of drill service, is upon dismissal, still on the active list, and during the first month of his leave, he must present himself to the commander of the company of *rédif*, or reserve, nearest his home and have his papers countersigned. The military outfit that he has brought with him on leave are then given up, duly catalogued, and returned when the troops are levied. When a man on the active list has completed his twenty-sixth year and is to pass into the reserve, he gives up to the battalion commander of the reserve his papers of the active army, and receives from him his "*rédif*" papers. This done he presents himself to the commander of the "*rédif*" company of his home, who endorses his papers, and writes on the company rolls the man's new status.

The inscription on the muster rolls of the "*rédif*" battalions is made according to the class as recruited, and in each class according to lot, under the supervision of the recruiting board. The order in which the names are drawn is followed in case of mobilization, should only a portion of a class be called out. The names are then examined and carefully verified. The mobilization of the men still on the active list and of the "*rédif*" is provided for and arranged in all its details.

Each man of the "*rédif*" is called out for instruction every two years for a period of one month. The odd numbered battalions are convoked one year and the even numbered the year following. The assembly takes place each time precisely as for mobilization: 1st. Assembling in localities under the civil authorities; 2nd. Concentration at the headquarters of the company; 3rd. Uniforming, equipping and arming at the headquarters of the battalion.

The "*rédifs*" live in tents during their terms of instruction. At the end of each period of instruction their papers are endorsed with remarks as to progress during the period. Similar endorsements are made by the company commanders during their monthly rounds, on the papers of the men who have been declared unable to attend the assembly on account of sickness.

If a *rédif* without valid excuse, absents himself from an assembly, that year is not deducted from the time he must serve on the "*rédif*." If he misses the next assembly, he is compelled to serve two months in the active army for each of the assemblies he has missed.

Such is the administrative organization implanted in the Ottoman Empire by imitation of the methods of the German "*landwehr*" and of the "*landwehr*" districts, and competent judges hold it superior to the model after which it is fashioned. It is easy to see how much it is superior to the rules in force in France for discipline of the reserves, which give rise to so many errors and to so much discontent. Each district of an army corps is divided into eight principal recruiting bureaux. On each of these principal bureaux depend eight secondary offices; there are thus 64 of these latter in an army corps district, and from each of these branch out four company bureaux, making a total of 256 for a principal bureau.

The principal recruiting bureau is placed under the direction of the general commanding the corresponding "*rédif*" brigade; the secondary offices are directed by the major commanding the corresponding "*rédif*" battalion. It results therefore that each army corps district includes eight "*rédif*" brigades formed of eight battalions each, these latter being subdivided into two regiments, the odd regiment being commanded by a colonel, the even regiment by a lieutenant colonel.

These are the broad lines of the organization of the Turkish "*landwehr.*" It is completed by the organization of the militia, which is composed of the six classes following those of the "*rédif*." In case of mobilization it is formed into battalions of 800 men to serve as garrisons and to guard lines of supply. Each battalion depot for the "*rédif*" contains clothing, equipments and arms for a battalion of militia.

Such is the very considerable progress realized by the Ottoman Empire in the line of establishing reserves and militia corresponding to the German "*landwehr*" and "*landsturm*." The mobilization of the Turkish army requires but three weeks for completion, and the conditions are little different from those of the mobilization of the great European armies.

—*L'Avenir Militaire.*

(b) Light Artillery—Russia.

By a recent order an important modification has just been introduced into the Russian artillery, by the creation of a unit intermediate between the battery and the light artillery brigade (*piechaia artilleria*). This new unit, composed according to circumstances of two or three batteries is to have a rôle similar to our (French) "*groupes.*"

At the present time the light batteries of the active service are divided up into forty-eight brigades, comprising as a rule six batteries each; each of these brigades is permanently attached to one of the forty-eight divisions of infantry, of which they constitute the divisional artillery in time of war. In peace the artillery brigade is subordinated to the commander of the infantry division, as regards general service, discipline and combined military instruction; its immediate chief is a brigade commander with the rank of brigadier general.

Each battery includes eight pieces divided into four sections, and is commanded by a colonel or lieutenant colonel. Each half of a battery is commanded by a captain. The grade of major intermediate between those of captain and lieutenant colonel was abolished in 1884. The battery has besides three lieutenants or sublieutenants, one of whom has charge of the caissons.

Hitherto there has been no unit between the battery and the brigade. It was necessary, therefore, to lay down a rule as to the command of the groups formed by batteries coming together in the contingencies of battle. This command fell to the senior battery commander present at the position, but his authority went no further than simply directing the fire.

Here lay a serious defect in the organization. On the one hand, when the batteries were united, it was a very difficult thing for the brigade commander to command six batteries effectively; and on the other hand, when the batteries were formed in groups. the command of these groups was not sufficiently assured. The new organization remedies this state of affairs. By an imperial order of the 23rd of October (November 4th), 1894, the light artillery brigades (active and reserve) of European and Caucasian Russia are to be subdivided into groups of two or three batteries. Each of these groups is called a "division."

A second order of the 26th of February (March 29), 1895, gives the details relative to the command of these divisions, and prescribes the formation of these divisions in the forty-four active brigades of European Russia, viz: in the three brigades of the guard, in the three grenadier brigades, and in the thirty-eight brigades of the line. These forty-four brigades, hitherto forming one undivided unit of six batteries, will henceforth comprise two divisions of three batteries each, that is to say, eighty-eight divisions in all.

By the same order the command of batteries will hereafter be exercised as follows: in the guard by colonels, in the grenadiers and in the line by lieutenant colonels. However the battery commanders of European Russia who have now the grade of colonel will hold their command until they are detailed for other duties, or until they are retired.

—*Revue d'Artillerie.*

B. PERSONNEL.

(a) Promotion—Germany.

The list of seniority which has just appeared gives us an idea of the rate of promotion, and approximately of the age of the officers.

The period of promotion from the lowest grade of officer (grade of second lieutenant) which we find on this list, extends:

1st. For generals commanding army corps, from 1850 to 1867; 2nd. For lieutenant generals, from 1856 to 1862; 3rd. For major generals, from 1858 to 1865; 4th. For colonels, from 1860 to 1866; 5th. For lieutenant-colonels, from 1864 to 1870; 6th. For majors, from 1866 to 1872.

The senior captains have been from seven to eight years in that grade. Those who have just been promoted have passed about five years in the grade of first lieutenant, and the senior first lieutenants entered the service in 1881. The senior second lieutenants were promoted in 1887 or 1888.

A great many colonels do duty as brigadier generals in the cavalry.

The list of seniority does not give the date of birth; but the grade of second lieutenant is generally obtained about the age of 21. Starting with this it is easy to obtain approximately the age of the officers in each grade.

—*Revue du Cercle Militaire.*

C. INSTRUCTION.

(a) Firing at Captive Balloons—Austria.

The Austrian journals publish the following results of target practice against captive balloons, which was the final event of the annual course in military aerostation.

The following is the account of two trials with shrapnel:

1st. After nine attempts producing eighteen bad tears, the balloon still kept its buoyancy. This result obtained in a short time and with comparatively few rounds shows the risk the aeronaut runs of being hit. The range was 4000 paces. The height of the balloon did not exceed 300 meters and a heavy rain was falling.

2nd. The balloon was soaring at 800 meters or thereabouts, and the range was 5000 paces. Strong oscillations occasioned by the wind and the unusual height of the target made the firing very difficult. The balloon was not hit until the 65th round; the projectile made two rips more than a meter long, and the balloon fell rapidly.

The Austrian journals think that these experiments prove that captive balloons could be exposed long enough to be useful, provided care was exercised in the choice of ground.

—*Revue Militaire de l'Etranger.*

(b) Firing at Captive Balloons—Germany.

The target practice against balloons, carried on in Russia at Oust-Ijora in 1890 and at Krasnoé-Selo in 1891, have shown with what effect shrapnel can be used against captive balloons.

Trials of the same kind were undertaken last year in Germany at the proving grounds of Jüterbog.

It was proved first of all that musketry fire is useless, by having six sharpshooters fire at a balloon at an elevation of but a few hundred meters: the escape of the gas through the small holes produced by these balls was insignificant.

The balloon was then elevated to about 1000 meters and a field battery firing shrapnel opened against it. After a first long shot the rest reached the balloon which kept swaying considerably; the envelope shriveled up considerably and ripped; and soon the balloon began to descend and the cable had to be taken in rapidly. The envelope had large holes in it, the netting was badly injured, but the boat was nearly untouched.

From this we can conclude that when a balloon does not exceed in height those altitudes at which useful observation is practicable, it has nothing to fear from the rifle, but is in danger of destruction from shrapnel.

—*Razviedtchik.*

(c) The Artillery at Port Arthur.

The siege artillery did almost nothing in the combat, though it occupied a very advantageous position in the center of the line of battle. The field artillery, on the contrary, was remarkably well handled, the battery commanders quickly getting the range by bracketing, overwhelming the defenders of the parapet with shrapnel. Surprise has however been expressed at the insignificant material results produced by shrapnel bursting at a good height and near a parapet lined with troops, and it is cited as an anomalous fact that only 23 dead bodies were found in the fort of Niriuzan, which was defended by a thousand men, and on which field artillery had been playing for a long time at a fair range (2500 meters). But there is nothing surprising in this, for whatever be the precision of firing shrapnel, artillery can not pretend to make serious ravages in troops under shelter; first, due to the low remaining velocity of the balls on bursting, the number of killed must be small compared to the number wounded; beside this, the consequences of a fire is not alone to be measured by the men hit, but we must also take account of the moral effect as well; a well directed fire, covering the approaches of a work sheltering troops by a parapet, will very likely lead to a speedy retreat of the defenders, as it did at Port Arthur.

—*Revue Militaire de l'Etranger.*

(d) Military Lessons of the Chino-Japanese War.

Hilary A. Herbert, Secretary of the Navy, in the *North American Review*, New York, June. Condensed for *Public Opinion*.

Japan has leaped, almost at one bound, to a place among the great nations of the earth. The common impression is that while Japan has been making phenomenal progress, China has been stagnating. This is not true in a military sense; if it were, experts would not be everywhere studying, as they now are, the lessons of the recent war in Asia. The value of preparation, of being ready for war, has never been more conclusively shown than by the results of this struggle. The Chinese government seems to have understood the importance of sea power. Preparing itself for whatever emergency might come upon it, possibly for this very conflict, it had made large expenditures in procuring modern ships and modern guns, and upon these and their effectiveness it seemed almost entirely to rely. When the war began China only had a comparatively small number of well-equipped soldiers. For defense against invasion by land it would seem to have reckoned largely on the power of the numbers it could put in the field, though its arsenals were entirely without proper supplies of arms and ammunition. The Japanese were thoroughly prepared. They had arms and munitions in abundance and of the most modern types. The drill and discipline of their troops and of their navy had been carefully perfected after the best European models. The organization of all their forces seems to have been without a flaw.

From the very first Japan pushed the war with vigor, and her armies and her navy were handled with consummate ability. The issue was practically decided by two battles, one upon the land at Ping Yang on the 15th and 16th of September, and the other upon the water off the Yalu on the 17th of September. It does not follow as a natural conclusion from the results of this struggle, that the Chinese are, as a people, incapable, under proper leadership and proper organization, of waging a great war. The disparity between the land forces of these two countries in training, equipment, arms, and in other, respects was so great as to render it almost impossible to institute any comparison between this war and other wars; yet it should not be forgotten that quite often where the difference in these regards was not so notable, as in several of Napoleon's campaigns, one or two signal victories destroyed the power and struck a terror into the hearts of armies that greatly enfeebled, and sometimes absolutely ended, all further resistance. Within the memory of the present generation occurred a war between two of the greatest nations of the earth that teaches, in as striking a manner as does the struggle we are considering, the value of thorough preparation.

When the Franco-German war began in 1870, it will be remembered that public opinion everywhere, and especially in America, was much divided as to what was to be the outcome. A majority, perhaps, of disinterested lookers on, remembering Wagram, Austerlitz, and Jena, and forgetting the battles fought by the Germans under Frederick the Great, inclined to the opinion that France was to be the victor. But Germany in 1870, like Japan in 1894, was ready for battle. Her troops were drilled, disciplined, thoroughly equipped, and armed to perfection; her commissariat complete; her means of transportation provided for beforehand; her plans perfected. Von Moltke had organized victory before a gun was fired. The campaign had been wrought out and perfected, even to the minutest detail. The German army moved like clockwork. Wherever there was a strategic point, there were the Germans in superior numbers. In the German lines and in the German plans there seemed to be no weak point. The French armies lost heart, and though they made many gallant fights, it is safe to say that there were not many detachments of the French army who, after Bazaine was shut up in Metz, ever fought as their ancestors had fought under Napoleon I. This does not argue want of courage, for there are no braver people than the French. It shows only, what all history demonstrates, that signal defeats often demoralize armies.

China had in this war a chance, and only one chance, to win, and that lay in her fleet. The ships of China, including armament, were, in offensive and defensive power, superior to those of Japan. Both the Chinese and Japanese fleets were modern. The Japanese Navy was, however, like the Japanese people, one organized body. The Chinese navies were several independent organizations, each lacking in drill and discipline. It was apparent from the beginning that the control of the sea was vital to China, and on the sea was her only chance. The action off Yalu pronounced the doom of all unnecessary woodwork on naval vessels, and all navies are now dispensing with wood as far as possible.

There is nothing, so far as known at this writing, in the recent treaty of peace to prevent China from preparing herself in the near future for another struggle with Japan, just as France has been for twenty years putting herself in readiness for another possible test of strength with Germany. What if this giant nation should rouse herself, and through the influence of some great leader, shake together her loosely-jointed limbs, as Bismarck under William welded the disjointed German states into one? Her strength lies in three hundred and fifty millions of people, singularly patient, wonderfully industrious, and capable in a remarkable degree of enduring hunger and cold. United they could accomplish almost any result. If China begins to gird up her loins, Japan will respond, and indeed whatever may or may not happen in Asia, it may be confidently predicted that Japan will immensely increase her naval resources. She will not be slow to find in the events of the recent past many reasons for this course.

This Queen of the Asiatic seas the world has been in the habit of looking upon as a small country, but it will now be remembered in every reckoning of the resources of the nations that Japan's people, homogeneous and united, are quite equal in numbers to the population of England, Ireland, Wales, and Scotland, and that the United Kingdom is and has been for years mistress of the seas. Americans must remember, too, that only the waters of one ocean, a wide one no doubt, but easily traversed by navies, separate their country from Asia. Our policy, it is true, is and has been one of peace—peace always when it can be maintained with honor—peace and good will not only with, but among, all the nations of the earth. We avoid entangling alliances with other nations, but we have constantly exercised our good offices witn both

China and Japan, as far as we might, to bring them again into peaceful relations. Such, it is hoped, will always be our aim, but let us bear in mind that we can never be assured of the ability to command our peace unless we are prepared for emergencies.

—*Public Opinion*, June 27, 1895.

(e) The Mobility of Field Artillery.

(Answer to the article in Nos. 5 and 6 of the *Militär Wochenblatt*, 1895.)

The effort to increase the mobility of our arm is certainly to be acknowledged with thanks, and we wish it could be pushed in every way where it does not come up to the requirements of the tactics.

We include ourselves in the number of the artillerists, without prejudice, but we differ from the author of the above article in his assertion that "lack of mobility of the field artillery meets us on all sides." The writer does not explain where and how our arm fails to meet the requirements of the regulations regarding mobility. From our standpoint this lack of mobility presents itself only during the autumn maneuvers; for on the even drill grounds of garrison tracts, or firm level artillery practicing such a lack could scarcely be felt. The tactical requirements mentioned by the writer (No. 6 page 146) certainly authorize the supposition that we understand him rightly, because during the autumn maneuvers tactics are practically managed *kat' exochen.*

Now particularly during the autumn maneuvers of the last few years, the field artillery has received unlimited recognition on account of its timely appearance at the right place. Accordingly we think one cannot truly speak of its "remaining perpetually behindhand." We make a point of this to prevent our comrades, in other branches of the service, from losing faith in this, their sister arm, a thing which might well result from reading the article we refer to.

If, however, during the autumn maneuvers the field artillery is sometimes absent where it is looked for, the responsibility for this non-appearance should not, we think, always fall upon the arm itself, nor in by far the most numerous cases be attributed to its lack of mobility. Any of the following reasons may prevent the field artillery from appearing at the right moment in the right place:

I. Injudicious formation of the ranks of the field artillery in the column of march, so that it is rendered incapable of taking part in the action upon a sudden order.

II. Too late advance of the light artillery, consequent upon delayed decision on the part of the commander of the troops regarding the use of this arm.

III. Too late arrival of the order to advance on account of accidents which may have happened to the bearer on his way to the field artillery.

IV. Insufficient knowledge on the part of the leader and scouts of the field artillery of the ground they are marching to, and consequent delay of the following guns over bad roads or impassable places.

V. Objectless manipulation of the troops in the place itself, such for example, as unnecessary, or too early, unlimbering behind a height, and the consequent necessity of slowly raising the guns into position by hand, where it would have been possible to take them up by the horses without betrayal of the position.

Through the introduction of one or more of these possibilities, many cases may surely be explained in which the field artillery without being deficient in mobility, failed to appear opportunely and in the right place.

It cannot however be denied that occasions do sometimes arise when insufficient mobility does merit the blame of the tardy arrival of the arm in question. The occasions would be still more frequent if the guns and wagons were fitted out with ammunition as in time of war.

The causes which lie at the root of this fault, are not, however, in our opinion to be sought for in the insufficient education of our draught horses for riding, nor in the slight training of our batteries in driving.

It would be bad indeed for our arm in war-time if its mobility depended essentially upon these elements. The few regular battery horses, which the author evidently has in his mind as being trained well enough for riding in a battery (about 50 at peace strength, in war 150) would be found at the beginning of a campaign principally with the batteries in action. Their number would consequently be so greatly reduced after the first big fight, that the remnant would scarcely be worth mentioning.

The guns would, in our opinion, soon after the first serious fight, have to be harnessed with horses drawn from the ammunition column; horses which since the beginning of the mobilization would rarely or ever have carried a rider. Such a battery would according to the author of articles No. 5 and 6, be well nigh incapable of action, because their draught horses are not trained for riding, and the teamsters could employ no definite system of driving, even if they themselves had learned one.

The campaign of 1870-71 showed us however that batteries thus harnessed are in no wise incapable of efficient mobilization, and we hope, nay we are sure, that the next campaign will show the same result. No man was happier in 1870 than he of the three battery drivers who had in his section the most ammunition horses. He was sure at least that his guns would not halt, and that his onward progress was assured. We congratulated ourselves in those days at such good fortune.

The condition of things has fortunately now changed. We have now stronger battery teams than formerly, and any one would of course accept them for drawing guns as readily as the raw augmentation horses.

But we believe that the latter still compare favorably with even our present team horses, and that the mobility of our batteries would not in any way be impaired by their use. Horses from a street railway company which are capable and accustomed to drawing heavy street cars upon flat pavements offering small purchase to their hoofs, would also be more than welcome as teams for our guns in war: even if they, as in most cases, possessed absolutely no training in riding or had gone through no particular school of driving.

We would also gladly take plough-horses, two of which could easily pull a greater weight through heavy ground than six of our ordinary battery horses. These plough horses likewise lack real riding training, neither have they gone through any special school of driving.

Upon the same ground we agree with the author that remount stock, such as the heavy cavalry now receives, is much to be desired for the field artillery. All the above named category of horses have the advantage of being stronger than the majority, and in this lies the gist of the whole matter.

The author of the article referred to touches upon this point, but we think he does not give enough importance to it. Also we agree entirely with him that the system of remounting, as at present conducted, fails to bring to the field artillery the kind of horses it needs.

Even if isolated remount purchasing committees are sometimes made up of field artillery officers, it does not entirely prevent many a good horse, capable of excellent service with field artillery, from being rejected as unfit for military use. Cavalrymen preponderate in the remount purchasing committees.

The cavalryman naturally thinks first of his own arm, when he judges remount horses, and considers the qualities of all those which come before him from that standpoint, even the artillery draught horses. This is not only understandable but natural enough.

How often one hears on the part of the gentlemen forming the purchasing committee this expression: "Horses such as the field artillery needs are not to be found in the country," and how often when quartered on estates, have we had excellent horses shown us with the remark that "they had been presented to the remount purchasing committee in the hope they would be bought for draught horses." It is true that these horses may have looked differently when they were presented to the committee; young horses change a good deal in a few months, but we would like to object to the expression that "such horses as the field artillery needs are not to be found in the country," as not quite to the point.

The mobilization of 1870-71 proved that such horses are to be found in the country, also during the last ten years many good horses have been bought in open market by field artillery officers to supply the demand arising from the repeated increase of their arm. Many of these horses are still serving, or have served for a long time as pole-horses.

Even though some of these horses have little pure blood in their veins, we do not consider that fact detracts from their usefulness as artillery draught horses.

The chief pace of the field artillery in war is a walk—not always over a good road. Then come long movements at a slow trot—followed by, perhaps, a few hundred paces at a gallop—the first rarely, the latter scarcely ever over good roads, but oftener across ploughed fields. This kind of work can be done just as well, nay, rather better by horses of less noble race, and the result is more satisfactory than if more highly bred horses were used.

The artillery horse can of course be educated up to a certain point, but upon the whole we consider the use of too highly bred horses a mistake. The quickly pulsating blood of the thoroughbred unfits him for the steadiness necessary to set a heavy weight in motion. He wastes his strength in violent shocks against the collar and wears himself out, or becomes refractory at his unsuccess. We may be sure that with a team of six thoroughbred horses, we shall be left in the lurch before the cannon, just as soon as the demand for heavy pulling arises. Thoroughbreds are fit for coach horses but not for artillery draught horses. The great endurance in running of the blooded horse can not be utilized in field artillery work, except perhaps where long movements of cavalry must be followed.

Having named the qualifications which present themselves to us according to their value, and the effect that they would produce upon the mobility of the field artillery in time of war; we now come to the education our draught horses should receive in time of peace, in order that they may be advantageously utilized in training our drivers in riding and driving.

We do not consider it possible to carry the riding training of our artillery teams to so high a point as that of the cavalry-horse, because, as before stated, we consider many horses excellent for draught purposes which are lacking in the elements necessary for the saddle or incapable of receiving the training such as the editor demands in No. 5 and 6. Moreover we hold such training unnecessary, nor is it required by the demands which our present tactics make for a mounted battery.

We think our regulations are right in making such small demands because their fulfillment is possible in the situations which must arise amongst the troops after the first great battle. To fulfill these requirements no riding-training of the horses under saddle is needed, nor would it be of the slightest use on account of the short time of service of our drivers, whose limited education in riding would incapacitate them from valuing, or profiting by it.

We consider it a great step forward that we no longer have to fulfill the requirements as they existed prior to the time of the prematurely deceased cavalry leader, General von Podbielski, and we are glad that our drivers no longer have to vault at a gallop. We hold also the abandonment of the short wheeling of the guns to be another forward step, as it spares us a special riding school. General von Podbielski was penetrating enough to see that the short services of our men (then 3 years) necessitated the rejection of all such scientific requirements. We shall follow his ideas if we simplify and cut down in war everything possible.

To attain the needed simplicity, we repeat, we do not consider special riding-training of artillery horses at all essential. Also, in view of our short two years service period, we would consider the establishment of a driving school to be a distinctly backward step.

We agree entirely with the author in his desire for a thoroughly higher horse standard in time of peace, particularly as it would certainly render mobilization easier, but we must put the wish aside, its attainment is for us at present an utter impossibility.

What might be done to insure greater mobility—or, to express it better, insure the appearance of the field artillery at the right moment in the right place, we would condense as follows:

I. Place the field artillery as far forward in the column of march as its security will permit (Field Artillery Regulation No. 252.)

II. Timely decision of the commander of the troops in regard to bringing his field-artillery into action, and therefore a livelier interest on the part of the superior commanders of all other arms in the functions of the field-artillery.

III. Increase the number of messengers to the field-artillery of the order to advance, so that in case of accident the order may not be delayed or entirely wanting.

IV. More frequent exercise of the drivers of field-artillery in conducting their teams over unfamiliar ground; to be achieved by increasing the time given to field work just before the Autumn Maneuvres.

V. Purchase of remounts for the field-artillery by remount-purchasing committees composed entirely of field-artillery officers, or by adding some older field-artillery officers to the now existing remount-purchasing committees, so that the really excellent horse material of the country may be utilized by our arm.

VI. Train the artillery draught horses according to the present thoroughly practical method outlined by the war office in its enactment of July 3rd, 1890, so that our guns in time of peace may not be hitched to saddle horses, but to draught horses which have been ridden.

—*Militär Wochenblatt*, February 16, 1895.

(f) Ammunition Supply—France.

A new regulation on ammunition supply was published on the 9th of December, 1893. Its distribution to the whole army took place only a few weeks ago. The following are its chief provisions:

1st. The ammunition for the infantry line of battle consists of the cartridges carried by the men, those carried in the company wagons and those carried in the caissons of the infantry sections of the ammunition train.

2nd. The corps parks supply the troops directly.

3rd. The ammunition for the line of battle will be, for each man, 254 cartridges of which he will carry 120, beside the 65 which he will put on the company wagon before the combat. By the regulations of 1890, the total number of cartridges per man was 204; of this number he carried 112, besides 26 which were in the battalion caissons. The soldier will go into action now with 185 cartridges in place of 138.

4th. With the parks the individual supply was only 257 cartridges by the regulations of 1890. It is increased to 303 by those of 1893.

5th. The company wagons when loaded follow their battalions, and the distribution is made before the formation for action. As soon as they are emptied, the wagons go to the rear of the regimental reserve and follow it at a distance—the maximum being 1000 meters.

6th. During the action, it is the sections of the ammunition train which directly supply the troops engaged, a caisson for each battalion being sent forward as soon as the company wagons have been emptied. These caissons rejoin the regimental reserves, or are distributed by the corps chief between his battalions.

7th. These caissons, held in rear of the battalion reserves are emptied, and profiting by a suspension of the combat, or a slackening of fire, cartridges are sent to the fighting lines by fatigue parties taken from the reserves.

—*Revue Militaire Suisse*, September 15th, 1894.

(g) Japan.

The high qualities displayed by the Japanese Army during the hostilities with China should lend interest to the instructions issued by the Mikado to his soldiers nearly twenty-five years ago, for a German translation of which the *Pesther Lloyd* is responsible. These instructions would seem to show that Mutsuhito's advisers had attentively studied European writers concerning the moral qualities necessary in the soldier, and some of them bear curiously upon recent discussions touching discipline in Germany. The Mikado begins by showing how military conditions have changed since the Emperor Zumnu, 2,500 years ago, commanded in person, how the Army decayed in a long period of peace, and lost unity and value under the feudal nobles who usurped the imperial power. Considering the political conditions of the time, it is not surprising to find the Mikado insisting forcibly upon the fact that he is the fount of authority and power, to whom obedience and devotion are due. He then proceeds to lay down five rules of conduct. First he insists upon fidelity as the soldier's first duty, and that upon which his country depends. "Be it remembered that fidelity is firmer than a mountain, and death lighter than an ostrich feather, to the end that dishonor come not, for if fidelity be endangered we are cast into misfortune." The second direction concerns obedience to superiors and honor to seniors. "Inferiors are to conform to the orders of their chiefs absolutely as if these orders emanated from myself," but they are never to be treated with arrogance or indignity, and friendly relations are to be maintained.

Having laid down this general groundwork, the Mikado proceeds to enforce bravery upon the soldier, but he discriminates the headlong and violent bravery of youth as false bravery from the reasoned and understanding courage of the veteran, which is the true bravery of the good soldier. The truly brave man will be beloved, but he who possesses merely false bravery "will certainly be hated like a savage wolf." Soldiers, moreover, says the fourth instruction, must be men of honor, and a man of honor is defined as one who holds himself faithful to duty and fulfills exactly the duties of his profession. The special doubts and difficulties that confront the soldier are also dwelt upon for the assistance of the soldier's judgment. Finally, the Mikado enforces strongly a simple method of life. "He who will not live frugally habituates himself to the weaknesses of civil life; he loses his firm spirit, gives himself up to prodigality and vanity, and succumbs to a passion for riches." To him bravery and the moral qualities seem to lose their value; the lax manners of such a prodigal spread on every side like a deadly malady, to the undermining of the true qualities of the soldier. The maxims of conduct thus laid down, says the Mikado, are to be present in the minds of the soldiery. To practice them a man must have a sound heart. Otherwise he may indeed put on the external manner of a true soldier and yet be worthless. These instructions are certainly very noteworthy, and doubtless have conduced to the maintenance of the high moral qualities which Japanese forces have displayed.

—*The Army and Navy Gazette*, June 8, 1895.

(h) Mountain Artilleries—France and Italy.

Major H. C. C. D. Simpson, R. A., in a paper which appears in the current issue of the *Proceedings* of the Royal Artillery Institution, gives an interesting account of a visit he paid this last summer to the French and Italian Alps, with a view, if possible, of comparing the merits of some European Mountain Artilleries with our own. By substituting Russia for France, and Great Britain for Italy, the military problem in the north-west of the Italian Peninsula is not altogether unlike that in the north-west of the Hindostan Peninsula. The principal routes through the Alps on both French and Italian frontiers are commanded by well-armed hill forts. The French positions are artificially and naturally the stronger of the two passes; and whereas the passes from France all converge on one objective—Turin—the routes from Italy to France lead to numerous and in many cases unimportant points.

Major Simpson observes:—The slopes of the Alps are steeper and more abrupt on the Italian than on the French side. I proceeded first to Modane, and afterwards to Oulx, Cesana, and Bousson (all places in the neighborhood of Mont Cenis). I received the greatest kindness and civilty from all the French and Italian officers with whom I came in contact, who assisted me in every way in the object of my trips. My thanks are especially due to the officer commanding the 13th (*bis*) French Alpine Group, and to the general officer commanding the 1st Italian Army Corps, but for whom I should have seen nothing in each case. I wish some of my brother-officers would also avail themselves of any opportunity of seeing the Mountain Artilleries of other European powers. Their fixed ideas, like mine, on these matters would be rudely shaken. I never saw a greater number of what, to us, are golden rules more violated, and yet withal such satisfactory results accrued from the sacrilege.

FRENCH MOUNTAIN ARTILLERY.

On August 5, at Modane, I obtained permission from the officer commanding the III. (*bis*) Alpine Group there to attach myself for two days to the Mountain battery (the 16th battery of 2nd Regiment Artillery, Headquarters

Grenoble) of his Group. The other units of the group consisted of the XII. Regiment Chasseurs-à-Pied (Alpine), and a detachmenf of Engineers, and Medical and Veterinary sections. There are fourteen of these groups at present on the strength of the French Army, stationed on the Franco-Italian frontier, their duty being, in the Alps, to carry out that which in the plains is usually performed by the Cavalry Division, the screening on mobilization of the main bodies concentrating in rear, and in this case advancing by the main valleys on Turin. On the first day I inspected the camp and billets of the battery, together with the regimental transport of the Chasseurs.

The men of the battery were housed in one long building, the floor of which was thickly covered with straw and acted as a bed. They seemed, according to their ideas, comfortable and contented. They are a fine body of men; physique quite as good as our Mountain gunners, the majority of them mountaineers selected with great care. Their uniform is a sort of loose serge stable jacket, blue with red piping, a light blue cummerbund, khaki trousers, dark blue putties, ankle boots, and beret cap (a cap resembling a Tam o'Shanter).

The officers wear the usual French Artillery dolman, breeches cut like our Mountain battery pattern, ankle boots, and gaiters of black leather, the latter shaped to the leg and fastened with laces, and hunting spurs, the ordinary sword belt, but on the hillsides sword attached to the saddle, short alpenstock (like an ordinary stout walking-stick with long spike) carried in the hand, beret cap with gold grenade on left side, and binoculars and aneroid (for ascertaining heights) slung over the shoulder.

The mules were picketed in rear of the guns, which with the ammunition boxes are always packed at close interval. They were a very strong and level lot, averaging, I should say, about 15 hands, with proportionate girth measurement. The Government price varied from £35 to £40 I was informed. The battery mules were picketed by means of the head chain attached to a broad stout leather throat-lash, the other end of chain being attached to a long picketing rope, to which the whole of the mules of one section were attached. The regimental transport mules of the Chasseurs were, on the other hand, picketed like our battery mules, by the fore-foot picketing arrangement, which everyone seemed to prefer for mules. Unlike the Italian Mountain Artillery, which is formed into a distinct regiment, the French Mountain batteries are attached for administration purposes half to each of two regiments of Field Artillery. The tendency is, therefore, to assimilate them as closely as possible to all Field Artillery arrangements and methods, whether always suitable or otherwise. The above was an example of "otherwise," they considered. I saw no signs of galls, although the battery had been undergoing some rough work and long marches for six weeks. The officers' and mounted men's cobs are the most serviceable chargers for warfare of a mountainous or irregular nature I have seen, and much superior to any in our Mountain batteries, whether in India or at home.

The pack-saddlery is very roughly finished and dirty, somewhat resembling that of hired transport mules in India in condition. The pads are serge-lined, stuffed with horse-hair. A leather lining instead of serge was being experimented with. There are practically only three different pattern cradles in the battery—one for the gun and wheel mules, one for the carriage mule, and a third for the ammunition mule, slightly modified for baggage, etc. The side pieces, front to rear arches, are deeper, and are continued right down to the bottom of the pads, making the cradle much heavier, but doubtless necessary, as the loads are heavier than in our Mountain batteries.

The girth is a single broad leather band passing under the stomach—not girth—and fastened to metre straps on either side like our body rollers, with a strip of raw hide to a D on either side with a Hungarian knot. The breast pieces and breechings are similar in pattern to ours, but there are no adjusting chains, and the supporting strap breast-piece is attached to D's on either side of front arch of cradle. All top-loaded mules have a crupper pad provided. The saddles were stacked under tarpaulins in rear of the mules as with us. Blinkers are worn on head collar. Riding saddles were of good pattern and clean.

The forage was good and ration plentiful, similar in quantity to our home ration for 15-hand mules. The mules were clipped and manes hogged, forelocks left and tails not squared. They were all shod. They appeared quiet and well-broken, but were badly groomed. In fact, grooming at stable hour, both with French and Italian drivers, was, for slackness and want of elbow-grease, quite on a par with that of the very worst Native driver I have ever seen. And yet the animals were undoubtedly in good condition.

The six guns and their ammunition boxes, entrenching tools, etc., constituting the gun park, were neatly stacked, but no tarpaulins are provided for it. The gun is a 12-pounder breech-loader on the De Bange principle, weighing 220 lb., muzzle velocity 842 foot-seconds, 3.149-inch calibre; height of axis of trunnions from ground about 2½ feet when mounted. The carriage is divided into two portions at the trial to permit of high-angle firing. A pair of detachable folding-up shafts is provided. The weight of the carriage is about 405 lb., including wheels. The ammunition boxes are of wood, and contain each —seven shrapnel shell, a projectile, weighing with fuze, which is always fixed, but without detonator, about 13¼ lb. When necessary, a mélinite shell of weight slightly less than the shrapnel is carried in "first boxes." There are eight cartridges each of 170 grammes of smokeless powder and 10 grammes as primer of black powder, and ten friction tubes. Eighty-four rounds per subdivision are carried by six mules.

There are three sets of wooden racks (one per section) containing entrenching tools. The racks are as heavy and cumbersome as those just rejected by us in our batteries in India in favor of the leather rack.

On August 6th I accompanied the battery in a reconnaissance made by the group on the Col de Fréjus to Croin, near the Italian frontier. The troops marched off at 5 a.m. The order of march of a group is somewhat as under:

Advanced Guard 1 Company.	Point—¼ section.	
		From 150 to 160 yards in rear.
	Head.	¼ section. Detachment of Sappers. 2 engineer mules with tools, dynamite, etc.
		From 150 to 800 yards in rear.
	Main body.	3 sections (throws out also a few flanking files). 1 mule with cacolet. 3 mules with tools.
Main body.		From 500 yards to 3,000 yards in rear.
		1 company. 2 mules with intrenching tools. 1 company. "*Batterie de combat*" (i. e. fighting line of mountain battery). 3 companies less ¼ section for rear guard. Baggage preceded by remaining battery mules 100 yards in rear.

Rear guard—¼ section.

This order of march was not strictly observed on the day in question.

The ascent from Modane (3575 feet) to Croin (8350 feet) was a steady grind the whole way, but not a difficult path for a battery. The men all wore knapsacks, and carried sling carbines and a portion of *tentes d'abri*. In one hand they carried a short alpenstock. An August sun in south-eastern France is sufficiently trying, but neither men nor mules, for whom there is no relief, appeared unduly fatigued on return to camp at 4 p. m., after only a lengthened halt of two hours from 11 to 1, when breakfasts were eaten and mules unsaddled and fed.

In all reconnaissances only that portion of the battery styled the "*Batterie de Combat*," corresponding to our "gun or fighting line," takes a part. It consists of thirty-one mules, made up as follows: To each subdivision four mules in the following order in "column of route." Carriage mule, carrying the body of the carriage, which includes axle and elevating gear permanently fixed, drag ropes, and on the cradle near side in sling a lantern. Wheels mule, carrying the wheels, the trail portion, a pair of folding shafts on top of trail; a carriage bearer across the cradle supports the wheels; this load necessitates a certain amount of lashing aud a very awkward one, especially when moving through a woody country. Gun mule, carrying the gun with breech and muzzle caps and lifter, a leather wallet containing small gun stores, and a slung case-shot. Ammunition mule, carrying two wooden boxes of ammunition (contents already given). One mule per section carries entrenching tools. One mule per section, spare, barebacked. One mule per battery, cacolet. All mules carry their own stable gear and nosebags, and the blanket is under the saddle. All the loads seemed to have a lot of unnecessary lashing about them.

I was anxious to know the French opinion on the subject of draft in mountain batteries. I was informed that draft was required only as a relief when marching on the high roads, where from no variety in the "going," and the hardness and dust of the highway, men and mules suffered considerably more from blistered feet and galls respectively than in the mountains. It also enabled them, when making forced marches in the plains, to carry the men's packs on the unladen mules. Their draft system consists of a pair of shafts, one end of which is attached to the trail, the other end (points of shafts) being attached to the gun mule with the carriage mule hooked on in front of the former, tandem fashion. Then follows the ammunition mule carrying the boxes, and in rear again, the wheel mule laden, if ordered, with the men's knapsacks, otherwise without load. In action, at drill—which took two minutes to come into—the guns were at 7 meters distance from trail to trail, and 15 meters in rear were the first pair of ammunition boxes per subdivision on the ground, and 1 meter in front of the ammunition mules, the remaining mules of each subdivision were in column in rear of the ammunition mule. The detachment consisted of one *chef de pièce*—gun captain—and six gunners, one of whom is the layer selected after a three months' course and wearing a red grenade on the left arm.

The fire discipline is that laid down for the field artillery, and not nearly as thorough as our own. Their rates of fire vary from one round a minute slow fire to ten or twelve rounds a minute quick fire. The number of rounds per minute is given by the battery commander as a rule. Sometimes, when firing with indirect laying, if the commander wishes to assure himself that the direction is correct, he orders a gun to fire with time fuse set to three-tenths of a second longer than is correct for the range. The other guns loaded with percussion shrapnel lay on the burst of the shell fired with time fuse.

Words of command were rarely used, everything in routine being carried out by the blast of the battery commander's whistle when not actually maneuvering or fighting the battery in action. The detachments both in French and Italian mountain batteries, with the exception of the layer, who alone kneels, work standing. What struck me as much as anything was the small amount of ammunition carried by the battery, that is, fourteen rounds per gun with the "fighting line," as against our thirty-two rounds per gun. Their idea is that in mountain or irregular warfare of any kind the amount of ammunition required, compared to that for warfare of the plains, is as three-fifths to one.

There are fourteen batteries in the Alps, eight in Algeria, and two in Tonkin. The war strength of a battery in the Alps is 4 officers, 156 non-commissioned officers and men, 34 horses and 60 mules. In the batteries in Algeria there are 82 more men and 73 more animals. The thirty-four horses of the batteries in the Alps are partially for the carts which convey along the high road the baggage, rations, etc., of the battery, and for mounting a few mounted non-commissioned officers. The trumpeters are, however, not mounted, the farrier acting as mounted orderly, when required, to the battery commander. In the mountains neither officers nor mounted men are mounted as a rule, their horses being led in rear.

The battery worked well on the hillside, but very slowly in handling the loads and coming into action; much behind the Italians in this respect. Drag ropes were put on the top loads by the detachment on ground where it seemed to me quite unnecessary to use them. When the battery returned to camp, saddles were taken off at once instead of, as with us, being left on for at least three-quarters of an hour. I saw several stomach swellings from the girth being placed so far back. One officer superintended the stacking of the saddles and another the stable duties, which were of a very light order. I was told that with four field days like this, at least every week, there was no time to devote to long stable or harness cleaning duties, and that the mules and harness were cared for in the same manner as they are in commerce in France. With the exception of the batteries in Algeria against their old foes the Kabyles, and the batteries in Tonkin, in fighting somewhat similar to our experiences in Burmah, the French Mountain Artillery of the Alps has not yet had the benefit of war experience. A new edition of the *French Manual of Mountain Artillery* deals very fully with the subject; it is published in two volumes, the first of which is just issued, and the second, dealing with the organization and tactics of Mountain Artillery, is expected in the autumn.

—*United Service Gazette*, June 29, 1895.

D. MATERIAL.

(A) ARMAMENT AND EQUIPMENT.

(a) The Stability of French Armored Ships.

In the *Engineer* of January 25th last we dealt at some length with the difficulties that have arisen in the shape of certain French armored ships, owing to the discovery that they are very deficient in stability. We showed in a woodcut the condition of the *Hoche* heeling over at an angle of 15 degrees, as she would when turning at speed. We mentioned that the *Magenta* and *Brennus*, as well as the *Hoche*, have manifested so dangerous an absence of stability that great structural alterations are decided on for all of them. Since the appearance of the article in question, matters have taken a more serious aspect—so serious, indeed, that it is wonderful that in this country public attention has not been drawn more definitely to the matter. We can hardly do better than put before our readers a summary of a speech made on March 11th in the Chamber of Deputies by M. Lockeroy. Seldom indeed has such an attack been made on the fleet of a great naval power—an attack formidable alike on account of the serious character of the charges, of the number of branches dealt with, and of the weight which must attach to the words of an adversary who, while he delivers very heavy blows, evidently measures them carefully, and has such a grasp of the subject that it is very difficult to challenge the statements he makes. The full text of the speech may be seen in the *Journal Officiel*. We only propose to deal with prominent features in it.

M. Lockeroy first took up the question of cost. For an example he instances the *Suchet*, 3434 tons, launched in 1893, which he compares with the British *Brilliant*, 3600 tons. The hulls cost respectively 4,170,000 f. and 2,411,750 f. The total cost given in Brassey's *Annual* is £226,360 for the *Suchet* and £205,228 for the *Brilliant*. Again, the *Brennus*, 11,000 tons, is said to have cost 21,221,000 f. for hull and machinery, as compared with 12,077,450 f. for the British *Centurion* of 10,500 tons. Lord Brassey gives relatively £991,767 and £608,908. The English estimated prices include more and are less widely divergent than those quoted by M. Lockeroy, but the difference is still very large and in the same direction. We need not follow M. Lockeroy into the question of money thrown away in trying to bring the French *Heroine* up to modern requirements, but will pass on to more vital matters. Coal capacity and consequent range of action are next taken up. The *Magenta*, it is urged, carries only 610 tons, enabling her to run 900 miles at 15 knots, her maximum speed; whereas British and Italian ships are provided with coal enough to run 1800 miles. Again, the French cruisers *d'Entrecasteaux* and *Jeanne d'Arc* carry only 1000 tons of coal, while the British *Blake* carries 1500. A mere sentinel fleet, or "*flotte au piquet*," M. Lockeroy termed the French ships. He next passed to a still more serious matter, the question of stability. It appears that the trials made with certain French ships gave such alarming results that operations must be now undertaken which are not only costly, but which involve the sacrifice of some of the most cherished features of ships in order to obtain a reasonable margin of safety. In fact, that the fatal capsize of the *Captain* has not been reproduced again and again in the French fleet appears to be probably due to the circumstance that the ships have not been severely tested. The superstructures of the *Brennus*, *Magenta*, *Hoche* and *Charles Martel* are doomed, so are the military masts of the *Chasseloup-Laubat*, *Latouche*, *Treville*, *La Friant* and others. For the superstructure itself M. Lockeroy can have few regrets, for it is an old cause of offense to him, constituting, as he holds, an enormous target for the enemy's fire, under which it breaks into fragments, forming langridge, and multiplying the hail of projectiles, and lastly jeopardising the stability of the ship. It is, however, humiliating to find that a new vessel just completed at great cost must come to pieces at further cost, and with some of her guns lose a serious part of her fighting power. 30,000 f. apiece the military masts are said to have cost, and now they have to be cast "into the dockyards like old logs." The French engineers, said M. Lockeroy, are among the best in Europe. "Suppose they were incapable, what could you say worse of them?" asked M. Jourde. This led to M. Lockeroy explaining how he considered the evil came about. Instead of leaving a vessel's design and completion to the same authorities, and making them responsible as in other countries, in France many other officials have power to add to and doctor the original design, which becomes a complicated monstrosity for which no one can be held responsible. Thus it has happened that the day when the *Brennus* should take her position as a fighting unit, she has to go into dock to be demolished.

Another evil is the submerging of the armor by the weight of additions made to the ship, leaving her so exposed, and her armor in so useless a position, that it has been gravely proposed to replace many plates by wood painted black. M. Lockeroy then read a recent letter from the Minister of Marine to the Vice-Admiral Superintendent at Cherbourg on the subject of modifying and transforming the *Furieux*, the *Surcouf*, and the *Requin*, all more or less in the same evil case as the ships above noticed. After comparing the French and British systems of design and turning out ships, very much to the disadvantage of the former, M. Lockeroy proceeded to review the actual condition of the fleets on which France at the present time depends. He takes as an example the northern squadron. This is supposed to contain six armor-clads, viz: the *Suffren*, the *Victorieuse*, the *Hoche*, the *Requin*, the *Jemmapes* and the *Bouvines*. Of these the two first are manifestly unable to take their place in the first line, being altogether obsolete and weak. The *Hoche* has been for six months in dock, and will be so for six months to come. The *Requin* requires the same alteration, being similarly topheavy. The *Jemmapes* carries 310 tons of coal only, and has an insufficient armament and a torpedo tube in a dangerous position. M. Lockeroy does not object to the *Bouvines* apparently, except as to supply of fuel. She is of the same type as the *Jemmapes*, but differs to some extent in her armament. He next passes to the cruisers—namely, the *Latouche-Treville*, *Dupuy-de-Lome* and *Friant*, which have serious faults, and absolute failures in their machinery, boilers, furnaces, &c. The *Chasseloup-Laubat* has to have her military masts removed. The engines of the *Coetlogon* are in a notoriously dangerous state, and there remains only the *Surcouf* which is pronounced to be a good boat. "*Voila*," said M. Lockeroy, "the forces with which we have to meet England and Germany, perhaps separately, perhaps united."

The Mediterranean Squadron is next considered, in which figure the *Brennus* and *Magenta*, already referred to. The main new feature to notice is the complaint that the fire of the heavy guns would prove so destructive to the men working the medium and light pieces on the superstructure, that they have to be ordered off by bugle call before the discharge of the heavy guns. We need not, however, follow M. Lockeroy to the end of his speech. Sufficient to say that no Englishman has yet succeeded in suggesting anything like such an indictment as this against our fleet, although some have based their conclusions upon mistakes or curious systems of reckoning, invented apparently with a view to the startling results they have led to, and on imagination. Vivid imagination and ingenuity have done much to cause alarm, yet never aught like this; and we cannot wonder when we read that "the orator, on resuming his seat, received felicitations." We must not, however, let anything distort the picture put before us. M. Lockeroy's indictment bristled, apparently, with ugly, incontrovertable statements of facts, some of great and some of less importance. Let us sum them up.

First, and above all, as to stability. It is generally assumed that all naval constructors have attended to this primary condition. Indeed, we may have what suspicions we like, no one is in a condition to investigate the question of a ship's stability thoroughly except her makers and possessors. Consequently ships that have mounted guns tier upon tier, and have claimed the obvious advantages accruing to the possession of such formidable batteries, have successfully imposed upon the public and deserve their ignominious downfall to be recorded. Unlike M. Lockeroy, we cannot blame the constructors unless we know that they consented to the dangerous inflation of their designs, against which it is in fact probable that they protested. Well-intentioned persons who have not mastered the necessary science, and who have not worked out the necessary laborious calculations to guarantee safety, should not be allowed to interfere with the elements of a ship's stability. For stability the final unqualified guarantee should be obtained from the highest responsible authority before the ship is constructed. So obvious is this, that it seems hardly necessary to urge it, yet we do not feel sure that France is alone in possessing dangerous ships. Next, what would have resulted had these evils not come to light? What would happen if France were plunged into war before all the necessary alterations were made in our ships? Well, we suppose without question the gallant French sailors would go to sea and take their risks. Under certain circumstances terrible consequences might follow, but the main effect of all the above would probably be greatly to curtail the action of the fleet. We have dwelt so far on the effect of deficient stability. Short supplies of coal would naturally still more inexorably limit the ships' sphere of action. Under favorable conditions the batteries might be very formidable and the ships not in danger of capsizing, but apparently the gun positions are faulty, and the pieces interfere with one another. To have to stop quick-fire guns to let a heavy piece be discharged is indeed unfortunate. The overmasting needs no comment, and we must touch on disappointments in machinery with the kindness of fellow sufferers. We hope that our critics will at all events do our constructors the justice to own that the courage of their own convictions or calculations has kept them from falling into temptation to which we think it quite possible other powers besides France may have yielded in greater or less degree. In the matter of accumulation of batteries, the United States has gone to considerable lengths, though we have not heard of bugles being brought into requisition to call men under cover. The main conclusion after all that appears to suggest itself is to be business-like in constructing ships, that is to say, when the combatants have decided on what part a ship is to fulfil and what element she is to possess, we should leave the working out in the hands of the most capable constructor we can find, be it Sir W. White or any one else. Give him a free hand and make him responsible. If such a result as those described by M. Lockeroy followed, he would almost deserve to be hanged. We have, however, in this matter apparently managed very well. They do not always "do these things better in France."

—*The Engineer*, May 17, 1895.

(b) Instability in Ships of War.

The people of France are learning a lesson, taught them with severity enough to impress it. And the lesson is, that three or four men with equal power, varying experience and specialties, cannot design a successful ship of war. We have already brought before our readers a condemnation of French ironclads, and we have given illustrations of certain ships which elucidate the condemnation. But the whole story has not yet been told. The fact is, that the French dockyard folk are going through an experience almost grotesquely like one recorded in our own recent naval history; the only difference being that the French naval authorities have made mistakes on a larger scale, and with much more perseverance and energy, than our own Admiralty. No doubt the greater number of our naval readers have forgotten certain ships designed by Sir E. J. Reed—then Mr. Reed—which could not stand up in a breeze until they had about 300 tons of ballast, which they were never intended to carry, put on board; and this although they already drew about 2ft. more water than their calculated draught. Mr. Reed was not directly responsible for these things; they were the result of changes forced upon him during their construction. Almost all the time that Sir N. Barnaby was Chief Constructor it is understood that constant warfare went on between his department and the gunnery men. The result was that certain ships were undoubtedly spoiled by the introduction of weights which the ships were not intended to carry. It is well known that Sir W. White has been from the moment he took the reins the uncompromising foe of all attempts to alter a ship during the period of construction, and the best results have attended his policy. In France the ships are so long on the stocks that all sorts of opportunities turn up for suggesting changes, and the naval architects appear to be too weak to pursue a wise policy of refusal.

A ship is designed to carry a fighting mast; someone thinks that if one mast is good, two must be twice as good. The single mast was to carry one fighting-top; but on the same principle that the masts were doubled the tops are doubled, and finally each mast becomes a great steel tower. In the same way a ship is designed to carry a 6in. gun; but a 7in. gun accomplishes at a target trial much more than the 6in. gun. At once the armament of the ship is altered, and so on—we see with what result. The great defect of the French ships is probably that they are too narrow. It will be remembered, no doubt, that in Nelson's time and before, the French ships of war were always better sailers than ours. They had, as Mahan among many others points out, better lines than our vessels. The French naval authorities of the present day have followed, *mutatis mutandis*, the example of their predecessors, and have endeavored to obtain speed by reducing beam. All might have been well but for the insane policy of permitting those responsible for the offensive power of the ship to overrule the naval architect, and pile on the top of a hull, already tender enough, weights which could only have been safely carried by ships with 4ft. or 5ft. more beam.

But the failure of French ships in stability may well induce us to look at home and consider whether all our own ships are just what they ought to be

In attacking this question, some points must be born steadily in mind which seem to us to be very persistently overlooked. We believe that we have no ships of war of any importance afloat in the British Navy which are not stable enough in the sense that no storm would capsize them, but it does not therefore follow that they are not encumbered with top hamper, or that they possess sufficient fighting stability. There are two stabilities, indeed, which every man-of-war should possess—one is the stability of safety, the other is stability regarded as a gun carriage, and the latter stability concerns the ship not only transversely, but longitudinally. It deals with pitching as well as rolling. Volumes have been written on the subject. It has been pointed out that a ship with excessive stability is the worst possible gun carriage. Tenderness has been advocated, now in this part of the rolling range, now in that. The value of bilge-keels as roll stoppers is too well known now to require elucidation; but we have heard it said that they would spoil a ship as a gun platform, because they would make her too lively. We need scarcely add that this is a total mistake. We do believe, however, that some of our ships carry guns which are too big for them, and that they would be very much improved if lighter pieces were substituted; and this is especially true of longitudinal stability. On more than one occasion guns intended to fire in line ahead, or nearly so, have had to be taken out, lighter ordnance being substituted for them with very great advantage. In our own opinion no greater mistake can be made than over-gunning a man-of-war. A difference of ten tons or so may seem a very small thing in a large ship; but it is not the weight of the gun alone that we have to consider, but that of its mounting and defence. A difference of ten tons in a gun may mean 300 tons in the gun-carriage, barbette or turret, the construction of the ship herself, ammunition, &c. It should never be forgotten that it is a vain thing to mount big guns if they cannot be fought to advantage; and even when there is ample stability, and all the conditions are favorable to the adoption of the heavy gun, it appears to us that more good might be done by using the available buoyancy in providing protection for the quick-firing broadside guns, which will probably play a more important part in future naval battles than the great guns ever will.

There remains something to be said, a word of warning to be spoken, about the enormous quantity of top hamper with which only too many of our own fighting ships are oppressed. We have deck-houses and bridges, and boats and cowls. These would be converted in five minutes, by machine and quick-firing guns, into matchwood. Probably the matchwood would be set on fire. Ships of war must carry boats, numbers of boats; but, why should not folding boats of the Berthon type be used, which could be stowed below when going into action? The steam launches being of steel would simply be blown to bits; they could not burn. No wooden structures of any kind should be permitted on the upper deck. The Eastern war has driven that lesson home. As to the funnels, it is clear that with anything like a smooth sea and a moderate range machine guns could cut these off pretty short. The cowls and ventilators would be reduced to small scrap. In the later ironclads, such, for example, as the *Royal Sovereign*, means have been provided by which even when the upper part of the cowl is removed in clearing for action, air can be drawn by the fans through the wind trunks; but these trunks are not in safe places, and are not adequately protected. The existence of a warship as an antagonist must depend in action on her fans, and we have never yet been on board a man-of-war in which the fan arrangements appeared to be the best possible. In many vessels the entrance to the wind trunks would surely be choked with *débris* very soon after an action had commenced. The ventilator hoods are ugly, but no doubt useful when a ship is not fighting; but it ought not to be impossible to arrange all the vital wind shafts so that nothing the enemy could do would affect them. We may say in conclusion that in the Navy, among engineers and executive officers alike, there is a consensus of opinion that machine-gun fire directed against upper decks will produce very serious effects, and that enough has not been done to reduce the amount of mischief that may be thus wrought to the smallest possible dimensions.

—*The Engineer*, June 7, 1895.

(c) Twelve-inch Guns for Battleships.

Twelve-inch guns are large enough for our new battleships, says Chief Constructor Hichborn, in a supplemental report to the Secretary of the Navy, in combatting the recommendation of 13-inch guns by the Chief of Ordnance. Mr. Hichborn reviews the best and latest foreign practice in this direction, and finds that 12-inch guns are the largest now being put aboard ships of war. He denies the broad claims made for the much greater efficiency of the larger gun under the conditions of actual battle, and believes that recent events prove that much attention should be paid to powerful secondary batteries. Mr. Hichborn says he is guided in his recommendation by general considerations of the best possible distribution of armor, armament, engine power, endurance, etc., to the end of producing the best fighting machine possible. The mechanical difficulties which are encountered by the English and French in handling the older heavy guns on board ship do not influence him.

—*Engineering News*, May 23rd, 1895.

(d) Maxim Rapid Firing Gun.

The light-weight Maxim rapid-firing gun was tested at Sandy Hook on June 8th. The gun weighs 25 lbs. or 45 lbs. packed in its case, with extra parts and mechanism, and can be easily carried on the back of a soldier. In use it is mounted on a tripod, and the ammunition is fed from a belt containing 100 cartridges. The test for rapidity was at 500 yards range. The gun was taken from its case on a man's back, assembled, and the first shot fired in 58 seconds. The ordinary rate of fire was 500 shots per minute, and a single shot could be fired by an expert, or it continued firing as long as the trigger was held back and the cartridges supplied. In a test for breakdown, one shot was fired which was supposed to break a part of the mechanism: this part was taken out and replaced by a new piece from the case in 26½ seconds. A rate of 600 to 770 shots per minute is claimed, with balls of .302 caliber and

25 grains of smokeless powder, and 3,200 yards effective range. Another test for accuracy of fire is soon to take place. This gun is not new, though it has been lately much improved. A similar gun was used by Stanley in his African explorations. In this trial 50 rounds were fired in 5⅓ seconds; and the barrel was changed in 1 m. 12⅗ s.

—*Engineering News*, June 13th, 1895.

(e) Navy Small Arm.

The Small Arms Board of the U. S. Navy has unanimously recommended for adoption in the navy and marine corps the Lee rifle, the invention of Mr J. P. Lee, of Connecticut. The new rifle weighs 8¼ lbs., with straps; the barrel is only 27 ins. long and is made of nickel steel, and the caliber is so small that the sailor can carry 200 rounds. It is lighter than the Krag-Jorgensen rifle, has a flatter trajectory and a rapidity of fire exceeding that of any other small arm, as five shots have been aimed and fired in three seconds when the gun was under test. At 500 yds. range perfect fire can be had; at 2,000 yds. range the accuracy is sufficient to hit an object the size of a man, and at 6,000 yds. range the bullet would still have force enough to penetrate the body of a man.

—*Engineering News*, May 23, 1895.

(f) Corn Cellulose.

A substitute for cocoa cellulose, for use on warships to close up shot holes, has been invented by Mr. M. Marsden, of Philadelphia. It is made from the pith of Indian cornstalks by a special process. Tests have been made by Naval Constructor Linnard, by firing with a 6-in. gun at a box filled with this new material. In one place a single shot was fired through it, and at another place five shots were grouped in a circle of 8 ins. diameter. Under a head of water of from 4 to 7 ft., no water passed through 3 ft. of this material in three hours. An examination showed that the water had penetrated 11 inches in the case of the single shot, and 12 inches in the group of shots. The material is absolutely incombustible and has about one-third the density of the best foreign cellulose.

—*Engineering News*, May 23, 1895.

The special board appointed by the Secretary of the Navy to test the Marsden American cellulose, manufactured from the pith of corn stalks, in competition with the cellulose hitherto used, which is made from cocoa fiber, were carried out at the Indian Head Proving Grounds, near Washington, last week. Two cofferdams 6 feet high, 6 feet wide and 6 feet deep, and constructed of ½ inch steel plate with a 4-inch wood facing and 12-inch water compartments in front and with ¼-inch steel plates on the side and back, were filled with the rival materials. The cocoa cellulose was placed in the cofferdam under pressure at a density of 7 pounds 8 ounces per cubic foot, thus requiring 810 pounds of material. The Marsden product was inserted at a density of 6 pounds 8 ounces per cubic foot, requiring less by over 100 pounds than the cocoa product. The cofferdams were placed at a range of 320 feet from the gun muzzles. The first shot was fired at the cofferdam containing the cocoa cellulose with a 6-inch gun and a 100-pound projectile, which passed entirely through the cover of the cofferdam, making an opening 7 x 9 inches. Water was turned on and in ten minutes commenced to run through the lower edge of the shot hole at an average of ½ gallon a minute. The next shot was sent into the cofferdam holding the Marsden product with the same gun and a similar projectile. The shot passed completely through, making a 7 x 8 inch hole. Water was turned on, but none went through, the material having so expanded that the inflow of water was entirely stopped. At the next test a 250 pound shot was fired from an 8-inch gun, making a 9 x 12 inch opening in the cocoa cellulose cofferdam. Water having been introduced, poured through in 37 seconds at the rate of 1 gallon a minute. The Marsden cofferdam was fired at under similar conditions, an opening 10 x 12 inches being made. Water being turned on, at the end of three quarters of an hour none was found to have gone through. The 6 inch holes were then immersed for 2¼ hours and the 8-inch 45 minutes, when it was found that the water had only penetrated 2 feet into each shot hole in the case of the cofferdam filled with the Marsden American cellulose, while the cocoa cellulose was found water-soaked in every direction in and around the shot holes. Experiments were also made in regard to the action of fire on the two products, by which the Marsden product was found entirely incombustible, while the cocoa material burned in each instance and twice burst into flames. The official reports of the test are to be shortly laid before the Secretary of the Navy. It is thought certain that the American cellulose will in future be exclusively used in the new war ships, provided its durability is equal to that of the foreign product. This feature can only be determined by time. In point of cheapness, the American product has the advantage over cocoa cellulose.

—*The Iron Age*, June 20, 1895.

(B) ARMOR AND PROJECTILES.

(a) Manufacture.

1. *Armor—America.*

The signal triumph of an American-made armor plate over gun and projectile of the latest and most powerful types, noted in this issue, is especially gratifying in view of the recent success of the Bethlehem Iron Company in competing with the foremost of European and English makers of armor for the plates to be used in the new Russian battleships. It was not so long ago that well-meaning, but doubting American legislators were insisting that our government should purchase its ships for the "new navy" and the armor to protect them, from foreign makers who had learned by long and costly experience the art of manufacture; and dire failure was predicted of any attempts at home production. Fortunately, wiser counsel prevailed; plants were created for the construction of ships and armor in a remarkably short time, and the warships now afloat, designed by Americans and built in our ship yards, are models of construction to the shipbuilders of Europe.

And in the matter of armored protection, the American nickel-steel Harveyized plates have shown a record of endurance against cracking and penetration not equalled by the best armor of the older European makers; in fact, this later type of armor is now approved and adopted by them. Now we have a prominent American armor-making firm winning the contract for the plates of Russian battleships against the active competition of all Europe, and winning solely on the superior merits of the plates made in one of the several newly created American gun and armor-making plants. The test of last Tuesday was a conclusive one; in the character of the gun, in the projectile used and in the enormous velocity and impact of the shot. It was, as the naval board expressed it, a signal triumph of armor over gun and projectile, in a battle for endurance between these types that has been waged for the last 30 years. It is a legitimate cause for national pride that this victory was won by a plate made by an American process and in an American works.

—*Engineering News*, February 21, 1895.

2. *Shape of Turrets.*

Oval, instead of circular turrets are proposed for the battleship *Iowa*, and the question of shape is now before Secretary Herbert for decision. The inside diameter of the circular turret originally proposed was 26 feet. The dimensions of the oval turret would be 26x19 feet. The advantages claimed for the latter are—less surface exposed to the enemy's fire by 7 feet; better balance in the turret in heavy weather, and the possibility of increasing the port plates 2 inches in thickness, with a total decrease in weight. In other words, instead of having a circular turret 15 inches thick, the side of the oval turret exposed to attack can be made 17 inches thick. The proposed change has been approved in part by Captain Sampson, Chief of the Bureau of Ordnance.

—*Engineering News*, May 16, 1895.

3. *Foreign Contracts.*

The two American armor-making firms have practically completed the original contracts entered into with the United States government. The Bethlehem Iron Works obtained the first contract on June 1, 1887; since that time it has created a plant and made and delivered 6,400 tons of armor plate. The Carnegie Company obtained its first contract on November 20, 1890, and under similar previous conditions, has made and delivered 6,000 tons of material. Under a contract of 1893 both of these companies still have considerable material yet to deliver, but it is expected that by October of this year, or earlier, all will be finished. The contracts for the vessels lately authorized by Congress have yet to be made. These will call for about 5,000 tons for the two battleships, and 100 tons, or a little more, for 2½-inch sponson armor of the eight gunboats. The battleship armor will be Harveyized nickel-steel.

—*Engineering News*, May 16, 1895.

4. *Projectiles.*

In an interesting communication to the London *Times*, apropos of the approaching meeting of the Institution of Naval Architects in Paris, a correspondent draws attention to the progress which has recently been made in the manufacture of armor-plates and guns, and hints that more attention might might now be paid to the manufacture of projectiles. The improvement in the resisting power of armor which has been brought about during the last seven years is stated to be nearly 50%. At an earlier period, when wrought iron was in use, 22-in. armor could have been perforated by the modern 12-in. projectiles and 19-in. armor by 9.2 in. projectiles. To-day, in plates of average thicknesses (6 in. to 12 in.), the best projectiles require a diameter nearly equal to the thickness of the plates which they are required to perforate. Six-inch plates will resist perforation from a 6-in. projectile fired at 1,960 ft. velocity per second. And plate 10½ in. thick has resisted well a 9.2-in. projectile with 1,800 ft. velocity. This plate has already received five rounds of 6-in. projectiles with velocities of about 2,000 ft. per second. None of these latter made more than a splash upon the plate. The projectiles go to pieces against these new plates. But the newest guns, with modern powder, are quite capable of doubling the energy of the projectile, and it is important to consider whether the projectiles hitherto produced would be capable of using up this energy. No doubt increased velocities may secure perforation, although the punch may go to pieces. It has been found, for example, that projectiles which, with 2,000 ft. velocity, did no serious damage to the plate, could be forced through the plate in pieces when the velocity was raised to 2,400 ft. per second. "May it not be," he asks, "that, as against the hardened plates, shots which will pulverize are less suitable for high velocities than shots made of a more ductile material, which will submit to a moderate flow of the steel during the instant that perforation is being effected? It appears to be useless to double the energy upon a punch which goes to pieces with the energy already commonly employed. We need to be reminded that the modern increase in the size of ships of war is largely dependent upon this relative advantage of the armor over the gun. So long as armor is believed to be capable of resisting perforation attempts will be made to cover larger portions of the ships with it, and the larger the ship the more easy it is to cover her sides with armor impenetrable to the average gun. With armor in the ascendant ships will grow in size; with guns in the ascendant numbers of ships rather than large ships will come into favor. He again asks: "How is the projectile to be so improved as to be capable of using effectively, against armor, the larger energies which the gun can give?"

—*The Engineering and Mining Journal*, June 22, 1895.

(b) Experiments.

1. *Carnegie Plate.*

The extraordinary ballistic resistance of Carnegie Harveyized armor was further demonstrated by a test which took place on Wednesday last at the

Indian Head Proving Ground. The plate was successfully attacked by two 12-inch Holtzer shells and a 13-inch Carpenter projectile with very flattering results for itself. The plate represented the second group of 18-inch armor for the belt of the battleship *Oregon*, weighing 306 tons. The plate was 16 feet 9½ inches long and 7 feet 5 and $\frac{13}{16}$ inches wide, tapering from a thickness of 18 inches at the top, which extended 4 feet down, to 8 inches at the bottom. It weighed 79,300 pounds, and was fitted to an oak backing 36 inches in thickness at the foot of the plate, and 26 inches at the top, being held in place by 16 3 and $\frac{6}{10}$-inch and 10 3 and $\frac{2}{10}$-inch armor bolts.

First round.—12-inch gun was used; Holtzer projectile weighing 850 pounds, and charge of brown powder, 294.8 pounds; velocity, 1,465 feet per second; energy, 12,662 foot tons. The projectile struck the plate 78 inches from the left end of the plate, 38 inches from the top and about 7 inches below the bevel. It penetrated approximately 6 inches, and then broke up into comparatively small fragments, the head remaining welded in. There were no cracks. A bulge was produced about the impact half an inch high, extending in an annular circle around the impact, its width being about 3 inches. As this was the cracking shot for acceptance, and no cracks were produced, Captain Sampson ordered that the final or penetration shot for acceptance be fired.

Second round.—12-inch gun; Holtzer projectile weighing 850 pounds; charge, 443.4 pounds brown powder; velocity, 1,926 feet per second; energy, 21,885 foot tons. The projectile struck the plate 42 inches to the right of the first impact, and a little closer to the bevel. A crack formed on the right side of the impact, extending from top to bottom of the plate, and was from three quarters to 1 inch in width. Around the impact an annular crater 3 inches deep and 6 inches in diameter was formed. The head of the projectile was mashed, resembling a clod of mud thrown against a brick wall. The sudden conversion of the energy of 22,000 foot tons of the shot into heat had produced a temperature sufficient to melt and weld together the two metals. The metal of the plate for a depth of 3 inches and for 6 inches around the point where the projectile struck had been fused and bubbled up like a volcanic crater. It however remained in the hole, the body and base falling outside. The estimated penetration was 10 inches. No damage was done to the armor bolts or backing. Upon this showing the plate was accepted. A 13-inch projectile was then fired at the plate.

Third round.—13-inch gun; Carpenter projectile weighing 1,100 pounds; charge, 489.2 pounds brown powder, specially intended for guns of this caliber; velocity, 1,810 feet per second; energy, 24,981 foot tons. Projectile struck the plate 32 inches to the left of the first impact. It penetrated only 10 inches, and broke up, the head remaining welded in the plate and the body and base rebounding. Although a crack developed from 3 to 4 inches in width at the top of the plate and 2 inches in width at the bottom, the plate still held together, the crack not being apparently continuous. All the backing and structure behind the plate was crushed. The ability of the plate to keep out other projectiles was shown by the fact that only one armor bolt in the backing was destroyed. Everybody is praising the toughness of the metal, and seems to believe that the armor so far is the conqueror, instead of the conquered, as was heretofore believed to have been the case.

—*Army and Navy Journal*, May 4, 1895.

The 18-inch Carnegie armor-plate, which successfully resisted shots from a 12-inch and a 13-inch gun, on May 1, was shattered, on May 17, at Indian Head, by a harder blow from the 13-inch gun. In the last trial an 1,100 lb. Wheeler-Sterling solid steel shot was used, with a muzzle energy of 1,942 feet per second, and a striking energy of 28,800 foot-tons. This shot broke the right half of the plate into four pieces, completely demolished the oak backing and passed into the sandbank beyond. But the shot was found broken to pieces, with head whole, but the point slightly fused. The ordnance officers decided that no armor in existence could have kept out this shot at 1,300 yds. range. The experts claimed, however, that the test was not conclusive against the armor, as this plate had already stood the strain of two acceptance shots from the heaviest guns. A second steel shot, similar to the last, but hollowed out to receive 53 lbs. of explosive, struck the plate where it was only 15.6 inches thick. This shot had the same velocity and also broke the plate after the shell had penetrated 7 inches and passed through; but the shot was found in fragments.

—*Engineering News*, May 23, 1895.

2. *Curved Armor Plates.*

At the Indian Head proving grounds last Friday test was made of a 5½ inch curved plate representing the turret armor protecting the 8 inch battery of the *Brooklyn*, *Oregon* and *Massachusetts*. Two shots were fired from a 4-inch rifle, specially selected Wheeler-Sterling projectiles, weighing 33 pounds, being used. The first shot, which was fired with a velocity of 1774 feet a second, penetrated the plate 3 inches, and was then broken to pieces without doing any actual damage to the armor. The second shot, with a velocity of over 2000 feet a second, which was designed to perforate the plate, only did so to the extent of 4½ inches, sticking uninjured in the plate. The last test was considered entirely satisfactory both in regard to the excellence of the armor and of the shell. The batch of armor represented by the test plate will be accepted and placed upon the new vessels.

—*The Iron Age*, June 20, 1895.

3. *Backing.*

An actual ballistic test of an armored turret is proposed, at Indian Head, to settle questions of resistance, effect and construction. The one-sixth of a turret would be set up, with its 8 inches of oak backing and ⅝-inch steel lining. The ordnance experts expect to prove by this experiment that the backing must be made to fit the armor: and that it is an element of weakness to piece out the armor by a wedge-piece, as has been done in several cases. They claim that this "filler" would be dislodged in action; the constructors, on the other hand, say this wedge in nowise impairs the efficiency of the turret. The experimental turret wili be arranged to test the effect of firing on a similar wedge.

—*Engineering News*, May 16, 1895.

4. *Explosive Shells.*

Shells loaded with high explosives were fired, on May 11, at Sandy Hook, from a 15-inch gun converted from an iron smooth-bore by rifling. The first test was made with 117 pounds of gun-cotton mixed with paraffine and carefully packed in a steel shell; with a powder charge of 124 pounds, this projectile was fired with satisfactory results. In a second test, 230 pounds of gun-cotton were fired with similar results. In the third test 230 pounds of emmensite were loaded into a steel shell, and the gun was fired, as before, by electricity. In this case the explosive was too sensitive; the shell exploded in the gun, tearing it and the carriage into fragments, and making a hole in the ground 10 feet deep and 25 feet in diameter. Previous to this test charges of 25 to 30 pounds of emmensite had been discharged from smaller guns with uniformly successful results. The present verdict is that it is too sensitive to be used in large charges. The whole test was important as involving the handling of the largest charges of high explosives ever tested in this manner.

—*Engineering News*, May 16, 1895.

Following recent experiments made by the artillery committee, on board the *Nettle*, at Portsmouth, the British Admiralty has decided to introduce into the navy, a new type of ordinary shell for all breech-loading guns between the calibers of 42 cm. (110 tons) and 15 cm. (5 tons), and for rapid-fire guns of 15 cm. The new projectile will be made of steel with pointed head. Hitherto the bursting charge ordinarily used by all the heavy artillery has been loaded from the base of the projectile and for rapid-fire has been detonated by means of a fuse fixed in the head of the projectile; but this system diminished the penetration of the shell and it has been found necessary to adopt a pointed head. The base of the projectile, which until now has been exclusively used to receive the charge, will be arranged to contain the fuze. The projectile for the 42 cm. gun will weigh, empty, more than 1600 English pounds and will receive a charge of about 200 pounds of powder. The new projectile will be distributed to all ships whose dimensions exceed those of the *Pearl* type.

—*La Marine Française*, April 10, 1895.

(C) ARTILLERY.

(a) Mountain Artillery—Spain.

Colonel Ordoñez of the artillery, the inventor of the well known cannon which replace the Krupp guns on the new Spanish warships, has just completed his work in designing a piece to take the place of the rapid fire mountain gun now in the service. The Ordoñez mountain gun consists of a steel tube and jacket, and is 57 millimeters caliber. It weighs without the carriage 85 kilogrammes; the cartridge case is metallic containing 200 grammes of ballistite. The projectiles used are the shell of cast-iron and the shrapnel weighing 3 kil. 170; initial velocity is 400 meters. This cannon, concerning which more particular details are not at hand, will probably be tested very soon.

At the present time the Spanish mountain artillery is furnished with a cannon of 78 m./m5, Plasencia system; the weight of the piece is 102 kilogrammes and of the carriage 170. The projectiles in use are the common shell and the shrapnel, weighing respectively 3 kilo. 600, and 4 kilo. 670.

—*Revue du Cercle Militaire.*

(b) Horse Artillery—England.

At the end of each year the Institute of Royal Artillery has a report made upon the most recent field maneuvers of artillery, and this report furnishes subject matter for a paper which presents the most interesting fact in a sort of inventory.

This year's paper contains special information upon the putting to test of a new field equipment for horse batteries in England.

On this subject are given details taken from the *Militär Wochenblatt* No. 50, the *International Review* 5th volume.

The English artillery with its 12-pounders in 1884 were the first to realize the same caliber for its field and horse batteries.

The data of this 12-pounder, model 1884, is as follows:

Caliber, 76.2 mm.

Length, 31 calibers.

Weight of piece, 355 kgs.

Weight of piece in battery, 980 kgs.

Weight of piece harnessed, 1900 kgs.

Weight of projectile, 5.675 kgs.

Initial velocity, 524 m.s.

This data alone suffices to show that in trying one gun for both, a hybrid piece results which does not give complete satisfaction to either horse artillery because too heavy, or to field artillery because its projectile is relatively too light to maintain its initial velocity.

Is it not astonishing that this material has been cause for complaint from its very entrance into service. In consequence of these complaints—which the English military writers often tried to gloss over—a certain number of attempts have been made for several years past with a view of improving this part of the armament. Among these researches we will here consider only those pertaining to the material for horse batteries tested during the last year.

The tests took place with a 6-gun battery. The following was the proposed data of this material:

Weight of piece, 308 kg.
Weight of carriage without equipment, 472 kg.
Weight of carriage with piece and equipments, 785 kg.
Weight of limber, empty, 415 kg.
Weight of limber with 44 projectiles and its equipment weighing 44 kg., 734 kg.
Weight of piece harnessed (without grain rations), 1519 kg.
Weight of caisson body, empty, 417 kg.
Weight of caisson body with 48 projectiles and equipment weighing 44 kg., 748 kg.
Weight of caisson, complete, 1482 kg.

Practically these numbers were slightly increased. The piece tested weighed 1562 kg. instead of 1519 and its caisson 1537 instead of 1482. The caliber and weight of projectile were the same as for material, model 1884, while the initial velocity was fixed at 472 m.s. The charge was 340 gr. of smokeless powder (cordite). These conditions gave the following values for the living force and velocity of recoil:

Initial living force—total,	64.44 ton meters.
per kg. of gun,	209.20 kg. meters.
per kg. of piece in battery,	82.10 kg. meters.
Living force of recoil of gun—total,	13.38 kg. meters.
per kg. of carriage,	2.83 kg. meters.
Velocity of recoil of piece,	3.62 m. s.

The limber carries about 250 kg. of projectiles, that is 34% of its total weight. The caisson about 269 kg., about 36% of its weight. From this point of view of efficiency the new limber is the superior of all European artillery, while that of model 1884 whose efficiency is but 23% is the inferior. Of the material actually in service the French limber of '80 takes the lead in this respect with an efficiency of 33 %.

The carriage tested was a rigid carriage without axle-tree seats and without any special arrangement for traversing.

The piece was made by the Royal foundry at Woolwich. Its length is but 1.7 m., that is 22.3 calibers.

It has the screw fermeture with axial vent and plastic obturator. Length of bore is 19.7 calibers.

Path of projectile is 1.326 m.

The piece was made as follows:

An inner tube extends from the front end of the breech block to the muzzle. This tube is wound with steel ribbon for a length of .60 m. from its rear face. A jacket shrunk on by its front end while hot covers the wound portion. This jacket carries the trunnions and the breech-block so the tube is free from all longitudinal strain. A collar (*anneau de calage*) prevents the jacket slipping to the front. The steel ribbon which reenforces the gun is 6.3 mm. wide and 1.5 mm. thick. It makes 15 turns corresponding to a thickness of 23 mm. At its rear the hoop thus formed has not a vertical face. It diminishes progressively forming three steps, each 25 mm. in width. From the test of this steel ribbon it showed a tensile strength of from 142 to 157 kg. per mm. Equally severe bending tests were given to it.

Tests of wire wound or ribbon wound guns began in 1891. They appear to have led to favorable conclusions, and this mode of hooping seems now to have definitely entered the domain of practice. The recently published edition of the *Official Manual of Artillery* for authorized materiel, in fact admits of a description of this new system, and mentions its use for rapid fire guns of 12 and 15 cm. 40 calibers in length in use in the English navy.

Among other advantages wire and ribbon winding allows of guns stronger and at the same time lighter. However this advantage is not known to exist in an appreciable manner for field guns which are here considered, for the above mentioned efficiency 209.2 kgm. can be obtained without the help of this mode of hooping. In fact it has been surpassed in France and Germany with guns lately manufactured by private industry.

The tests of this new materiel have given equally useful indications of the value it is best to adopt for the angle of twist at the muzzle.

In the 12-pounder, model 1884, firing the same projectile, 5.675 kg., with an initial velocity of 524 ms. this angle was 6° 24′. For an initial velocity of 472 ms., trial shots were fired from pieces with the angle of twist at the muzzle 6° 24′, 5° 7′ and 4° 29′. The angle 5° 7′ was adopted. With the angle (4° 29′) the accuracy of fire left much to be desired, but on the other hand it was proved that for this angle the efficiency of the time shell at this range, 1830 m., was 30% superior to that of the same shell fired from a piece with muzzle angle of twist 6° 24′. This result brought forward the real importance of the angle of twist in its effect upon time shell.

—*Revue d'Artillerie.*

(c) New 30 cm. Gun.

Experiments have just been made with the new 30 cm. gun on board the *Excellent*, at Portsmouth, under the direction of Captain Douglas. They were all the more important because new model shot-hoists for these guns were at the same time submitted to trial. The gun, made of steel and steel wire, which was designed to weigh 40 tons and actually weighs 47 tons, is a marked improvement upon the 67-ton guns with which the ships of the *Royal Sovereign* and *Admiral* class are now armed. This gun is 1.52 meters longer, has a greater penetration, is more easily handled, and because of an automatic breech-opening gives a more rapid fire. While it takes two and a half minutes to load and fire a gun of the *Royal Sovereign* battery, a minute and a half suffices for the new gun. The shot-hoist is lighter by several tons than that of the older ships. The chief object was to verify the strength of the gun. The gun and the hoists are destined for the principal armament of ships of the *Majestic* class. They will be well protected, as in the *Centurion* type. The charge is 150 pounds of cordite.

—*La Marine Française*, April 10, 1895.

(d) Auxiliary Appliances.

1. *Electric Sights.*

We were shown an interesting adaptation of the electric light to ordnance the other day. Small glow-lamps attached to the fore and back sights are caused to throw their rays on two strips of white metal visible to the sighter, and by this means just enough light is provided for aligning the gun at night without at the same time obscuring the target. The idea itself is not new, but the difficulty has always been that the shock of discharge has very soon broken the carbon filaments of the glow-lamps, and so rendered them useless. In a lamp for this purpose, which we were able closely to examine, the carbon filament is sealed to the platinum terminals through the medium of very fine springs, these latter being sufficient to break the shock of discharge, and so to prolong the life of the lamps.

2. *Crusher Gauges.*

Messrs. Eley Bros. have recently paid attention to perfecting the manufacture of their lead crusher gauges, which are used almost exclusively in this country for measuring the initial pressure in gun barrels. The result of these improvements is that a much greater regularity, comparing one lead with another, and one part of the same lead with another part, as regards homogeneousness of composition, dimensions, etc., has been achieved. The mode of manufacture consists first in rectifying any irregularities in the composition of the alloy, and then "squirting" the crushers, or, in other words, pressing them in a die till the lead squirts through a hole leading from it. After this they are all stamped under a similar pressure and then carefully gauged to a standard. We append herewith a table of equivalents as recently worked out by this firm on a principle of their own, which they believe to provide more accurate readings than any other. The dimensions of the lead cylinder before crushing are .325 inch diameter and .500 in length, and when the piston of the crusher gauge has a diameter .225 inch, the figures in the second column represent the pressure in tons per square inch, which brings about the crushing represented by the remaining length of the cylinder as shown in the first columns. Considerations of space have led to our taking only every third measurement instead of the entire number.

.49975	.500	.457	3.002	.412	4.250
.499	1.000	.454	3.156	.409	4.326
.496	1.625	.451	3.250	.406	4.392
.493	1.830	.448	3.334	.403	4.456
.490	1.955	.445	3.418	.400	4.521
.487	2.072	.442	3.500	.397	4.584
.484	2.179	439	3.575	.394	4.647
.481	2.286	.436	3.650	.391	4.710
.478	2.394	.433	3.725	.388	4.768
.475	2.500	.430	3.800	.385	4.824
.472	2.593	.427	3.875	.382	4.877
.469	2.687	.424	3.950	.379	4.930
.466	2.781	.421	4.025	.376	4.982
.463	2.874	.418	4.100	.375	5.000
.460	2.969	.415	4.175		

—*Arms and Explosives*, May, 1895.

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(E) TORPEDOES AND TORPEDO BOATS.

(a) The New Boats—United States.

By an Act of the last Congress, approved March 2, 1895, provision was made for the construction of three torpedo boats, not to exceed in individual cost the sum of $175,000. As Governmental superintendence, preparation of plans, and the providing and installing of ordnance outfit must be compassed by that appropriation, the bidding basis will be assumed no doubt to fall somewhere near $150,000, and the present reasonableness of material makes it possible to get the boats constructed within that margin. They will have twin screws, each actuated by its own triple expansion engine working in a separate water-tight compartment.

The principal dimensions are:

Length on load-water line	170 feet
Beam, extreme, on load-water line	17 feet
Draught, mean, normal	5 feet 6 inches
Displacement, normal	180 tons
Indicated horse-power	3,200
Speed, in knots, an hour	26 knots

All parts must be of domestic manufacture, and bids are asked for under two classes. Class 1 embraces bids upon the plans and specifications prepared by the Navy Department, while class 2 embodies boats to be constructed in accordance with the designs of the bidder, the essential requirements of the Government's design being assured. The craft will be built of steel or other metal, or of alloy, whichever the contractor, with the Department's approval, may deem best fitted to this end in an economical distribution of strength and weight. The armament will consist of 3 torpedo tubes and mounts; 4 1-pounder rapid-fire guns; 4 automobile torpedoes; 600 rounds of 1-pounder ammunition; 1 stowing case.

The torpedo discharges will be arranged upon the main deck, the forward broadside tubes being placed in echelon, and, besides, the extended arc of fire of each on its own side will be capable of considerable range athwartships. The after discharge will be on the centre line, and will have an arc of fire of well-nigh 280°. This disposition admits of a wide field of action, and gives an all-round discharge equal to any emergency. The torpedoes will be of the 18-inch Whitehead type, having a motive force of compressed air.

There will be two conning towers, one forward and one aft, and each 35 feet from its respective end; steering gear in each admitting of control from either station. The forward tower will be surmounted by one of the 1-pounder rapid-fire guns, the three others being arranged where most advantageous along the sides in line with the torpedo discharges.

Forward, the freeboard is carried up to 12 feet 6 inches, and a forecastle deck runs from the stem aftward to the forward tower. The arrangement adds materially to the sea-going qualities of the craft, while affording increased berthing facilities for the crew and a housing for the windlass and other gear forward.

Steam at a pressure of 250 pounds to the square inch will be supplied by three water tube boilers, two of which will be placed in a water-tight compartment forward of the engines, with a common fire room between them, while the other boiler will be placed in a separate water-tight compartment abaft the engine space. The normal coal supply will be 12 tons, with a bunker capacity, however, for 60 tons. Each boiler will have its own smokestack. The boats will have no search-lights, but will be lighted throughout by electricity, and forced draught for the boilers will be induced by blowers. The living spaces will be well ventilated without resorting to artificial methods.

There will be no premiums offered for increased speed, but should the speed fall below the required 26 knots, and yet be above 25 knots, the penalty will be at the rate of $10,000 a knot below 26 knots. Should the speed fall below 25 knots an hour, the boats may be rejected, or, at the discretion of the Secretary, accepted at a reduced price to be agreed upon by the Secretary and the contractors. The time limit for construction is fifteen months from the date of signing of contract. Accommodations will be provided for four commissioned officers, four machinists and sixteen seamen.

—*Army and Navy Journal*, June 29, 1895.

(b) Carrying Capacity of a Torpedo.

An experiment was recently made at Willett's Point to test the ability of the Sims-Edison torpedo to bear the weight of a man. A chair was lashed to the top, and the man stationed thereon took a ride at the rate of about 18 miles an hour, having the torpedo under perfect control at all times, the electric current being supplied from the shore.

—*The American Engineer and Railroad Journal*, April, 1895.

(E) POWDER AND EXPLOSIVES.

(a) Powder for Field Artillery—Austro-Hungary.

A smokeless powder called 2'' mm. gun powder, brand 1893, has just been officially adopted for field guns. It took Austria somewhat longer than the other European powers to solve the problem; however, it must be remembered it was more difficult for her on account of the fact that she still used guns of hardened bronze, (euchatius bronze). This does not stand the high temperature developed by the combustion of the new powder, as well as steel.* The

* That is at least a generally current opinion. But as will be seen later, Captain Langer of the Austrian army protests against this assertion. As to the resistance of hardened bronze to the pressure of the gases, it cannot be brought into question with the adoption of a smokeless powder, the pressures developed by the new powders being less than those given by black powder for the same initial velocity.

Nevertheless certain papers have drawn precisely this conclusion that the Austrian Military Administration, while keeping the same initial velocity with charge of "powder brand 1893" had, above all, intended to profit by the diminished pressure thus obtained, in order to lessen the fatigue to the hardened bronze cannon and so allow them to be used for a few years more. (See *Reichswehr*, Nos. 601, 626, etc.)

See on the subject of hardened bronze—*Revue d'Artillerie*, Vol. 5, January, 1875, p. 297, February, p. 465.

results of the 1893 tests at the different proving grounds, Weiner Neustadt, Budapest, Lemberg, published in the Austrian journals were not at all favorable. In fact they recorded quite a number of miss and hang fires attributed to various causes and an early solution of the problem was not expected. So the announcement of the adoption of a new powder was received with mistrust by a portion of the Austrian military press and its final adoption was greeted with surprise and unconcealed satisfaction.

Captain Langer, on the staff of the Austrian Artillery,* has just delivered an interesting lecture at Vienna in which he treated of powder for large guns and its evolution. Later will be given, in addition to supplementary information under form of notes, a *resumé* of that part of the lecture in which the author treats of smokeless powders tested in Austria. Before smokeless powders were the order of the day Austria had in Lenk's gun-cotton† an explosive of that nature. Yet its bursting power and its instability made it both difficult to fire and dangerous to handle. It was only after long research that these defects were overcome by repeatedly washing it and treating it with suitable solvents (acetic acid for example).

Such is the origin of the different small arm powders, particularly Germany's laminated powder, "brand 1890," tested in Austria, and brand 1892,‡ authorized at present.

Use of nitro-cellulose compounds as powder charges were first investigated in 1891. Here it was no longer a question, as with small arms, to seek in connection with smokeless powder greater range and flatness of trajectory, but rather to maintain the ballistic conditions of firing without changing either piece or projectile.

The first attempts were with laminated powder exactly like the brand 1890, excepting dimensions of grains. By use of a suitable solvent the gun-cotton was put into a gelatinous mass which was given the desired homogeneity by proper trituration, and after being pressed into cylindrical grains was subjected to final operations of drying, glazing, etc. Powder obtained by this method at the mills at Blumau for 9 cm. field guns, model 1875, had grains 1 mm. long and 0.8 mm. in diameter. It gave the same initial velocity with a charge of 0.620 kgs. as Stein's cubic powder of 7 mm. did with a charge of 1.5 kgs.

The maximum pressure was only 1100 atmospheres, with Stein's it was 1500. Like all the nitro cellulose powders it was less inflammable than black powders and needed the use of stronger primers. The favorable results of the firing tests in the fall of 1892 in the artillery practice was unfortunately counterbalanced by its deterioration from moisture. The proportion of water absorbed even after long exposure to moist air was it is true but 2%, yet that

* Lecture published in the *Organ* No. 5, for 1895.

† As early as 1861 Col. Lenk had, in reality, invented a system of rifled artillery using gun-cotton, but the many accidents occurring soon compelled the Austrian Government to abandon it. (See *Revue d'Artillerie*, December, 1872, Vol. 1, p. 170.)

‡ See *Revue d'Artillerie*, October, 1892, Vol. 41, p. 68.

was more than sufficient cause for considerable loss in initial velocity and for miss and hang fires. There were also cases of incomplete combustion, an obvious fact for powders exposed to moisture. These were revealed by a flash of flame issuing as the breech was opened. The hygroscopic properties of powders of nitro cellulose alone, stopped research in that direction.

As early as this Nobel's Ballistite* had been successfully tested abroad. Its different varieties were composed of from 30 to 50% nitroglycerine with from 70 to 50% of guncotton. Rounds of this powder were fired from the 9 cm. field gun, model 1875. Like the nitro cellulose powder it gave the desired initial velocity with a less maximum pressure than the 7 mm. powder. It was more uniform in its effects than the nitro cellulose class and less susceptible to moisture. In spite of these well known qualities† it did not seem possible for the Austrian Government to adopt this powder without serious inconvenience. The question was whether to transform the plant of the national powder mills or whether to be dependent on foreigners. It was therefore a real success for the powder mill of Presbourg when during the winter of 1892-3 it succeeded in using the existing plant to produçe a powder exactly like Nobel's Ballistite.

Because of the results of the tests of 1893 it is this powder, under the name of "2 mm. powder brand 1893," that has just been adopted for field guns of g. c. m, model 1875, and model 1895 and 1897 of the horse artillery.

To a mixture of guncotton and nitroglycerine in determined proportions, certain substances are added to diminish the sensitiveness of the mass. Thus a pulp is obtained which is treated in a manner analogous to that mentioned above in reference to nitro cellulose powder of Blumau to form it into cylindrical grains. These grains in the dry state are from 1.4 mm. to 1.7 mm. in diameter and from 3 to 5 mm. in length. This powder has the consistency of leather and its surface is a brilliant black. Besides its essential constituents nitro cellulose and nitroglycerine, it contains 3% of water, a small per cent. of graphite and other inert substances. Its density is between 1.60 and 1.62. In open air it burns quite slowly with an orange yellow flame and without smoke. Placed on iron and struck by an iron hammer it explodes, and from this point of view is somewhat more sensitive than black powder, On the other hand, in manufacture it has the desirable advantage that only the particles ignited by the shock of impact are exploded, the rest being expelled without ignition.

A charge of .440 kg. of the 2 mm. powder, brand 1893, gives an initial velocity of 450 m. to a 9 cm. projectile. It is thus equal to 1.500 kg. of the 7 mm. powder.

The maximum pressure does not exceed 1250 atmospheres, while with the 7 mm. powder it may reach 1500. Moisture scarcely affects it, being exposed to moist air for some time it absorbs at the most .8% of water without its ballistic qualities being appreciably affected. If cartridges be completely

* See *Revue d'Artillerie*, July, 1893. Volume 42, page 436.

† The preservation of Ballistite does not seem to be universally recognized at the present time. [See on this subject *Renseignments Divers—Revue d'Artillerie*, September, 1894, Volume 44, page 581—a note borrowed by the *Rousskii-Invalid* from an Italian journal.]

immersed in water and then dried in the open air, they will resume their normal qualities. Extreme cold does not affect it neither does a rise of temperature up to 60° C.* This powder like ballistite and the nitro cellulose powders is more difficult to ignite than black powder, so a new primer, "model 1893" is used. It differs from the model 1859, only in having a case 8 cm. longer and contains a larger charge. This admits of two cylinders of compressed powder, which are projected all aflame into the cartridge and so carry ignition to the center of the charge.†

It is well to point out one quite current idea, especially abroad,‡ that the high temperatures of combustion of ballistite causes that powder to be unfit for guns of hardened bronze. This temperature is about 2700 C. for nitroglycerine powders similar to ballistite, while it is only 2200° C. for nitrocellulose powders and 2000° C. for black powders.

These figures have been confirmed by Colonel von Wuich for combustion of powder in a closed chamber, and have been published in the *Mittheilungen* for 1891, No. 2.

Indeed it has been proved in the use of ballistite as a small arm charge, that there is a singularly more rapid heating of the piece than in the use of powder, brand 1892. Now although a like heating would be of less importance in charges for large guns, it might be expected that the rush of the gas at the high temperature of the charge would cause erosions similar to those found in small arms. Consequently the Austrian technical committee thought it necessary to make regular tests in this matter. The result was that hardened bronze withstood the use of ballistite and the powder, brand 1893, as well as that of black powder. It even seems that hardened bronze resists the rush of gas better than steel, and that the erosive action of gases of combustion must be attributed less to their high temperature, which lasts but during an indefinitely short time, than to chemical phenomena. In any case the better conductivity of the bronze favors it.

To sum up: The 2 mm. powder, brand 1893, ought to be considered as deciding the question of a smokeless powder for field guns in an entirely satisfactory manner. It may be added that the tests already made allow us to forsee a near solution for other types of guns. It is evident that it will be necessary to adopt an appropriate type of powder for each of them, but

* It is interesting to compare this statement with certain information given by the *Reichswehr*, No. 600, relative to firing tests at the Steinfeld proving ground, February 17, 1894. Partial freezing of the nitroglycerine having taken place in the cartridges by exposing them to cold long enough before firing, when the firing took place either for this reason or some other out of 38 shots 16 were miss fires and 10 were hang fires. See als *Reichswehr* No. 601.

† A cartridge for 9 cm., model 1893, has also just been adopted. Its exact description has not yet been given by the journals, but it is known that the case of the old cartridge is kept. The new charge filling but about one-third of the case, a filling tompion is placed in such a way as to keep the length of the cartridge. The *Reichswehr*, No. 626, announces that a special description of this cartridge is in preparation.

‡ Various articles published by the Austrian military press seem to prove that the opinion is also current in Austria, and in a general way it is believed there now as heretofore, that hardened bronze will be replaced by steel in the more or less distant future. See *Reichswehr*, No. 626, *Armeeblatt*, Nos. 11-213. See also *Revue d'Artillerie*, October 1892, Volume 41, page 69.

because of the relatively slow combustion of the new powder, there will be no need of varying the size of the grains in so large proportions as with black powder. Thanks to the use of a uniform method of manufacture there will be also but slight variations in density. On the other hand the consistency of ballistite, which prevents its accidentally breaking up during combustion, allows it to approach the best theoretical form of grain. Thus in the "2 mm. powder, brand 1893," has been put in practice the principle of decreasing the initial surface of combustion by lengthening the grain in one direction. It does not seem idle talk, making due allowance for the already relatively low inflammability of the powder, to still further lengthen it as has been done in England with cordite and in Italy with filite. But the lengthening of the grain in two directions, which approaches scales, presents as many advantages as its lengthening in a single direction which approaches thread.

On this principle powders have been made in square plaquettes for the 7.5 cm. mountain howitzer, the 15 cm. mortar, and the 12 cm. hardened bronze siege gun, model 1880. The thickness of the grain bearing to the side of the square the respective relations of $\frac{1\text{ mm.}}{2\text{ mm.}}$, $\frac{1.5}{3}$ and $\frac{3\text{ mm.}}{7\text{ mm.}}$.

For example of the results obtained see the firings of the 12 cm. gun. The initial velocity obtained was 500 m, and the maximum pressure less than 1400 atmospheres. While for the same initial velocity the pressure of black powder may reach 1900 atmospheres. Everything therefore tends to show that it will not be long before the new powders are adopted for all guns.

—*Revue d'Artillerie.*

(b) Normal Powder.

The Syndicate has been formed to acquire from a Swedish company, called "Aktiebolaget Svenska Krutfaktorierna," the exclusive right to sell in the British Isles and its Colonies and Dependencies, and also in Turkey, Egypt, Persia, China and Japan, a smokeless powder known as Normal Powder, at present manufactured under secret process by the vendors at Landskrona in the south of Sweden, and also the exclusive right to sell the secret process to the governments of, or to any company or person in, the same countries, subject to the ratification of the vendors, which, however, cannot be unreasonably withheld. Normal Powder is a guncotton, or more technically a gelatinized nitro-cotton powder, invented by Herr E. Schenker, the Swiss Government chemist, about the year 1888. It was subjected for several years to exhaustive trials by the Swiss military authorities, and having been finally adopted as the Swiss Government powder, has been the only powder manufactured at the Federal Powder Factory at Worblaufen, near Berne, for more than three years. The secret of the powder consists chiefly of various processes in its manufacture and the special machinery adapted to these processes. The manufacture has been, and is kept strictly secret in Switzerland, but the Swiss Government allowed Herr Schenker to sell the secret to the Swedish company, who are at present vendors, and to assist them to establish a large and well appointed factory for the manufacture of the powder in Sweden. Normal Powder, therefore, is not in a merely experimental stage, but, though hitherto quite unknown in England, is actually the service powder of an European army, and has been thoroughly worked out, not only for rifle small-arm caliber, but also for guns up to 4.72 inches.

The advantages claimed for normal powder are:

It does not unduly heat the barrel; in a comparative trial with a nitroglycerine powder, Normal Powder, after 100 rounds fired very rapidly, gave a temperature about 40% less than the other. There is consequently little danger of an accidental discharge after a course of continuous firing. Another important consequence is that the barrel is not eroded or destroyed. In Switzerland 40,000 rounds have been fired through one barrel with practically no injurious effects, whereas, after 3,000 rounds of a nitroglycerine powder a barrel is rendered useless. Normal Powder is therefore specially suitable for magazine rifles, quick-firing and machine guns. It is very stable; after being kept in cartridges in Switzerland 3½ years, Normal Powder gave the same ballistic results as when new. It is perfectly safe to manufacture in any climate. It is more simple to manufacture than nitroglycerine powders. It is practically flameless: in night attacks, therefore, the position of troops would be indistinguishable. No gases injurious to health are generated. It is not sensitive to friction or shock, and does not explode when fired on. It is economical; equal ballistic results are obtained with 20 per cent. less weight than is required for other guncotton powders. With the .303 rifle Normal Powder requires a charge of 30 grains, while other guncotton powders require as much as 35 to 43 grains. It is non-hygroscopic, and is not affected by variations of temperature.

Normal Powder has been officially tried, not only by the Swiss, but also by the Swedish military authorities, and the following average results of these trials have been supplied by the vendors:

IN SWITZERLAND.

Weapon.	Weight of projectile.	Charge.	Velocity.	Pressure.
.295 in. or 7.5 mm. infantry rifle	218 grains	30.86 gr.	2,033 ft.	14.3 tons.
2.95 in. or 7.5 cm. mountain gun	9.4 lbs.	7 oz.	1,049 ft.	7.15 "
3.3 in. or 8.4 cm. field gun . .	14.75 lbs.	21 oz.	1,840 ft.	11.3 "
4.72 in. or 12 cm. siege gun . .	39.5 lbs.	4.4 lbs.	1,738 ft.	12.3 "
IN SWEDEN.				
3.3 in. or 8.4 cm. field gun . . .	14.75 lbs.	18.5 oz.	1,558 ft.	9.3 "

Trials have been recently made with the .303 service rifle in the presence of certain of the directors, the average results of which were as follows:

	At Mess's Eley Bros. Range near London March 21, '95. Cap with two flash holes.	At Messrs. Greenwood and Batley's Range at Leeds, M'c'h 26, 1895. Cap with two flash holes.	At Messrs. Kynoch & Co's Range at Birmingham April 2, 1895. Cap with one flash hole.
Powder Charge	31 grains	30 grains	30 grains
Weight of Projectile	215 "	215 "	215 "
Velocity	2153 feet	2026 feet	2106 feet
Mean Variation in Velocity	12.5 feet	13 "	23 "
Pressure	16 tons	15.8 tons	16 tons

It will be seen, therefore, that Normal Powder has the good ballistic qualities of the nitroglycerine powders, besides the special advantages above mentioned.

The following are the results of further trials carried out at the works of Sir W. G. Armstrong, Mitchell & Co., at Elswick, on the first of April, 1895, with a 3-pounder quick-firing gun:

Round	1.	Charge	4	oz.	Velocity	1,202 ft.	Pressure under	3	tons.
"	2.	"	5	"	"	1,404 "	"	5.03	"
"	3.	"	6	"	"	1,575 "	"	6.7	"
"	4.	"	7	"	"	1,823 "	"	9.87	"
"	5.	"	8.5	"	"	1,965 "	"	12.14	"
"	6.	"	9	"	"	2,041 "	"	12.98	"
"	7.	"	9	"	"	2,049 "	"	12.79	"

The chief business of the syndicate will be to bring the powder prominently before the governments of the countries above mentioned, either for the purpose of selling the secret of the powder and the right to manufacture it, or of taking contracts for its supply, loaded or in bulk. As soon as circumstances warrant such a step, the directors will endeavor to form a company to erect works for its manufacture in this country, though in the meantime they will act as agents on commission for the Swedish factory. Negotiations are proceeding in various directions which it is hoped will lead to important contracts being given to the syndicate. A sporting Normal Powder is being worked out, and success with it is anticipated.

—*Arms and Explosives*, May, 1895.

(c) Powder—Austria.

The *Revue* noticed in its issue of April 27, the tests that were being made to produce a special powder for firing with blank cartridges. The Austrian press explained the object of these researches on the ground of economy, the cost of powder used in war being considerable.

A new explanation now reaches us. The Austrian smokeless powder burns up without noise when the tamping is insufficient. The noise of the firing becomes imperceptible when a cartridge is fired without a projectile, and from this point of view blank cartridge firing presents no analogy to warfare.

The researches were made not with a view to economy, but to obtain a powder which would make a loud enough report without tamping.

It was one of these powders which in the course of experiment caused the terrible explosion at the powder works of Blumau where 22 persons were wounded. This powder was composed of gun cotton treated with bichromate of ammonia.

—*Revue Militaire de l'Etranger.*

E. MISCELLANEOUS.

(a) Comparative Study of Small Arms.

The value of an arm as a whole, "*la bonté*" as Professor Hébler says, can only be determined, in our opinion, by the aggregate of the qualities possessed by the various parts composing it; that is, the barrel, breech mechanism, magazine mechanism, stock, etc., to which qualities must be added those that arise from the ammunition—that is to say, accuracy of fire and flatness of trajectory.

Let us first seek, among the arms in service, those which have the best barrels, those which have the best breech mechanism, etc., and let us then give to each of the parts of the arm examined a value, greater or less, as the element considered approaches more or less that of the best type; then we will establish coefficients differing according to the part examined—the barrel, being more important in the gun than the stock or other parts, will have a higher coefficient by which its *value* is multiplied.

Coefficients affecting each of the parts of the arm:

Barrel, sight, rifling	15
Breech mechanism and breech receiver	10
Magazine mechanism	5
Stock, bayonet	3
Form and weight of cartridge	5
Initial velocity	20

Let us now see which is the best barrel among the arms in service, then the best breech mechanism.

The best barrel is that of the Mannlicher, Holland, model 1892; the best sight that of the German gun, model 1888. The strongest and simplest breech action (breech mechanism) is still that of the Lebel—it complies with the condition of having its locking lugs as near as possible to base of the cartridge. The French cavalry carbine, model 1890, whose lugs are upright during fire is, however, superior to it. The breech receiver of the rifle, model 1886, is also preferable—the latter cut entirely in a block of steel, contains the breech mechanism and repeating mechanism, and is certainly the strongest. Moreover it facilitates the choice of wood for the butt and stock and hence is cheaper.

The system of magazine best adapted to give confidence to the soldier is that which fulfills the following conditions:

1. Of firing as a single loader, the magazine filled or not.
2. Of firing as a repeater by packet of cartridges—the packet being placed in the magazine as quickly as one cartridge in the barrel.
3. Of filling the magazine, cartridge by cartridge, without the aid of a packet.

Strictly speaking no arm complies in a satisfactory manner with all these conditions. The Swiss and English guns fulfill them in part; but unfortunately the cartridge packets are of paste-board and will not endure, in our judgment, transportation in cartridge chests during damp weather. The packets should be of metal. It would however be easy to perfect the magazine mechanisms of these two arms by reducing the number of cartridges contained in the magazine, and by making the packets of sheet steel. We think the Krag-Jörgensen mechanism too complicated.

The best stock is that of the French gun, the merit of which is the arrangement of the butt and stock with the breech action, but it lacks the hand guard of wood with which the Holland and Russian arms are provided. Again we were wrong in abandoning the socket bayonet which the Russians alone have retained, and in putting the bayonet, not under the axis of the barrel, which is its logical position, but to the right of the barrel.

There has been a return to the form of the old cartridge, and the bourrelet, more useful now than formerly on account of the enormous pressures of the new powders, has been taken up again. The best form for our construction is that which combines the bourrelet with the neck, the first is reduced a few tenths of millimeters in order to stop the cartridges at the entrance of the chamber, the second to insure the play of the extractor. Moreover the filling of packets (or magazines) for guns fed under the breech receiver is made very easy on account of the slight swell of the bourrelet. This form of cartridge shell has been adopted for the Lee-Metford English gun.

The above being established, let us take one by one the arms now in service and compare them with the types just examined.

The first in alphabetical order is the German gun, model 1888. This arm has a barrel so weak as to require a steel sleeve which completely envelopes it. Its breech action is likewise of little strength. The cartridge is without bourrelet, and finally the magazine allows only repeating fire. The desire was to make the piece too light.

Aside from its breech mechanism which is not designed for firing with new powders, and its magazine which is of too great a capacity, the English gun is well constructed. It is desirable however that the cartridge cases be made of sheet steel instead of card-board.

The Austrian Mannlicher, model 1888, is quite simple but its breech action is not symmetrical; the locking lug is too far from the base of the cartridge, and the magazine does not permit fire as a single loader. The Austrian cavalry carbine is fitted with a better breech mechanism, though too complicated.

Belgium adopted in 1889 a Mauser gun of 7.65 mm., of which the magazine is extremely simple. But does it possess sufficient strength? The barrel covered over with a steel sleeve is too thin. Cartridge is without bourrelet.

Denmark has had her new guns constructed following the Krag-Jörgensen system. The barrel and breech mechanism are too weak to endure war service. The magazine has a cut-off.

In 1891 Spain adopted a Mauser gun which has not the defects of the Belgian prototype; the barrel and breech are stronger and the caliber is reduced. The cartridge has no bourrelet.

The French gun, model 1886, has against it only its magazine mechanism, more than twenty-five years old, complicated and of little use. The cavalry carbine is much superior.

Holland and Roumania have adopted the best type of Mannlicher, having a breech mechanism simplified and improved. The only criticism to be made of these arms is that the magazine does not permit firing as a single loader.

The Italian gun has the same value as the two preceding arms, except that its breech action is not as simple.

Russia adopted in 1891 a good strong gun having a caliber 7.62 mm. (3 lignes); the breech mechanism resembles that of the Lebel gun and the magazine that of the Mauser, but it is stronger.

Sweden has contented herself thus far with changing the barrels of her Remington, caliber of 8 mm., the ball being projected with an initial velocity of 623 m.

The Swiss gun, model 1889, though well constructed, has against it a complicated and comparatively weak breech mechanism. Cartridge is without bourrelet. The Swiss cavalry carbine has a better breech action; it is borrowed from the Austrian carbine and is of the rectilinear Mannlicher system simplified. The magazine holds six cartridges but has no cut-off.

The Turkish and Argentine arms are of the Mauser model, 1889, but more durable than the Belgian type. They have not the metal sleeve, the object of which we have already mentioned.

We give herewith a table in which will be found the values and points obtained corresponding to the parts of the arms now in service. The latter will be classed in alphabetical order. Below will be found the total values obtained and the classification according to order of merit.

Classification, according to merit, of the arms in service:

1.	Holland, Roumanian and Italian	934	points.
2.	Spanish	914	"
3.	Russian	833	"
4.	French cavalry carbine	824	"
5.	Turkish and Argentine	819	"
6.	English	809	"

7. French . . . . 805 points.
8. Swiss cavalry carbine . . . . 783 "
9. Swiss gun . . . . 773 "
10. Austrian . . . . 769 "
11. Austrian cavalry carbine . . . . 759 "
12. German . . . . 754 "
13. Belgian . . . . 744 "
14. Danish . . . . 724 "
15. Swedish . . . . 700 "

COEFFICIENTS.	Barrel, sight, rifling.		Breech mech'nism Breech receiver.		Magazine mech'nism		Stock and bayonet.		Cartridge (form)		Initial velocity.	
	15		10		5		3		5		20	
Name of the arm.	value.	points.	value.	points.	value.	points.	value.	points.	value.	points.	value.	points.
Gun, German, model 1888, 7.5 mm .	13	195	14	140	12	60	13	39	12	60	13	260
Gun, English, model 1889, 7.7 mm .	16	240	10	100	16	80	13	39	18	90	13	260
Gun, Austrian, model 1888, 8 mm.	15	225	9	90	16	80	13	39	15	75	13	260
Carbine, Austrian, model '90, 8 mm.	15	225	13	130	10	50	13	39	15	75	12	240
Gun, Belgian, model 1889, 7.15 mm.	13	195	14	140	14	70	13	39	12	60	12	240
Gun, Danish, model 1889, 8 mm . .	13	195	10	100	13	75	13	39	15	75	12	240
Gun, Spanish, model 1891, 7 mm . .	17	255	15	150	14	70	13	39	12	60	17	340
Gun, French, model 1886, 8 mm. . .	16	240	16	160	7	35	15	45	13	65	13	260
Carbine, French, model 1890, 8 mm.	16	240	17	170	14	70	13	39	13	65	12	240
G'n Hol. & Rou'ian. mod. '93 6.5mm.	18	270	15	150	12	60	13	39	15	75	17	340
Gun, Italian, model 1892, 6.5 m. . .	18	270	15	150	12	60	13	39	15	75	17	340
Gun, Russian, model 1891, 7.62 mm.	16	240	16	160	14	70	16	48	15	75	12	240
Gun, Swedish, model '67-'89, 8 mm.	16	240	10	100	0	0	15	45	15	75	12	240
Gun, Swiss, model 1889, 7.5 mm . .	16	240	10	100	17	85	16	48	12	60	12	240
Carbine, Swiss, model 1890, 7.5 mm.	16	240	14	140	15	75	16	48	12	60	11	220
Guns, Turkish and Argentine, model 1889, 7.65 mm.	16	240	14	140	14	70	13	39	12	60	13	260

The perusal of the preceding classification shows us at once the superiority of the arms of 6.5 mm. and of 7 mm. over those of the 7.5 mm. and 8 mm. As for the last two, they have about the same ballistic value.

As to their strength and ability to endure campaign service, the qualities of their breech mechanism as well as of their magazine, determine the difference of the points that have been given to them above. The German gun for example, classed the 12th, the fire of which is excellent, is of little strength, its cartridge without bourrelet is not perfect and its magazine does not permit single fire as a single loader; if it be compared with the English gun, class 6th, whose breech action is not of the best, we see that the English barrel is excellent, and that the magazine permits fire as a single loader whether the magazine is charged or not—the ballistic qualities being the same in both guns.

From what precedes what should we conclude? The instruction of soldiers and especially of line officers and non-commissioned officers, will in the field surely establish the superiority of one arm over another. That infantry will be best armed which best knows how to judge distances, to appreciate the kind of fire to employ over the various *terrains* occupied by the enemy and to replenish itself with ammunition.

—*Revue du Cercle Militaire*, May 11, 1895.

(b) Reward for Excellence in Target Firing—Germany.

To increase emulation new rewards for excellence in fire practice have been instituted in Germany under date of January 27, 1895.

Every year, the following classifications based upon the results of the fire practice will be made:

Between companies of infantry of each army corps (excluding the chasseurs and carbineers).

A similar classification will be made in the artillery for artillery fire:

Among the field batteries.

Among the foot batteries.

The units which achieve the first class, will each receive from the Emperor a special prize (the Kaiser-prize) which will become their property.

A special souvenir will be sent to their commanders (*Bleibendes Erinnerungszeichen*).

The men belonging to these units will wear for a year upon their right arm an insignia with the imperial emblem (*Kaiserabzeichen*).

The Kaiser-prize will be a bust of the Emperor.

The commanders of the units will receive an escutcheon in silver, 20 cm. high, surmounted by an imperial crown, and resting upon trophies which form the borders of the two sides. In the escutcheon, above the heraldic eagle, a garland of laurel surrounds the inscription "William II, Emperor of Germany, King of Prussia, to Captain X———, in recognition of the success obtained by his battery (or company) in the fire exercises of 189—; in the —*corps d'armée.*" The garland and the crown are gilded.

The particular badge to be worn by the men belonging to the successful units, consists of double branches of laurel, 6 cm. high, in yellow metal, surmounted by an imperial crown and bearing in the center, following the arm of service, two crossed-cannon or two crossed-muskets.*

The Emperor charges the expense of these rewards to his privy purse.

—*Revue d'Artillerie.*

* By a recent order affecting the navy, the insignia will be worn for a year by the cannoneers of the ship to which the silver escutcheon is awarded.

DEPARTMENT OF SCIENTIFIC AND MILITARY INFORMATION.

Revue d'Artillerie.

(5 *Rue des Beaux-Arts, Paris, France. Monthly. Per year* 22 *Fr.*)

APRIL.—Firing regulations of the Austrian field artillery. The Corps Artillery of France. The Borchardt repeating pistol. The influence of the inclination of the screw threads upon the strength of the breech mechanism.

MAY.—The artillery at the beginning of the revolutionary wars. Artillery firing by night. A new level adopted by the Swiss field artillery. Distribution of strains in metals. The offensive and defensive armament of the battle in the Yalu, (Vignaux).

JUNE.—General Englehardt on the material of artillery. The material of the Russian field artillery at the beginning of 1895. The French Artillery Corps. Armstrong campaign material.

Revue Militaire de l'Etranger.

(*L. Baudoin, Rue et Passage, Dauphine* 30, *Paris, France. Monthly. Per year* 15 *Fr. Single number* 1 *Fr., plus postage.*)

APRIL.—The German army estimates for 1895-1896. The Chino-Japan war. The infantry reserve of the Russian army in 1894. Attack of sea coast fortifications by ships, according to English military writers.

MAY.—The horses of German cavalry during the campaigns of 1870-71. The *Feld-Jäger* of the German army. The means of transportation employed by the English in their African expeditions. The Chino-Japanese war (continued). Military news.

JUNE.—Despatch bearers in Germany. Organization of mountain convoys in Italy. The Chino-Japanese war (continued). The means of transportation employed by the English in their African expedition (concluded). Military news.

Revue du Génie Militaire.

(*Berger Levrault Cie, Rue des Beaux-Arts* 5, *Paris, France. Bi-monthly. Per year* 27 *Fr.*)

JANUARY, 1895.—Operations of the Joffre-column before and after the occupation of Timbuctoo. [Official report of Lieutenant-Colonel Joffre, of the engineers.]

FEBRUARY.—The German pioneers in 1870. Note on the improvement of the cess-pools of the camp of Chalons. The fortifications of Gibraltar.

MARCH.—The German pioneers in 1870 (continued). The invention of bastions. Review of Rocchi on the origin of modern fortification. Organization of the engineer troops of Russia for the field. Transportation by camels. On certain methods of construction practiced by Belgian military miners.

APRIL.—The German pioneers in 1870 (continued). The fortifications of Spain. Results obtained in Holland in firing at materials used in fortifications. Chimney pot for smoking chimneys. Coating for metallic cables and cordage. Engineer sappers in Russia. Winter maneuvers in Germany. Motors with compressed gas. New military balloon in Germany.

Revue Maritime et Coloniale.

(*L. Baudoin, Rue et Passage, Dauphine* 30, *Paris, France. Monthly. Per year* 56 *Fr.*)

MARCH, 1895.—The *Volta* in China and Tonkin (1883-1885). Naval warfare (an analysis of Rear-Admiral Colomb's work) (continued). The attack on the *Aquidaban* by the Government torpedo boats on the night of April 15, 1894. (Based on information furnished by officers who were present as spectators or participants). Description and working of the hydraulic apparatus of the 340 mm. (13.5 inch) cannon, model 1887 (continued). Naval notes.

APRIL.—Naval warfare (continuation of the analysis of Admiral Colomb's work). Description and working of the hydraulic apparatus of the 340 mm. cannon, model 1887 (concluded). The American fisheries.

MAY.—Bibliography of the works concerning Dahomey. The English budget of the marine for 1895-6. Naval notes (very full).

Revue de Cavalerie.

(*Berger Levrault Cie, Rue des Beaux-Arts* 5, *Paris, France. Monthly. Per year* 33 *Fr.*)

April.—Instruction and management of cavalry (translated from the German). Operations of the 5th Division of German cavalry on the 15th of August, 1870 (with a colored map). Food and work of the cavalry horse. Cavalry against cavalry. Reconnoitring duty (conclusion). Horse grenadiers. How to make a trooper in the shortest time possible. The horse's gait, with five plates (continued).

May.—Observations on the French army from 1792-1808 (continued). Instruction and management of cavalry (continued). Report of General Nansouty, commanding the First Division of heavy cavalry, 1808. How to make a trooper in the shortest time possible. The purchase of remounts. The action of the Texel.

June.—The Austrian cavalry. Operations of the 5th Division of German cavalry from the 12th to the 15th of August (concluded). The Cossack *lava*. Formations of the three arms in Germany for the march, for battle, and for assembly. Necessary information for reconnaissance and fire.

L'Avenir Militaire.

(13 *Quai Voltaire, Paris, France. Semi-weekly. Per year* 18 *Fr. Single number* 5 *centimes.*)

April 2.—The new equilibrium of Asia. National Defense.

April 9.—Cuba. Expenses of an European war. The infantry coat.

April 11.—Hova politics. The non-commissioned officers' mess. The leisure of the soldier. Mortality in the French army.

April 16.—Letter to Fanette.

A humorous article on the subject of the defeat, etc., of the law of 1889. He maintains that good soldiers can not be made in three years. He argues that the French soldier is now supposed to know all about every subject except those which apply directly to his own branch. The cavalryman, for example, must know gardening, telegraphy, butchering, and in fact twenty other trades which have nothing to do with his own. The author points out the difficulty and proposes a remedy. The letter has created a deep sensation in the French army.

Civil employés and the circular of March 6. The re-organization of the Ottoman Empire. The Madagascar gunboats and the *Brinkburn*.

APRIL 19.—Tactics of the offensive combat. Old guns and the new cartridges. Gifts to the troops for Madagascar.

APRIL 30.—Europe and Japan.

MAY 3.—The struggle for Liao-Toung. The *Bouvines*. The battle of Villiers, Nov. 30, 1870.

MAY 7.—Military schools. Ratification of the treaty of Simonosaky.

MAY 10.—France and Japan. Field firing exercises.

MAY 14.—The school of the scout. The soldier's food.

MAY 17.—The society for protecting the native races of the colonies. Russia and Japan. The retreat from Russia after the Berezina.

MAY 24.—Military schools. Artillery troops. Candidates for Saint Maixent.

MAY 31.—Military singing. Effective forces of the budget of 1896. Losses of the French armies during a century (total loss estimated, 6,000,000). Colonial politics. Territorial officers and the war office.

JUNE 4.—Organization of the engineers. Our naval marine. Destruction of obstacles on the field of battle.

JUNE 7.—Recent progress in the French army. Examination for admission into the polytechnic school.

JUNE 11.—The tactics of the battle of Yalu. Artillery Fire.

JUNE 14.—Rules for artillery maneuvers. The publication of the treaty of the triple alliance. Bicycle service in the army.

JUNE 18.—The mobilization of the Algerian troops. The European intervention between China and Japan. The present balance of power in Europe. Parliament in time of war.

JUNE 21—The battle of Yalu. Reorganization in the Swiss army.

JUNE 25.—Japan and the balance of power. Promotion of lieutenants.

JUNE 28.—Unjustifiable expenses in the war budget. Moch on coast defense.

La Marine Française.

(23 *Rue Madame, Paris, France. Semi-monthly. Per year* 30 *Fr. Single copies* 1 *Fr.* 50 *centimes.*)

APRIL 10.—Paris in thirty-six hours from Algiers. Marine infantry. The present state of opinion of the English upon naval tactics. The discussion of the marine budget. Boats built and launched in 1894. The new English program of construction. The new 30 cm. cannon. A new shell. Works of the Admiralty. The new German coast-guard ships. The new torpedo boats. Coast defense and the navy.

APRIL 25.—Debate on the navy budget. Sea-coast defense and the navy (Moch). Modern German colonization. The canal from Marseilles to the Rhone.

MAY 10.—England in the Mediterranean. The real state of English opinion on naval strategy.

MAY 25.—Report of Admiral Vallon on the *Magenta*. Supplementary report on the instability of the battleships *Magenta*, *Marceau* and *Neptune*. The Indo-China transports. Yachting notes. Methodical stoking. The geographical and colonial movement. Naval notes, home and foreign.

JUNE 10.—A note on the *Magenta*. Staff organization. Coast defense (continued). Postal service and mobilization. Yachting.

JUNE 25.—The Rochefort Arsenal.

Revue du Cercle Militaire.

(37 *Rue de Bellechasse, Paris, France. Weekly. Per year* 27 *Fr. Single copies,* 50 *centimes.*)

APRIL 6.—English recruiting (continued). The Spaniards in Cuba.

APRIL 20.—The folding bicycle.

APRIL 27.—Aerial navigation. The folding bicycle (concluded). Recruiting in England.

MAY 4.—Aerial navigation. The instructions of the Japanese Emperor to his army.

MAY 11.—Comparative study of small arms in service. The Italian army in 1894.

MAY 18.—The artillery in conjunction with the other arms.

MAY 25.—The mounted orderlies of the German army. The artillery in conjunction with the other arms (continued). Pneumatic guns in the United States.

JUNE 1.—The colonial troops of Holland (continued).

JUNE 8.—The war budget for 1896. The rations in the Italian navy.

JUNE 22.—The Italian Army Annual for 1895. The navy budget for 1895.

JUNE 29.—To the north pole in a balloon.

Le Yacht—Journal de la Marine.

(55 *Rue de Chateaudun, Paris, France. Weekly. Per year* 30 *Fr. Single copies,* 60 *centimes.*)

APRIL 6.—The colonial army and the marine artillery.

APRIL 13.—The navy in the senate. A study upon the fatigue of ships. The Madagascar gunboats and the *Brinkburn.*

APRIL 27.—The peace between China and Japan (E. Weyl). The Wei-Hai-Wei expedition. Trials of the *Friant.* The French maritime fisheries.

MAY 4.—New warships in construction in Italy. The cruiser *Suma* of the Japanese navy. The *Renown* of the British navy. The stability of sailing ships.

MAY 11.—The English navy. New warships in construction in Italy (concluded). The German coast defense ship *Siegfried.*

MAY 18.—Effect of the Japanese projectiles (illustrated). The stability of sailing vessels. The technical bureau. The expedition to Madagascar. Construction of a new Russian cruiser at Havre.

MAY 25.—Episodes of the Chino-Japanese war. Yachting news. The new German coast defense ship *Frithjof* (with photograph). The merchant marine, home and foreign.

JUNE 1.—The loss of torpedo-boat No. 20.

JUNE 8.—Rear Admiral Fleurais. State transports (E. Weyl). French yachting union. Foreign navies.

JUNE 15.—The canal from the Baltic to the North Sea. Valkyrie III. The great Austrian cruisers.

JUNE 22.—The naval architects in Paris. The trials of the

Linois, French cruiser of the third class. The squadron of the Mediterranean at Bizerte.

JUNE 29.—The opening of the Baltic canal. The naval architects in Paris.

Mémoirs de la Société des Ingénieurs Civils.

(10 *Cité Rougemont, Paris, France. Monthly.* 30 *Fr. per year.*)

MARCH.—Congress of Naval Engineers at Chicago. The coal mines of France.

APRIL.—Electric cranes at Havre. Note on the accident to the Packet *Gascoigne*. Public relief in case of accidents, in France and in foreign countries.

MAY.—Retirement of miners, organized by the coal companies in France. The *Laval* steam turbine.

Le Génie Civil.

(6 *Rue de la Chaussée d'Antin, Paris, France. Weekly. Per year* 45 *Fr. Single copies,* 1 *Fr.*)

APRIL 6.—The engines of the English torpedo boat *Daring*. The prolongation of the coal basin of the *Pas-de-Calais*. The committee of defense and social progress. Parabolic beams.

APRIL 13.—The viaduct drawbridge on 16th street, Milwaukee. Gold in Transylvania. Casting pipes with knee joints. The De Cohorne solar regulator.

APRIL 20.—The construction of a suspension bridge. The manufacture of steel tools. The alloys of aluminum. The new steamships of the German Lloyd line. Pasteur's laboratory at the Normal School.

MAY 11.—The breaking of the Bouzey Dam. Universal machine for working wood. New nomenclature of sedimentary rocks. The cistern-packet "Aco" for transporting oil.

MAY 18.—Machine for ruling and folding paper. Utilizing heads of water.

MAY 25.—River and and ferry boats in the United States (Fall river line boats). Traction on tramways by means of compressed air. Proposed suspension bridge over the Hudson. Cremation in Paris.

JUNE 1.—River and ferry boats of the United States (concluded). The Exposition of 1900. A study on reservoir dams. The South African Republic in 1894.

JUNE 8.—Transmission of electrical energy (20 kilometers.) Viaduct of Pecos (Texas). Oscillating furnace for melting steel. A new electrical tramway in Paris. The use of aluminum in ship building.

JUNE 15.—The Kiel Canal.

JUNE 29.—The carburet of calcium and acetylene.

Revue de l'Armée Belge.

(22 *Rue des Guillemins, Liége, Belgium. Bi-monthly. Per year* 13 *Fr.*)

MARCH–APRIL.—Infantry as support for cavalry when serving at a distance. War preparations, organization of the railroads. The work in Africa, and Leopold II. The Sartow mitrailleuse. The war matériel of Creusot at the D'Anvers Exposition. Rapid fire guns of 75 mm. of the Nordenfelt-Cockerill system. National defense, and fortification at the close of the 19th century (a review of Gen. Brialmont's work).

Revue Militaire Suisse.

(*Escalier-du-Marché, Lausanne, Switzerland. Monthly. Per year* 10 *Fr. Single number* 1 *Fr.*)

APRIL.—A combat in the Alps nine centuries ago. The role of Swiss cavalry according to the order of August 31, 1894. The military articles of the federal constitution and the project of military organization.

MAY.—Role of the Swiss cavalry, pursuant to the order of August 31, 1894 (continued). The French scheme for mobilization towards Switzerland and Savoy. The Chino-Japanese war and peace. Reorganization of the train.

JUNE.—Swiss military reorganization. The Daudetau rifle (with plates).

Memorial de Artilleria.

(*Farmacia, num.* 13, *Madrid, Spain. Monthly. Per year* 18 *pesetas. Single copies*, 1 *peseta*).

APRIL.—Memoir upon the exchange of draft horses and tests of the new harness, collars, etc. Memoir upon the handling and transportation of the Whitworth and Ordoñez material from Cadiz and Carraca to Torregorda. A simple pantograph. Artillery in ships at the beginning of the 16th century. Memoirs upon the 2nd of May, 1808.

MAY.—Employment of the artillery in the field in Cuba. Metallic gun cartridges. Memoir upon the exchange of draft horses and tests of the new harness, etc. Memoirs of the 2nd of May.

Revista General de Marina.

(56 *Calle de Alcald, Madrid, Spain. Monthly. Price U. S.* 22 *pesetas. Europe* 20 *pesetas. Single numbers* 2.50 *pesetas.*)

APRIL.—Memoir upon the Chinese war, drawn up by the ship lieutenant of the 1st class, chief of the naval commission in Hong Kong. The naval combat of the Hai-Yang. Electrical projectors. Compensation for magnetic declinations in the Spanish peninsula (continued).

MAY.—The battle of the Yalu. Elementary electro-dynamics (continued). The Chino-Japanese war. Torpedo boats.

JUNE.—Observations upon traveling through the United States. The North Sea canal. Vocabulary of powders and explosives.

Revista Cientifico Militar.

(5 *Calle de Cervantes, Barcelona, Spain. Semi-monthly. Per year* 32 *Fr.*)

APRIL 15.—Military exposition of Vienna in 1894. Heavy field artillery. Observations upon the French cavalry.

MAY 15.—Observations upon the tactics of modern combat (continued). Heavy field artillery. Modern infantry tactics (continued). Instructions of the Emperor of Japan to his army. The health of the soldier. Papers upon the history of the Chino-Japanese war (continued). Observations upon the French cavalry compared to that of Germany. Who invented powder?

JUNE 15.—The fire of infantry in war. The preponderating importance of the soldier as an element in war. The necessity for the armed institution and the military art. Practice in topography and railways in the infantry academy.

Circulo Naval,—Revista de Marina.

(*Casilla num.* 852, *Valparaiso, Chili, S. A. Monthly*).

JANUARY.—Internal ballistics. A lecture before the Philosophical Society by Captain Noble, C. B., F. R. S (continued). The war upon Paraguay. Official test of the *Presidente Errazuriz.* Principles and comments upon modern naval tactics.

FEBRUARY.—Points and observations for perfecting oneself in the exercise of target practice. Official test of the *Capitan Prat.*

MARCH.—Internal ballistics. Organization of the directing personnel of the navy in foreign countries (continued). Principles and comments upon modern naval tactics.

APRIL.—An account of the operations on the Benin river in August and September, 1894.

MAY.—The defenses of the Italian maritime frontier. Project for the organization of the personnel relating to the rudder and signals. Organization of the directing personnel of foreign navies.

Revista Militar.

(262 *Rua da Princeza, Lisbon, Portugal. Semi-monthly. Per year* 2$220)

APRIL 30.—Points upon the manufacture of powder. Military schools of gymnastics, fencing and of fire in foreign countries.

MAY 31.—Study upon crime. The reserve officers.

JUNE 15.—The national flag. The initiative. The organization of artillery. Study upon criminology. Ancient military organization, especially of Greece and Rome (continued).

Revista do Exercito e da Armada.

(*Escadinhas de S. Luiz* 22, *Lisbon, Portugal. Monthly. Per year, for Europe,* 300 *reis.*)

APRIL.—Historical study of the campaign of Marshal Soult in Portugal. Notes and facts upon cavalry (continued). Some words upon the reorganization of the services of storing and manufacturing war material (continued). Colonial armies. The French expedition to Dahomey, commanded by General Dodds.

MAY.—A few ideas upon the combat tactics of the present (continued). Columns for operation beyond the sea.

JUNE.—Episodes in the war of Zululand in 1879.

Revista da Commissao Technica Militar Consultiva.

JANUARY.—Experiments upon artillery. The nitro-cellulose compounds. Explosive cotton and ballistite.

FEBRUARY-MARCH.—The regulation of the 4th of July, 1891. Military technical work in the United States. Pietruski system of automatic submarine mines. Box ammunition cart. Blank cartridges.

Rivista di Artiglieria e Genio.

(*Tipografia Voghera Enrico, Rome, Italy. Monthly. Per year,* 30 *lira*).

APRIL.—Coast batteries and the new means of attack.

The writer, after a brief introduction, explains the cases which may be presented to a fleet in attacking a fortified place. He then passes to the considerations of the attack, using numerous historical illustrations. The argument tends to the necessity for many quick firing guns from which results as important may be obtained as from the heaviest types of gun. The adoption of a smokeless powder, it is claimed, will remove many difficulties. The conclusions are that navies are in a period of transition, and that the most competent judges are not in accord upon their future development. Small ships and rapid firing guns will compel coast forts to change their methods of defense, and will introduce a complete revolution in the present methods of attacking the coast.

The direction of field artillery fire.

This article is a discussion of the different questions of field artillery fire under the heads I. 1. Fire against the artillery and infantry. 2. Fire at short distances. 3. Against an object moving rapidly. II. Deals with the means of firing upon objects more or less concealed. III. Is devoted to conclusions.

Tactical considerations upon the attack of fortresses and upon present permanent fortifications. Upon the laws of the resistance of the air. The fire exercises carried out by the French field artillery at the polygon of Chalons in August, 1894. Heavy artillery intended for the army. Experiments upon penetration with the Argentine model Mauser gun. The Russian field mortar. The new Nordenfelt 75 mm. rapid firing field gun.

MAY.—Study upon the most suitable speed for musketry fire. The service of the engineer troops in the mountains. Note upon the action of naval artillery against coast batteries. Results and deductions from some tests of the Prony recoil brake. Movable target mounted upon wheels. Fire from covered position in siege artillery warfare. Data upon the Spanish Mauser.

Rivista Marittima.

(*Rome, Italy. Monthly. Per year,* 25 *lira. Single number,* 5 *lira*).

APRIL.—English coal in Italy. Dynamometers to marine engines. Sporting navigation. Naval strategy. The Madagascar question.

MAY.—The mechanical application of electricity upon warships. Torpedo boats. Maritime commerce and the Italian administration. The naval career of Napoleon I. Maritime and economic defense and the elements of strategy and naval tactics.

JUNE.—The Mediterranean military situation. The influence of maritime power upon history. The degree of approximation in the regulation of astronomical sea observations, and in their relative calculation. The Italian maritime commercial association.

Archiv fur die Artillerie-und Ingenieur Offiziere.

(*Koch Strasse*, 68-78, *Berlin, S. W.* 12, *Germany. Monthly. Per year* 12 *M. Single number* 1 *M.*)

APRIL.—Communication between France and Russia in the event of a war.

A discussion of the feasibility of establishing communications between France and Russia by balloons, should the triple alliance, whose territories separate these countries, also gain control of the sea.

The Hyperbola as a ballistic curve.

MAY.—Indirect laying of field and garrison artillery.

Jahrbuecher fuer die deutsche Armee und Marine.

(*Mohren Strasse*, 19, *Berlin, W.* 8, *Germany. Monthly. Per year* 32 *M. Single number* 3 *M.*)

APRIL.—Improvised fortifications. Claims of the present upon military legislation. The command of our hospital detachments in the field in view of the effect of modern fire arms. The new discipline, regulations and the directions for the development of the infantry in Portugal. A forgotten regulation of promotion of the time of King Frederick William III.

MAY.—The Partisan Frederick von Hellwig. A study in the history of partisan warfare from 1792–1814 (continued). The taking of Bonn by the Elector Frederick III of Brandenburg in the year 1689. [An essay on the military history of Brandenburg from original Bavarian sources.] (continued). The reform of the military penal laws. The English cavalry maneuvers in 1894. The Royal Italian Army and Navy in the latter half of 1894. The Austrian occupation of Montenegro.

JUNE.—The Paschwitz telemeter. Frederick von Hellwig (continued). The Emperor William I (a reminiscence). The Archduke Charles and the Austrian army. The North Sea canal.

Geography as a subject in military high schools. Military notes from Russia. Review of military inventions.

Militaer-Wochenblatt.

(*Koch Strasse*, 68, *Berlin*, *S. W.* 12, *Germany*. *Semi-weekly*. *Per year* 20 *M*. *Single number* 20 *pf*.)

No. 30.—The ideal of a war academy (continued).

No. 31.—Dangers to discipline. Five letters from Gneisenau during the years 1813, 1816 and 1824.

No. 32.—The influence of sea power on history.

No. 33.—The small arm question. The lessons of war (continued). The thorough-bred horse and his importance in the breeding of half-bloods. The horse material of the field artillery.

No. 34.—Railroads in the east Asia powers from a military standpoint.

No. 35.—The employment of tents in winter.

No. 36.—The field guns of foreign private companies. A means of enhancing the mobility of the artillery.

No. 37.—Cavalry divisions in peace. Smokeless powder. Mounted orderlies for the infantry.

No. 38.—Cavalry divisions in peace (conclusion). Bicycle infantry.

No. 39.—The training of the cavalry. The campaign in Italy of 1866.

No. 41.—The Royal Armory. Tactics.

No. 42.—New rules for infantry brigades and divisions in the attack, based on historical study. A field artillery question. The Austrian course in telegraphy for cavalry.

No. 46.—The field artillery of the future. New directions for pioneers. French ship construction.

No. 47.—The principles of mobility in field artillery.

No. 48.—List of seniority of the Prussian army. Horse artillery, what it is and what it should be. Germany in south west Africa. Military notes.

No. 50.—The French colonial army. Latest changes in the Bulgarian army.

No. 51.—Our military colleges. A field lamp for night service.

No. 52.—Observations upon the French cavalry. Hints on a practical method for harnessing in field artillery.

No. 53.—Another word on the organization of cavalry divisions in peace. The French Army Annual for 1895. An English torpedo tube of aluminum.

No. 56.—The organization of the field artillery. The Eider in ancient times.

No. 57.—Further observations on the new rules for infantry brigades and divisions in the attack. Two years in the Chinese service.

No 58.—Physical condition of the French army.

Beiheft zum Militaer-Wochenblatt.

(*Koch Strasse*, 68, *S. W.*, *Berlin*, *Germany*).

Part 3.—The development of our infantry tactics since our last war. Infantry and artillery shooting.

Part 4.—Observations on the use of the reserve at Vionville. Mars la Tour with especial regard to the 5th infantry division. My experiences in the battle of Vionville (Von Schaumann).

Marine Rundschau.

(*Koch Strasse*, 68-70, *Berlin*, *Germany*. *Per year*, 3 *m.*)

April.—The influence of sea-power on history. Deductions from the Chino-Japanese sea fights with respect to ship construction and armament.

May.—The origin and historical development of the naval officers' profession, from the Middle Ages to the present time (continued). Means of obviating vibration in vessels. Trial trips of the new cruiser *Gefion*. The results of the trial trips of the battleships (4th class) *Hildebrand*, *Heimdall* and *Hagen*. A voyage to the East Indies in 1751.

June.—The capture of Wei-Hai-Wei (with a sketch and plan). The naval war college of the United States. The injury to the engines of the French mail steamer *La Gascoigne*. Trial of 12-inch hardened nickel-steel Krupp plates (with twelve photographs). Foreign naval notes.

July.—The proposed canal from the Mediterranean to the Atlantic across France. The dangers incident to coal stored in bunkers. The commerce of Germany.

Allgemeine Militaer-Zeitung.

(*Darmstadt, Germany. Semi-weekly. Per year,* 24 *m.*)

MAY 2. The German and French maneuvers of the present year. The list of seniority of the army and navy for 1895.

MAY 6.—The opening of the North Sea Canal (continued).

JUNE 1.—The North Sea Canal considered from a military stand point.

Schweizerische Zeitschrift fuer Artillerie und Genie.

(*Frauenfeld, Switzerland. Monthly. Per year* 8 *Fr.* 20 *centimes.*)

APRIL.—Visual field signaling. A study of our 12 cm. mortars. Small arms (continued).

MAY.—Information concerning the Swiss artillery and engineers.

Monatschrift fuer Offiziere Aller Waffen.

(*Frauenfeld, Switzerland. Monthly. Per year* 5 *Fr., plus postage.*)

APRIL.—Revision of the Swiss army organization.

JUNE.—Thoughts on the present and future instruction of our soldiers (continued). The taking of Port Arthur.

Allgemeine Schweizerische Militaer-Zeitung.

(*Basel, Switzerland. Weekly. Per year,* 8 *Fr.*)

APRIL 13.—The latest changes in the Russian forces in Poland under General Gourko.

APRIL 20.—The war situation in East Asia. Military news from Italy.

APRIL 27.—Trial mobilization of the Paris military. Autumn maneuvers of the IVth Army Corps, 1894.

MAY 4.—The British expedition to Chitral. Autumn maneuvers of the IVth Army Corps.

MAY 18.—The Italian campaign in Africa.

JUNE 1.—The Madagascar expedition.

JUNE 8.—Military news from Germany.

Mittheilungen ueber Gegenstaende des Artillerie und Genie-Wesens.

(*Wien, VI, Getreidmarkt* 9, *Austria. Monthly. Single number* 1 *Fl.* 50 *Kr.*)

NO. 4.—The French fortress artillery. The automatic aiming apparatus of M. Deport (with plate).

No. 5.—Pendulum for verifying ballistic chronographs. Mathematical discussion on quadrants. New organization of the German fortress artillery. The rapid fire 7.5 cm. of the Maxim-Nordenfelt firm. New barracks in Germany.

No. 6.—Field Marshal Julius Vogl. Selection of auxiliary targets, estimation of distances. Permanent works and their siege (based on General Brialmont's recent work). The Russian 6-inch siege mortar. An automatic explosive apparatus for destroying railroads. Improvement of nickel cast-iron by heating and sudden cooling. Cement-iron construction by Cottancin system.

Organ der Militaer Wissenchaftlichen Vereine.

(*Wein I, Stauchgasse No.* 4, *Austria. Per year*, 6 *Fl.* 8-14 *numbers per year*).

No. 5.—Field service regulations (German army). Attack and defense of fortifications. Wholesome drinking water in camp and on the march, with special relation to filtering.

No. 6.—The Cossacks and their fighting methods. Improvements in naval artillery (especially electrical). Temporary camps in the snow.

Neue Militaerische Blaetter.

May.—Defense of the Shipka Pass (continued). The Italian artillery and engineer school. The military and political importance of Central America (continued). The Chino-Japanese war (continued). Are the prospects of cavalry effectively engaging on the battle-field really vanished? Squadrons of mounted orderlies. The use of the bicycle on the march.

June.—Sea power. Eckernförde. The Chino-Japanese war (concluded).

Mittheilungen aus dem Gebiete des Seewesens.

(*Pola, Austria. Monthly. Per year*, 12 *marks*).

No. iv.—The new coast defense ships of the Royal and Imperial navy, *Monarch, Wien* and *Budapest*. The shape of the bows and sterns of racing yachts. On the sinking of the *Elbe*. Foreign navies of the year 1894. Preparations for draining the Zuyder Zee. The Russian armored cruiser *Rjurik*.

No. v.—The laws and prosecution of sea-warfare. Foreign navies in the year 1894. The French coast-defense armored ships *Bouvines* and *Jemappes*.

No. VI.—The influence of the movement of the ship on aiming (an exhaustive treatise). The coast defense battleship *Monarch*. The electrical signal telegraph, Pebal-Schaschl system. Naval notes (very complete). The new Italian battle ships and armored cruisers. Protection for gun crews. The French cruisers *Alger* and *Isly*. The new German coast defense ships of the *Siegfried* class.

No. VII.—The naval events of the war in the East to the capture of Port Arthur, inclusive. Submarine torpedo boats. Recovering the wreck of the English steamer *Yarrowdale*. The dirigible Halpine-torpedo. The English torpedo depot and workship *Vulcan*. The trials of the German third-class cruiser *Gefion*. The Italian battleship *Sardegna*. The machinery of the English battleship *Magnificent*. Foreign naval notes. The steamers *Saint Louis* and *Saint Paul* of the American line. The naval budget estimate of the United States of America.

No. VIII.—The North-east Sea Canal. English ships of the first class. Australasia.

The Engineer.

(33 *Norfolk Street, Strand, London, England. Weekly. Per year* 2£ 6d. *Single copies* 6d.)

APRIL 5.—The Institution of Naval Architects.

In this article the relative sizes of the ships now under construction in England and foreign countries are considered. The President of the Institution, Lord Brassey, in his address at the annual meeting advocates more ships of moderate size in preference to a few of the maximum size now being constructed. He points out that the ten battleships now approaching completion average four thousand tons greater than the average tonnage of all foreign ships now being built. He advocates a policy which will keep England's navy equal to the combined fleets of any two powers.

The meeting was further taken up with a paper on *Notes on Further Experience with First class Battleships*, in which are embraced trials at sea; rolling experiments made on the *Revenge* in which the subject is illustrated by numerous curves; and the influence of bilge keels on steering and speed. A paper on *The Elements of Force in a Warship*, being principally a voluminous set of tables with comments on them, was also discussed.

International building trades exhibition. Steel *v.* iron fire box stays. Waves and vibrations.

APRIL 12.—Electric motor for rowing boats. First-class battleships and bilge keels.

APRIL 19.—The working of light railways in Belgium. The institute of naval architects. Waves and vibrations. Method of preventing vibrations in marine engines. On the safe storage and conveyance of compressed gases. British fuzes for modern guns.

APRIL 26.—The tin plate industry. The miners national union. Electric currents. Vertical high speed engines. Mr. Howden on boilers for the navy. Baltimore and Ohio electrical locomotives.

MAY 3.—United States naval gun factory at Washington. H. M. S. *Royal Arthur*. Melloid, a new alloy. Failure of the Bouzey Dam.

MAY 10.—United States naval gun factory at Washington (conclusion).

The estimated cost of the entire plant was $1,806,000; the annual cost of maintenance and repairs is about $400,000. The range of the output is from guns of 4-inch calibre to those of 13-inch, and corresponding mounts. Powder tanks and experimental work are also treated of.

Concrete bridge over the Mary river, Maryborough, Queensland. American and Russian petroleum.

MAY 17.—Tin plate industry in the United States. Effect of arsenic on steel plate. Stability of French armored ships.

MAY 24.—Torpedo boat destroyers. H. M. S. *Terrible* (a cruiser of 14,000 tons displacement, and 20 knots speed). A review of Lieutenant Ackerman's paper on face-hardened armor.

MAY 31.—Submarine navigation. Todd's terminal exhaust quadruple-expansion engine.

JUNE 7.—The traction of boats on inland waterways. British fuzes for modern guns. Instability in ships of war.

JUNE 14.—The Baltic canal. Wood and copper sheathing for steel ships.

JUNE 21.—The International Railway Congress. Institution of naval architects. Drainage system of the Houses of Parliament. The cost of warships. Marine engineering and shipbuilding of the Thames.

JUNE 28.—The Great Western Railway Works, Swindon. Proceedings of the institution of naval architects. The cost of warships (continued). The Royal Agricultural Society's show, Darlington. English consumption of small arm ammunition. The Neclausse water-tube boiler. Express locomotives.

Engineering.

(35-36 *Bedford St., Strand, London, W. C., England. Per year, £2 6d. Single copy, 6½d.*

APRIL 5.—The Glasgow iron and steel company's works, Wishaw. The foundations of physics. H. M. S. *Bruiser*. The institution of naval architects (continued).

APRIL 12.—The new Nordenfelt guns. An aluminum torpedo boat. The torpedo boat destroyer *Ardent*. The propelling machinery of H. M. S. *Magnificent*. Our battleships.

APRIL 19.—State railways in Western Sumatra. Naval works. On the vibrations of ships and engines.

APRIL 26.—New drainage works of Paris. French standard screw threads. Mechanics at the royal school of mines. The new British cruisers.

MAY 3.—Failure of the Bouzey Dam.

MAY 10.—Electric traction. Glasgow harbor tunnel. Economics of coal. Electric welding for repairs. Paris International Exhibition of 1900.

MAY 17.—Thames bridges. The disengaging coupling of the *New York*. Japanese shipping. The development of naval ordnance.

MAY 24.—The new British cruiser, *Terrible*.

This is the largest, and claimed to be the most powerful cruiser yet constructed.

The following are the dimensions:

Length between perpendiculars	500 feet
Length, over all	538 feet
Breadth	71 feet
Depth to upper deck	43 ft 4 in
Weight of hull and armor	8480 tons
Draught (loaded)	27 feet.
Total displacement	14250 tons
Coal capacity	3000 tons
Indicated horse power (natural draught)	25000
Speed	22 knots

Armament; Two 9.2-inch 22 ton breech-loading guns; twelve 6-inch, and thirty smaller guns.

JULY 5.—The rotation of the earth, Foucault's experiment. The International Railway Congress. Distilling apparatus on H. M. Cruiser *Terrible*. Steam engine trials. Drainage in the fens. Locomotive piston-rods.

Engineering Review.

(29 *Great George Street, London, S. W., England. Monthly. Price single copy* 7½*d.*)

APRIL.—The North Sea and Baltic ship canal.

The new canal has been constructed by Germany chiefly for military or strategic purposes. A map accompanies this article, and the importance of the undertaking will readily be understood by a glance at it. Hitherto the part of Germany now intersected by the canal has been cut in two by the Cimbrian Peninsula, so that communication could only be opened by the narrow Danish straits, likely enough to be closed in time of war. Now the German navy will be able to proceed from the North Sea to the Baltic by the new waterway in a very short space of time.

Wire ropes and cables. The manufacture and qualities of manganese steel (R. A. Hadfield).

JUNE 20.—Economy of locomotive working and maintenance. Development of the Crewe system of compounding locomotives. The development of the locomotive. Pullman cars, past and present. Electric locomotives and railways.

Aldershot Military Society.

(*Gale & Polden, 2 Amen Corner, Paternoster Row, London, England. Single copy* 6*d.*)

FEBRUARY 26.—Field fortification as applied to modern conditions of war (Lieut. Col. G. S. Clarke).

MARCH 26.—Lessons to be learnt from small wars since 1870 (Captain C. E. Callwell).

Arms and Explosives.

(*Effingham House, Arundel Street, Strand, London, W. C., England. Monthly. Per year* 7 *s. Single copies* 6*d.*)

APRIL.—The Schultz gunpowder factory. The pistols bill. Magazines and stores.

MAY.—Recoil and velocity. Carriage of explosives.

JUNE.—Report of H.M. inspectors of explosives for 1894. The E. C. powder works and the testing of powders.

United Service Gazette.

(4-6 *Catherine St., Strand, London, W. C., England. Weekly. Per year, £1 10s 6d. Single copies 6d.*)

APRIL 6.—Cavalry maneuvers. Institution of naval architects. Our strategic position in the Mediterranean. Tne modern role of cavalry.

APRIL 13.—Field firing at Poonah. Warship construction. The affording of military aid to the civil power. Grievances of army doctors. War mobilization of the home army. Commissions in the army. Torpedo destroyers. The recent fight on the Niger.

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APRIL 27.—The strategic importance of the Baltic canal. The Chitral expedition. Launch of war vessels. The navy as the empire's representative. The *Times* and the war office. Militia rifle association.

MAY 4.—Training of the infantry militia. Navy boiler of the future. Chitral expedition. Cavalry reconaissance.

MAY 11.—The Japanese navy. The royal naval reserve.

MAY 18.—Shipbuilding policy. Relations between guns and cavalry.

JUNE 1.—Reorganization of the military of New South Wales.

JUNE 8.—The objects of the navy league. The hydrographer's report for 1894. The second division at the battle of Tel-el-Kebir.

JUNE 15.—The effect of war on our mercantile marine. Commerce protection in war time.

JUNE 22.—The imminence of war. Military reforms.

JUNE 29.—Water tube boilers. The mountain artilleries of France and Italy. The action in the Malakand Pass. Parliament and the defense of the country. Our own and foreign warships.

Journal of the Royal United Service Institution.

(17 *Great George Street, London, S. W., England. Monthly. Single number one shilling.*)

APRIL.—Sir George Rooke, Admiral of the Fleet. The most recent developments for crossing rivers and landing troops. Hydraulic gun mounts of French ships.

MAY.—Landing on an enemy's coast. Field artillery fire and Okehampton Experiences. Practical hints on the working and use of Maxim guns.

JUNE.—Cavalry maneuvers. The Antarctic expedition from a naval point of view.

Army and Navy Gazette.

(3 *York Street, Covent Garden, London, England. Weekly. Per year* £1 12*s* 6*d. Single copy* 6*d.*)

APRIL 6.—The health of the soldier. The question of displacement. Biserta: A thorn in our side. Institution of naval architects. The growth of the armor clad. The Chitral expedition. The Indian frontier. Colonel French on cavalry. The French army in 1870-71.

APRIL 13.—The position in Chitral. The North Sea and Baltic canal. The proposed Antarctic expedition. China and Japan.

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APRIL 28.—The command of the army. Water tube boilers. An arrow in the air. Chitral. A grand canard.

MAY 4.—Cavalry organization and training. Development of the cruising ship. The infantry militia. The Chitral expedition. Cavairy reconnaissance.

MAY 11.—Chitral. Position finders.

MAY 18.—The Italian army. Bilge keels and battleships. Chitral notes.

MAY 25.—Cavalry reconnaissance. Army and navy notes.

JUNE 1.—Naval ordnance.

JUNE 8.—Lord Wolseley and Sir E. Hamley. National naval education.

JUNE 15.—The war office and its critics. The Russians in the Pacific.

JUNE 22.—The naval festival at Kiel.

JUNE 29.—Sir E. Hamley and Lord Wolseley. Naval administration. The Duke of Cambridge and the government.

Journal of the Military Service Institution.

(*Governor's Island, N. Y. City. Bi-monthly. Per year* $4.00. *Single copy* 75 *cts.*)

JULY.—Discipline (first honorable mention, Lieutenant Steele). An antiquated artillery organization (Captain Wagner). Martial law and social order (Captain Chester). Recruiting and training of the company (Lieutenant Miller). Our artillery in the Mexican War (Lieutenant Van Deusen). A technical criticism (Lieut. Brooks).

The Proceedings of the U. S. Naval Institute.

NO. 71.—Naval Department organization. The manufacture of heavy ordnance and armor, their ballistics and resistance. Orders and signals of the Venetian fleet commanded by Mr. Jas. Dolfin, A. D. 1365. The dygogram, its construction, description and use. Naval ordnance. Changes in the battle exercises of the French infantry. Professional notes.

NO. 72.—The wreck of the *Kearsarge*. The gun in naval warfare.

An analytical discussion of the old and new conditions in naval warfare in which the differences between them is brought out. The influence of smoke, rapid firing and heavy guns are considered. The writer takes up the questions of 1. Concentrated broadside fire. 2. Concentrated fire at will. 3. Successive firing. 4. Firing at will.

Ancient naval warfare. Electric search lights at sea. Electric firing on board ship: electric primers and firing attachments.

This paper relates to the details of electric primers, necessary batteries and other electric apparatus which is used in prompt and efficient application of electricity to firing heavy guns on ship-board. Illustrations of the primers are given. Electric firing apparatus has been attached to all the 4″ and 5″ rapid firing guns.

Messenger pigeon service in connection with coast defense.

Relates to experiments already made, combats the idea that the homing pigeons in the country will be available, and urges the commencement of a systematic training of pigeons without delay for special use over water.

The naval war college.

Address delivered to the class at the naval war college upon the closing session of 1894, by Captain H. C. Taylor, U. S. N., president of the war college.

The Engineering News.

(*Tribune Building, New York City. Weekly. Per year* $5.00. *Single copies*, 15 *cents*).

April 4.—Portable wood preserving apparatus. Southern Pacific railway. Automatic block system and electro-mechanical slot. The Perkins surface heater for repairing asphalt pavements. Engineering schools in Germany. An experiment on the friction of water in a 21 m. main. Concerning the Nicaragua canal, and Darien canal routes. Folding beam compass.

April 11.—Method of determining the supply from a given water-shed. The jurisdiction of the Secretary of War over navigable rivers. Water power development with electric transmission—Folsom, California. Growth of the traffic through the St. Mary's Falls Canal. Mexican International Exhibition for 1896. The pneumatic telegraph in Paris.

April 18.—Standard tests of paving brick. Preservation of iron structures exposed to weather. Effect of fire on steel beams.

April 25.—The erection of bridges. Notes on soft steel for bridges.

May 2.—The effect of freezing on cement and mortar. Stand pipe accidents and failures. On the location of the Nicaragua canal. Sewage purification in America. Legal electrical units in the United States.

May 9.—A twelve wheel locomotive for the Southern Pacific railway. An instance of the value of state topographical surveys. A French aluminum torpedo boat. The free and promiscuous distribution of government publications. Experiments with Australian hard wood pavements. To find the moment of inertia of rolled sections of varying size.

May 16.—The Chicago main drainage channel. Standard connections for rolled beams. The friction of wood upon wood. Efficiency of compound locomotives.

May 23.—The new water supply of Atlanta.

May 30.—The construction of Fort Ethan Allen, Vt. Rise and progress of river and harbor improvements in the United States.

June 6.—Painting iron railway bridges.

JUNE 13.—Tank locomotives for the Brooklyn bridge. The Hussey delivering dredge. Chicago main drainage channel.

JUNE 20.—The Harlem ship canal. The Kiel canal.

JUNE 27.—Forty-ton self-propelling crane for the Mare Island Navy Yard. The prevention of boiler explosions.

JULY 4.—The new Brooklyn terminal station of the Brooklyn bridge. A piece-rate system of paying for labor. The Warrington steam shovel. Steam pipe explosion of the Lake steamer *Christopher Columbus*. Commercial education in Europe. The meaning of elastic limit in steel specifications. Detroit meeting of the American society of mechanical engineers.

American Engineer and Railroad Journal.

(47 *Cedar Street, New York City. Monthly. Per year* $3.00. *Single copy* 25 *cts.*)

MAY.—Eight wheeled coupled "Goods" locomotive. Electric weed-killer. Freight engine for the Mexican railway meeting of mechanical engineers. New torpedo boats. Trial of a Schmidt motor (boiler super-heater and compound engine). Some facts relating to certain types of water-tube boilers. The great Siberian railway. Taps for cutting threads for staying bolts. Yard arrangements along heavy traffic high-speed railroads. Superheated steam in electric light stations. Naval lessons from the war. Water tube boilers.

JUNE.—Coal storage at Port Richmond, Philadelphia (illustrated). Water tube boilers. Express locomotive of Hanover. Efficiency of compound locomotives. The curve of least resistance in water and air. Aeronautics (a variety of interesting matter relating to aerial navigation).

JULY.—The steamship *St. Louis*. Boilers and vessels of war. Air pump for the United States battleship *Texas*. Aeronautics.

The Iron Age.

(96–102 *Reade Street, New York City. Weekly. Per year* $4.50. *Single copy* 10 *cts.*)

APRIL 4.—Application of the electric arc to machinery repairs. Standard tests of iron and steel. The history of iron. H. S. Maxim on English labor. Standard analysis of steel. The Grant machine for grinding balls.

APRIL 11.—Testing fire brick. New types of air compressors.

Melting gray iron with natural gas. Specifications for structural steel. Nickel and nickel steel.

MAY 2.—The McDonald electrically operated clutch. Captain Eardley Wilmot on the United States navy. Aluminum for torpedo boats.

MAY 23.—Traveler used on Park Avenue viaduct.

MAY 30.—Notes on soft steel for bridges. Nickel-plating cast-iron.

JUNE 6.—Meteoric iron in Mexico. The new European ship canals (Corinth, Manchester and Kiel).

JUNE 13.—Centrifugal pumps for United States dry docks. The new Savage hammerless repeating rifle.

JUNE 20.—The Harlem River ship canal, New York. Seagoing torpedo-boats.

JULY 4.—The mechanical engineers at Detroit.

JULY 11.—Electro-hydraulic overhead travelling crane.

Engineering and Mining Journal.

(253 *Broadway, New York City. Weekly. Per year* $5.00. *Single copy* 15 *cts.*)

APRIL 6.—Who first liquefied air? Mineral industry. Mineral productions in Ontario in 1894. Electric lamps in coal mines. Silver mining and smelting in China. The desulphurization of liquid pig-iron. Liquefaction of gases.

APRIL 13.—The hardening of steel.

APRIL 27.—Method of determining chromium in chrome ore.

MAY 4.—Changes at the United States mints. The Broken Hill silver mines. Copper production of the United States in 1894. Interesting cases of abnormal condition in pig-iron. Improvements in quarrying machinery. Production of pig-iron in Great Britain in 1894.

MAY 11.—Mining industry of Bolivia.

MAY 18.—Silicon in cast-iron.

MAY 25.—The validity of nickel-steel patents.

JUNE 1.—Mineral and metal production of the United States in 1893-94.

JULY 6.—The micro-metallography of iron.

Electrical Engineer.

(203 *Broadway, New York City. Weekly. Per year* $5.00. *Single copy* 10 *cts.*)

April 10.—Fiske's range finder. The Rushmore and Huntington search lights.

Public Opinion.

(*Washington, D. C. Weekly. Per year,* $2.50 *Single copies,* 25 *cents*).

April 4.—The Anglo-French war cloud. Honoring Bismarck. The question of Alsace-Lorraine. The Hovas and their government. The stars and what they are made of. How to fight microbes. American iron-products in Canada.

April 11.—Australian federation. France and England.

April 18.—England should abandon the Mediterranean. England and the Nicaragua canal. The Chinese side. The truth about the battle of New Orleans.

May 2.—Nicaragua, Great Britain and the United States. The United States, England and the far east. Hawaii and Japan. The railroads of China. A great engineering project in Holland.

The Army and Navy Journal.

(*Bennett Building, New York City. Weekly. Per year* $6.00. *Single copy* 15 *cts.*)

April 6.—Assignment of cadets. Army equipments proposed. On the cruiser *Chicago*.

April 13.—New army cap and blouse. Military spirit in France. The spirit of militarism. For battleships.

April 27.—Transportation during the strikes. Advantages of double turret modern warships. The Chinese surrender. Tests of armor plates.

May 4.—Changes in department commanders. Army uniforms. Hints for militiamen.

May 18.—Krag-Jörgensen rifle.

June 1.—Soldiers' homes. The new battleships. Naval display at Kiel.

June 29.—The post exchange (from a medical standpoint). Testing the Fiske and Lewis position finders. The new torpedo boats.

American Manufacturer.

(*Pittsburg, Pa. Weekly. Per year*, $5.00. *Single copies*, 10 *cents*).

APRIL 5.—Improvement in wire rolling. Steel castings. Mechanical cleaning of glass. Best armor-plate ever made.

APRIL 26.—British iron and steel exports to the United States.

MAY 24.—American iron and steel production in 1894.

JUNE 7.—Manufacture of steel projectiles in Russia.

The Scientific American.

(361 *Broadway, New York City. Weekly. Per year* $3.00. *Single copy* 10 *cts.*)

APRIL 20.—The Sandy Hook mortar battery. Cost of torpedo boat destroyers.

APRIL 27.—New American torpedo-boats. Hadfield's projectiles. Naval carrier pigeons. Electrical appliances in the Japanese war.

MAY 18.—The marine gasoline engine and gas engine boat.

JUNE 8.—The U. S. battleship *Oregon*.

JUNE 15.—The Chicago drainage canal. Torpedo-boat for the ship *Maine*.

JUNE 22.—The new British cruiser *Terrible*. The North Sea canal.

JULY 6.—Recent tests of position-finders at Fort Hamilton. The annealing of armor plates by electricity. Tests of the Maxim gun.

Cassier's Magazine.

(*World Building, New York City, and* 33 *Bedford St., Strand, London, W. C., England. Monthly. Per year*, $3.00. *Single copies* 25 *cents*).

APRIL.—Some features of the inventive career of Hiram S. Maxim. The legal aspects of Electrolysis. Large guns as magnets. The first three high roll train. The mechanical equipment of power stations. More engineering fallacies. Corrosion of boilers and steamship pressure gauges. The American beet sugar industry. The installation of exhibits at the World's Fair of 1893.

MAY.—The telephone and its operation. Cast-iron water pipe. From an inspector's note book. Telegraphy as it used to be. Water works and stand pipes. Emery and emery wheel tests.

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A history of the telephone.

JUNE.—The care of steel ships, by Philip Hichborn, Chief Con
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machine tools at Niagara Falls.

SPECIAL NUMBER.—Niagara Falls Power Plant.

The Physical Review.

MAY-JUNE.—The capacity of electrolytic condensers. Therma
conductivity of copper. Chrystalline absorption. Resonance i
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Transactions East of Scotland Tactical Society, Session 1894-9

The Battle of Gravelotte and some tactical deductions there
from. Savage warfare. Outposts. Battle training of the thre
arms. Coast-defense. The strategy and tactics of the Corea
war. Hong Kong to Japan in a gunboat.

Journal of the American Society of Naval Engineers.

MAY.—Experiments on triple expansion pumping engine
Dryness of steam. Experiment on Cumberland coal. Mach
inery of British warships. Tubulous boilers in the French navy
Notes on warships, merchant steamers, and yachts.

Journal of Association of Engineering Societies.

APRIL.—The Chicago Sanitary District Canal (The Brighto
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JOURNAL

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VOL. IV. No. 4. OCTOBER 1895. WHOLE No. 17.

EXPERIMENTAL USE OF THE ESSICK PAGE PRINTING TELEGRAPH FOR TRANSMITTING INFORMATION IN SEA-COAST ARTILLERY FIRING 1895.

BY H. C. CARBAUGH, FIRST LIEUTENANT, FIFTH ARTILLERY, U. S. A.

The Essick instrument, by the aid of electricity to control its machinery, prints messages—on a sheet of paper five inches wide—and is operated, in a manner similar to a typewriter, so that the operator always has before him, in ordinary printed figures and alphabetical characters, an exact duplicate of what is being received at the several stations along the line.

The transmitter (shown in plate I) with the generator of electricity may be regarded as forming one part of the system and the receivers (one of which is shown in plate II) connected by line wire form another,—the telegraph line.

In our experimental use of the instruments a transmitter and a receiver were placed in each of two stations—A and H—about 1900 yards apart. Each pair was connected with another and separate pair in an intermediate or plotting station thus forming two independent systems or lines. The two pairs in the plotting station were united in one case. They required but one operator.

A gun circuit was also set up with two stations, each, having a receiver on a tripod. These receivers were connected in series with another receiver and a transmitter in the plotting station. As each transmitter must have its own source of electricity this arrangement gives five complete circuits, shown in Diagram I.

The construction of the instrument is such as to require about one-fourth of an ampere of current with which to be operated. It was decided to use a dynamo, running at a speed to give 70 volts electromotive force, for generating the required electricity. Each transmitter was accordingly connected with it by wire leading to a central switch-board, in the plotting house, to which the current from the dynamo was led.

The resistance of each circuit was then fixed at about 280 ohms, by adding thereto lamp resistance. This was necessary in order to give by the usual formula $c = \frac{E}{R}$, with the assumed 70 volts the required ¼ of an ampere for each circuit.

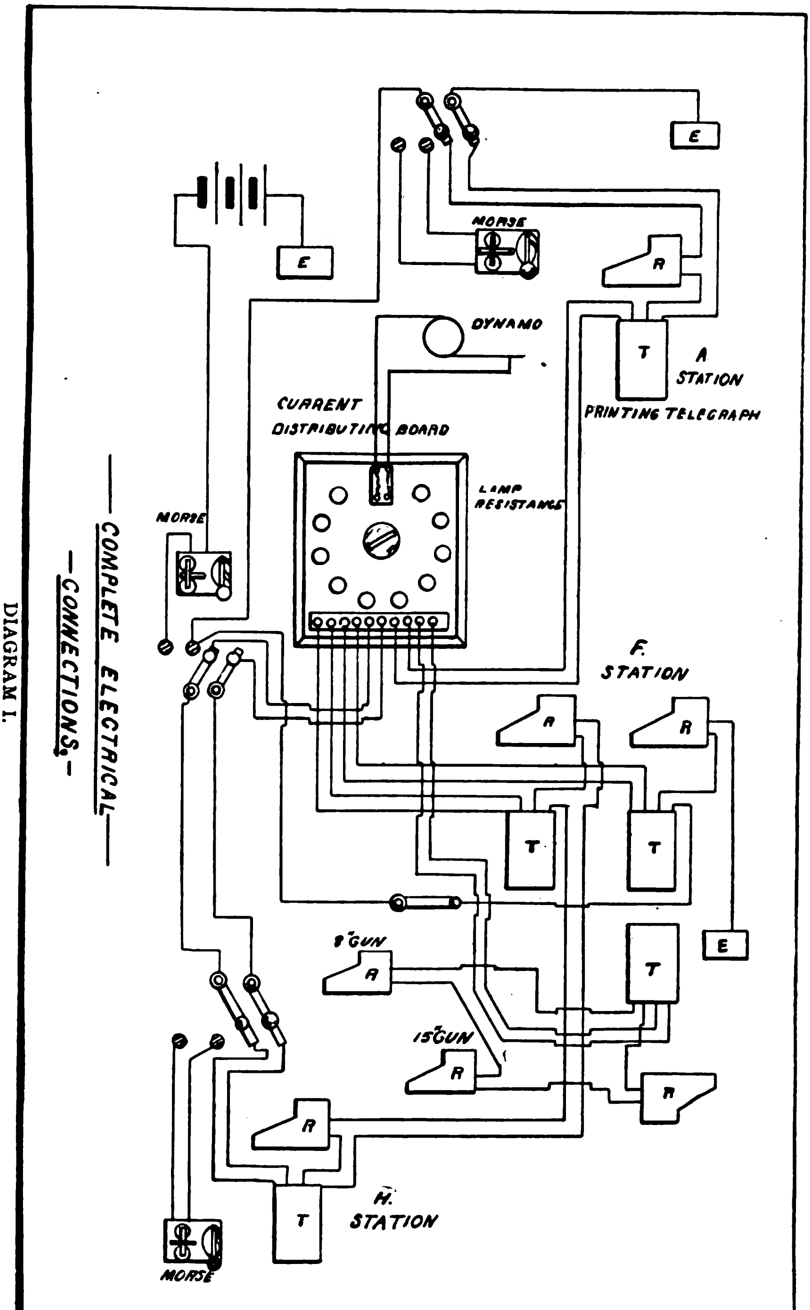
The resistance of a receiver is about 20 ohms and that of a transmitter about 10 ohms. The earth was used as a return line circuit from station "A" to the central switch-board but from "H" it was wire, to prevent short circuit.

The total resistance in ohms for each circuit was made up about as follows:

Power house to station "A"	circuit (wire)	45;	Instruments	50;	Lamps	185
Station "A" to Power house	"	115;	"	50;	"	115
Power house to station "H"	"	18;	"	50;	"	212
Station "H" to Power house	"	34;	"	50;	"	196
Gun circuit	"	12;	"	70;	"	198

The instruments were received at the Post on June 13th. They were unpacked, transported to the stations and their setting up begun on that day. The stations being in use for target practice, only a few hours at odd times between June 14th and June 22d could be devoted to getting the instruments in working order and in practicing the operators, who were enlisted men previously instructed in the use of the key-board but who were entirely unfamiliar with the practical use of the machines.

From June 22d to July 3d the instruments were in frequent use for transmitting angular readings in vessel tracking. During this time it was found that with ordinary observers and unskilled operators the angular readings could be taken, transmitted and



COMPLETE ELECTRICAL CONNECTIONS.

DIAGRAM I.

plotted at a rate to show consecutive positions of a moving vessel at intervals of 25 seconds. The rate being limited to this by the observers. Each angular reading could be transmitted in about 7 seconds and they came in simultaneously from the observing stations.

The following is a specimen of the printing:

E–BATTY 49 YDS OVER LINE SHOT

NEW RANGE 3524 YDS –

M–BATTY 2 YDS SHORT LINE SHOT

NEW RANGE –SAME–

On July 5th the instruments were used for transmitting information in actual target practice. They were so used on various days up to include July 23d. During this time no failure of the instruments can be recorded nor did any mishap occur save the breaking of several switch-handles—a defect already remedied. Several times, due to mishaps or misunderstandings in the power house, no current was supplied and the instruments could not be used. The instruments lay idle from July 17th to July 22d. On the latter date as soon as the current was turned on they worked well and continued to do so on that and the following day.

They were used during several thunder storms and rain storms. They were left in circuit several nights when thunder storms occurred, during which the lightning seemed to unsettle the permanent magnets to some extent.

The test of the instruments was under severe service conditions. Those in the plotting house were subjected to over one hundred shocks of discharge from 8″ and 15″ guns used in target practice. The plotting house being partly built on piles, its floor vibrates at each discharge of the gun sufficiently to throw a copper cent about half an inch from the floor.

Neither the instruments in the plotting house nor those at the guns were affected by the discharge, save that sometimes the paper was dislocated or the wires loosed in the binding posts.

The machinery of the receivers is in general well made but that of the transmitter seems inferior and even poorly made.

The construction of the instruments and the principles involved in their working theory may be understood from the following:

THE TRANSMITTER.

The object of the transmitter is to send out impulses of current—each in reverse direction to the next preceding or succeeding one, and to control the number sent out.

The essential parts are:

1. A pin-cylinder, seen in plate I, connected by the cog wheels on the right end with clock work, underneath and not visible, which causes the pin-cylinder to revolve when it is released.

2. A key-board having 37 keys as follows:

A unison key, the upper left hand one, to release the pin-cylinder and allow it to revolve indefinitely. *A space key,* blank, the lower left hand one, to stop the pin-cylinder at a blank point with which the printing mechanism of the receiver is brought into unison with it as a starting point or zero, *35 keys* bearing in all the 26 letters of the alphabet, the figures from 2 to 9 inclusive, and a dash.

The space key is usually down, when the current is on, in order to lock the pin-cylinder from revolving. If any other key is pressed down its lever arm, coming up under the pin-cylinder, pushes back a horizontal bar latch and releases the lever then up, and is itself in turn caught by the same latch and held until another key is pressed down. As soon as one lever is released and falls, the pin-cylinder begins to revolve and continues until another pin on it comes against the end of the ascending lever.

3. The pole changer or current reverser is operated by a small star wheel, with 18 cogs, situated on the left end of the pin-cylinder. This is seen in Diagram II. The star wheel necessarily causes the lever *L* to rise 18 times and fall 18 times while the pin-cylinder makes one complete revolution. This enables the current, by device marked *P. C.*, to be broken and reversed 36 times during the revolution of the pin-cylinder thus giving 36 impulses of current.

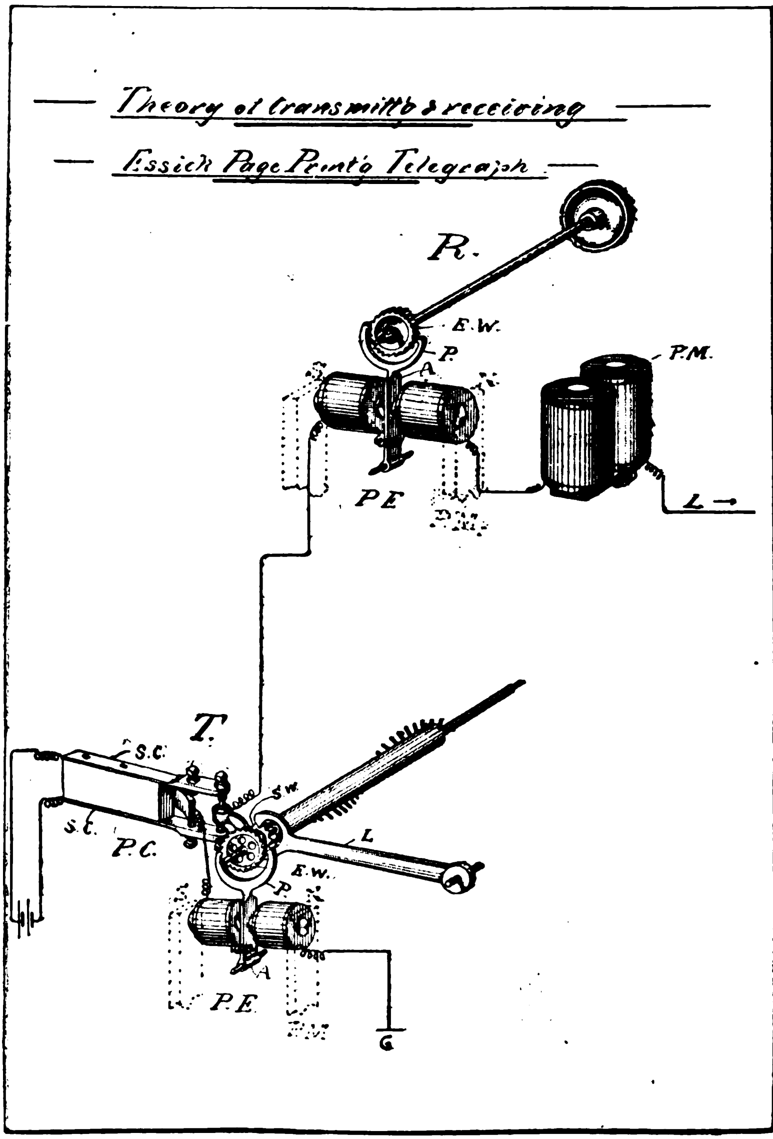

Theory of transmittg & receiving
Essick Page Printg Telegraph
R.
E.W.
P
A
P.M.
PE
L
T.
S.C.
S.W.
S.C.
P.C.
L
E.W.
P
A
P.E.
G

DIAGRAM II.

There being 36 character keys, including the space key, on the key-board each character corresponds to a different number of impulses, from 1 to 36, sent out. It will be seen later in the receiver how the proper number of impulses is made to release a type-wheel which revolves sufficiently to cause to be printed the same character that has been pressed down in the transmitter. The horse-shoe magnets on the left of the transmitter, together with their armature and the escapement wheel on the end of the pin-cylinder, might be omitted as non-essential. They were introduced in the original machine to make it work, as was then believed, more perfectly with the receivers but they will doubtless be omitted in the future. The working of the pole changer is shown in Diagram II. *T* is the transmitter and *R* is the receiver. The transmitting pin-cylinder is governed in its rotation by the polarized escapement *P. E.*, the escape wheel, *e. w.*, and the pole changer, *P. C.* The first two devices named, have their duplicates in construction and motion in the receiver, hence any motion in the pin-cylinder of the transmitter will be exactly duplicated by the type-wheel shaft of the receiver.

The spring clips, *s. c.* of the pole changer, insulated from each other, are the terminals of the battery, hence one is positive and the other negative. The star-wheel, *s w*, causes the lever, *L*, to rise and fall, thus bringing the two clips alternately in contact with the lever, *L*, to which the line wire is attached, hence reversing the current through the line. These reversals in turn pass through the coils of the polarized escapements in the transmitter and receiver, whose coils are already polarized by the permanent magnets, *P M*, therefore a current in one direction increases the strength of the magnetism on one side and neutralizes it on the other.

The escapement armatures are therefore drawn back and forth, vibrate, thus allowing the escapement wheels to move forward step by step under the turning action of the clock work attached to each shaft on which the escape wheels are mounted.

THE RECEIVER.

The essential parts of the receiver are:

I. A type-wheel, with rotating power attached to it, seen in plate II, and marked *R* in Diagram II. The armature on the left, being moved back and forth by the magnets seen there, releases the type-wheel shaft and allows it, as before said, to revolve step by step. The number of steps taken is determined by and equal to the number of impulses of current sent out by the transmitter because each step is effected by one impulse. The escapement wheel on the type-wheel shaft having 36 cogs, will make one complete revolution if released 36 times by as many impulses from the transmitter.

The paper carriage moves horizontally from right to left by clockwork. It is checked at each step that the type-wheel takes in order that a small hammer may strike the paper against the character opposite to it on the type-wheel. When the carriage has been moved to the extreme left as shown in plate II, the operator depresses the unison key in the transmitter. This brings into play a device for drawing the carriage back to the extreme right, whereupon the paper is fed upward a short distance for a new line of printed matter.

The type-wheel in the receiver stops with its blank space opposite the paper where the *unison key* is pressed down, but the pin-cylinder of the transmitter continues to revolve. If the space-key, blank, be now pressed down the pin-cylinder must stop, and as both the transmitter and receiver are at *blanks* they are in unison. The type-wheel has the same characters on it that are on the key-board.

If any character on the key-board is pressed down its corresponding number of impulses will be sent out and the type-wheel shaft will be released the same number of times and move forward far enough to bring the same character of the type-wheel opposite to the paper which is then struck by the little hammer and receives the imprint.

ADJUSTING AND OPERATING THE INSTRUMENTS.

A primary adjustment is made when the instruments are being set up. It has for its object to get the transmitter and receiver to work in unison.

The operating adjustment has for its object to keep the printing mechanism under control of the current impulses sent out

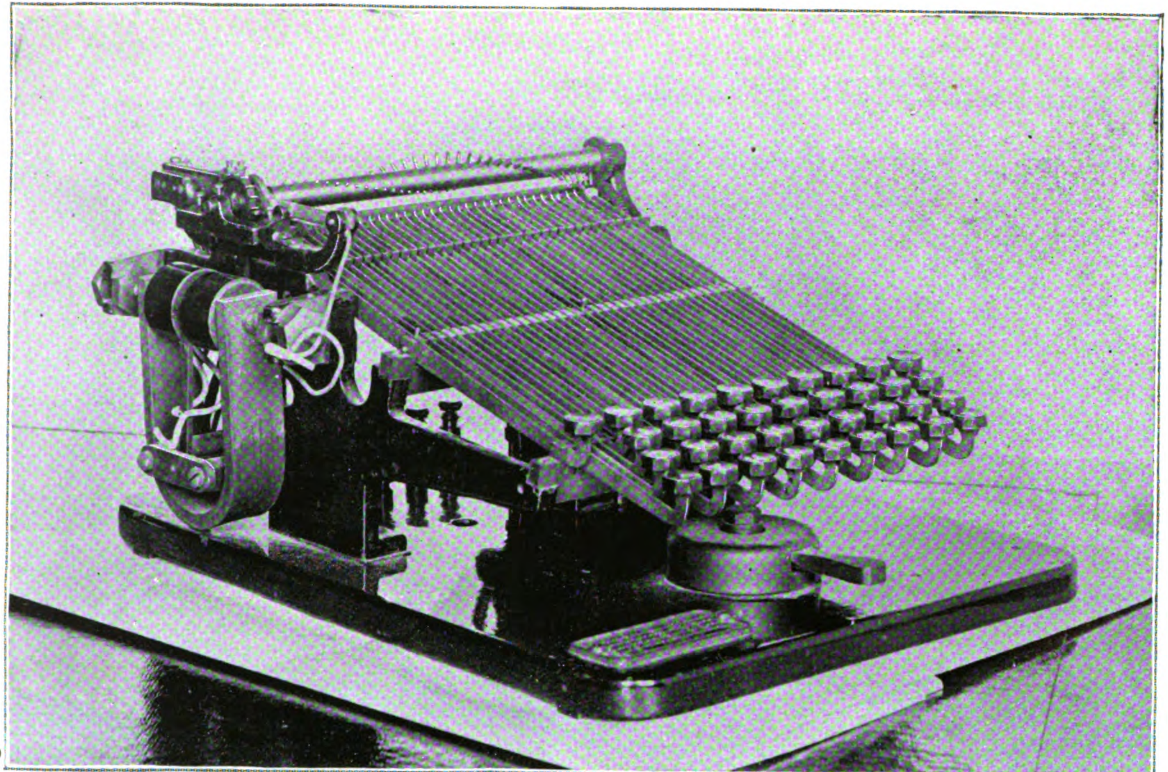


PLATE I. — Transmitter.

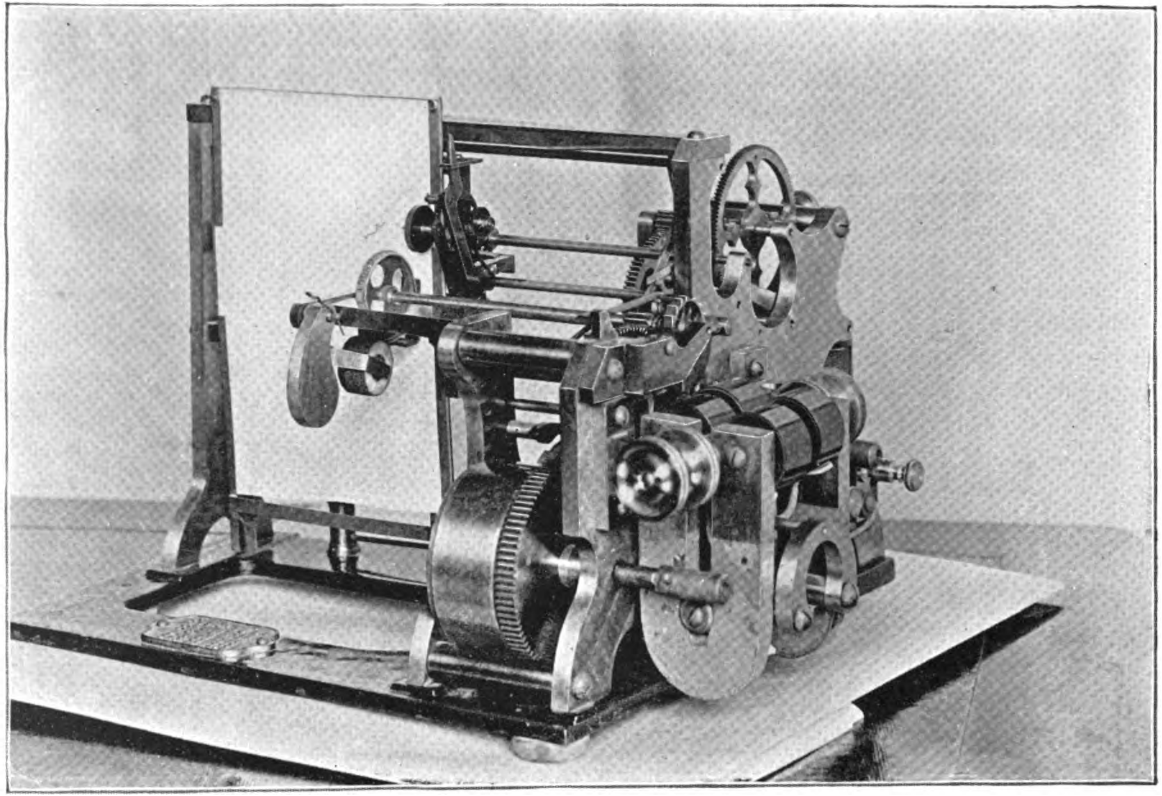


PLATE II. — Receiver.

and is especially necessary where the current varies in strength from day to day.

The primary adjustment is effected by an accurate setting of the star-wheel, by causing complete and uniform break of current by the pole changer, and by adjustment of the permanent magnets to secure uniform vibrations of the armatures of the escapements.

The operating adjustment is made by loosening or tightening a tension screw which governs the releasing of the carriage. If the paper carriage stops the tension is too tight, if it runs so as to throw in and print extra letters the tension is too loose. In addition all clock work must be kept wound up.

The switch on the base of the transmitter is always kept to the right when not actually sending a message. The transmitter is then out of circuit, but the receiver is ready for receiving. To send a message, the switch is thrown to the left and the unison key is pressed down. When the carriage has dropped back to the extreme right and the type wheel has stopped, the space-key is pressed down to stop the pin-cylinder and to bring the transmitter and receivers in unison.

Each letter of the message is now pressed down in succession on the key-board, giving due regard to spacing between words and to new lines.

Each letter must have sufficient interval of time for being printed—this is indicated by a distinct click of the printing mechanism. A gravity ink roller supplies the type-wheel with ink. The rate of sending is about 25 words a minute for a skilled operator. In a new design now being made this rate is believed to be increased to about 45 words per minute.

CONCLUSIONS AS TO THE INSTRUMENTS.

I. The primary adjustments are reasonably permanent and reliable, as the instruments have shown themselves ready at all times for over a month under severe military service conditions.

II. The messages are certain, for if the primary adjustment is out or the operator fails to keep his instruments in unison the message will be entirely unintelligible. If anything intelligible is being received it is sure to be what is being sent.

III. They are capable of being set up and primarily adjusted by an intelligent person who has been properly instructed. Any trouble can be traced out as to its cause with reasonable certainty.

IV. They can be operated and kept in operating adjustment by an operator of ordinary intelligence.

V. The receiver is capable of being reduced in size by having the type-wheel move horizontally instead of having the paper move.

The transmitter could also be reduced in size and both thereby be made more convenient, As now made they are too large for military purposes.

VI. Many parts of both the receiver and transmitter have rusted due to the failure of the maker to lacquer, blue or highly polish iron or steel parts.

VII. The transmitter makes a grinding or burring sound which is somewhat irritating, but not loud enough to interfere with conversation carried on around it.

NOTES ON CONFEDERATE ARTILLERY SERVICE.

By Professor M. W. HUMPHREYS, University of Virginia.

The following article is based almost exclusively on my own observations while serving in the Confederate artillery. A diary kept by me with considerable care during the war furnishes most of the facts cited, and the act of writing a synopsis of events from day to day presumably impressed upon my memory other facts not recorded in the diary. As a further precaution against errors of memory or misinterpretation of events, I have carefully and repeatedly studied the official reports of all the actions concerned, and the Memoirs of the commanders under whom and against whom I served. Many of the official reports, I am sorry to have to say, appear to have been intended as temporary "war measures," and they have to be compared with each other and carefully scrutinized, to obtain from them the uncolored facts; and sometimes they remain absolutely irreconcilable. If, therefore, the facts narrated here do not agree with the recollections of any reader, I trust he will accept the assurance that I have told the truth to the best of my ability.

An article published in this *Journal* (Vol. II, No. 4) was devoted to the experiences of the Confederate artillery in trying to learn how to hit. In the present paper it is assumed that the organization and equipment is satisfactory, that the gunners understand their duty, and that there is no obstacle to posting guns at any desired point; and the question considered is: *How should the guns be disposed with reference to each other?*

Since it is not my purpose to discuss the question in general, but to give the experiences that came more or less directly under my own observation, any value the paper might possess is diminished by the fact that the battery to which I belonged usually served with detached commands, and was not incorporated into a large army until 1864, when it took part in the Valley campaign under General Early. Even this army can hardly be called a large one, as it was really much smaller than some of our historians represent; but the number of cannon was perhaps large enough to justify an examination of the use made of them in that campaign. I shall not scrupulously avoid casual allusions to events that I did not witness, nor general remarks based upon our experiences.

The only question treated in this article is, whether the policy should be to mass the artillery or distribute it. Between the two extremes of massing it all at one place and distributing it along the whole line, there are many possibilities, and it will rarely, if ever, happen that either extreme is either practical or wise. I have never seen either adopted, though I have seen all the *available* guns, in case of emergency, suddenly massed at one point. It is now, I believe, a generally recognized principle that, in so far as it is practicable, artillery should be massed; but the "practicable" here is complex. It may be very easy to mass the artillery at a point where it will be rendered useless by an unexpected turn in the battle.

The first case I shall cite illustrates the last mentioned fact. At the opening of the great campaign of 1864, the Federal plan was to penetrate to Lee's rear through the Valley and West Virginia. One column, numbering over 6,000 men, with 12 pieces of artillery was approaching Dublin Depot in South West Virginia. A Confederate force of about 2,500 men with 10 pieces of artillery undertook to check their advance. The result was the very sanginary battle of Cloyd's Farm (or Mountain) on the 9th of May. The Confederates were drawn up on some hills, separated by a small valley from the eastern base of the mountain. The artillery was practically all massed on the left, commanding the defile in the mountain. It succeeded admirably in keeping the Federal batteries silent at first and even in disorganizing infantry that attempted to advance; but a double line struck the attenuated Confederate right, flanking and pressing it back, and the attempt to bring artillery to its support was utterly disastrous. The attempt not only failed to bring more than two guns into action on the right, but released the Federal batteries opposite the Confederate left and enabled the Federal infantry to turn that flank also, the Confederate infantry having been withdrawn from the left. On this occasion it certainly would have been better if half our artillery had been on each flank. It is, at the same time, true, that if our guns had been placed forward on the brow of the hills, so as to prevent the assailants from taking shelter in front of our guns or of the infantry which (as we actually stood) was 400 yards in front of us and on our right, we could readily have repelled the attack. I have carefully examined this battle field during the present year, and am confident that our artillery could easily have been made to win the day in spite of the great odds and the determined courage of the Federals. If any one will examine the official reports of this battle, he will see that this opinion is not an idle speculation. The number of guns employed here was so small that the affair scarcely throws any light upon the subject of massing; but as bearing upon the more general subject of the proper use of artillery, it may be worth while to remark that the defeat of the Confederates here led to the most serious embarrassment, and modified the whole campaign in Virginia. To pursue this aspect of the case further would not be appropriate here.

On the day after the battle just named, there was a lively artillery duel at New River Bridge. The river was between the opposing batteries. There were 12 guns on each side. The Confederate guns were in one compact park, the Federal somewhat dispersed. The former were on a hill, bare of trees and sloping from us towards the river, the latter on the much higher brow of the bluffs on the other side, about 800 yards distant. Both parties held their posts firmly, and every effort of the Federals to burn the bridge was frustrated until, after four or five hours of rapid firing, the Confederate ammunition became exhausted, and the guns were withdrawn. This was a case where, it seemed to me, no advantage was derived from the proximity of our guns to each other; but the affair, though very noisy, was more like a friendly athletic contest then a battle, and resulted in few casualties. Perhaps it is a waste of space to allude to it.

At the battle of Piedmont on June the 5th, the Federal artillery was practically massed, while the Confederate was separated into three batteries, one of which was far to the right and rear of the rest. After a very bloody conflict of seven hours, the Confederates were driven from the field by a movement upon the right flank of their left wing,—so far was the right wing drawn up to the rear of the left. The effect of the artillery fire concentrated at close range upon our left wing had been very deadly, but the men had endured it. The disposition of our guns in this battle was so bad that it would be waste of time to study it and its effects.

At Lynchburg on the 18th of June a considerable number of Federal guns,—perhaps 12 or more,—moved up quite close to the redoubts at the Confederate centre, and seemed to be silencing two batteries posted there, when Bryan's battery (with which I served) was moved, under cover of a hill, to a point in line with, and some 800 yards from the right flank of the Federal guns. In the duel that ensued we had decidedly the best of it, and were permitted to entrench our position without further molestation. In this case the fact that the Federal guns were somewhat massed was a decided disadvantage; but perhaps the error consisted rather in allowing us to plant a battery on the flank, than in massing the artillery.

At Lynchburg we were incorporated into the Army of the Valley, commanded by General Early. The batteries, including Bryan's, after this regularly had 4 pieces of the same sort, which were either Napoleons or 3-inch rifles, with rare exceptions. The batteries were organized into battalions of three batteries each, commanded by a field-officer and attached to a division of infantry, the entire artillery force being under a Chief of Artillery, with the rank of Brigadier General, though a Colonel acted in this capacity during most of the campaign. The artillery was theoretically subject to orders only from its own officers and the commander of the department, but practically a request from the commander of the division to which a battalion was attached had the weight of an order so far as that battalion was concerned.

Of the many battles in which this army was engaged, the first in which the question of massing artillery was strikingly concerned, was that fought at Winchester, on September the 19th. Though there was some fighting almost daily and we were, in a general way, prepared for a battle at any time, still the sudden onset of the Federal army on that day was something in the nature of a surprise, and the Confederate forces were not well in hand when it began. Consequently our dispositions were made, not according to any plan, but as developing circumstances rendered necessary, and the battle was rather spasmodic and confused; but still a careful study of it would illustrate the great capabilities of artillery. Such a study would require much space, and should be made by an expert. I shall, without giving even a general account of the battle, direct attention to two or three occurrences bearing upon the subject under discussion.

Early's army included (besides cavalry and artillery attached to it) the divisions of Ramseur, Rodes, Gordon, and Wharton, and the artillery battalions of Nelson, Braxton, and King. The numbers were so reduced that divisions were not larger than full brigades; but in the artillery the number of guns, four to the battery, had been maintained, and though many of them were served by incomplete detachments, still, as the pieces were all light, the service was efficient. Consequently there was more than the usual allowance of artillery and the importance of that arm was proportionably great.

On the extreme right of what became our line of battle, and considerably to the front of the rest of our irregularly encamped army, Ramseur's division with Nelson's artillery battalion was vigorously assailed early in the morning. Gordon came up and formed to the left and rear of Ramseur, and Rodes was filling the gap between, when it was observed that a heavy mass of Federal troops was moving in column across the front of Gordon and Rodes to attack Ramseur's left flank. Wharton's division and King's artillery were still remote. Early ordered Gordon and Rodes to strike the passing column with full force. This was done with almost complete success: the Federal column, struck on the right, was hurled to the left (that is, to the rear of the line of battle) in some confusion and pressed back, until Gordon's left became exposed to the overlapping part of the Federal column, and Evan's brigade gave way in turn and was pressed back through a grove. This disaster to the Confederates seemed irretrievable, and would have been hopelessly so but for the fact that the greater part of Braxton's artillery battalion was massed behind this grove. On emerging from the woods the defeated brigade passed over the artillery. When the field was clear the pursuing Federals were found emerging from the woods within close musket range of the guns, and rapidly advancing. The artillery opened with a rapid fire, at first of canister, and drove back in confusion that victorious column. All this was done in a few minutes; and the advantage previously gained by the Confederates was again pressed until the sixth and nineteenth corps of the Federal army seemed to have been disposed of for the day. The presence of this artillery at the right time and place was in a measure accidental; but that fact does not render the episode less instructive. It is also true that, if the Federals had pressed on regardless of consequences, the guns would have been seized and the day won, and that too, probably, with less loss than was sustained while falling back before the guns ; but no one can question the courage of those men, and what they did, other soldiers are likely to do under similar circumstances.

For several hours the above named three divisions of infantry and two battalions of artillery kept up a lively skirmish and repelled some more or less serious advances, while efforts were being made to bring up the rest of the army for a general assault. In the meanwhile, far to the left, Wharton's division, with some cavalry and King's artillery, had been involved in a complicated series of conflicts with the Federal cavalry, which formed an important and powerful part of Sheridan's army, and was well supported by artillery. The object of this fighting on the part of the Confederates was not so much to repel the cavalry, as to extricate itself from the entanglement and move to the right so as to join the main line and take part in a general attack on Crook's intact corps before the other two corps could recover from the shock they had suffered. The persistent fighting and repeated charges of the Federal cavalry, who probably thought we were gradually giving way, delayed the movement till it was perhaps 2 p. m. when it was at last effected, and that too, only partially. One battery had expended all its ammunition and gone to the rear, while one brigade of infantry and two guns of Bryan's battery had to remain on the flank. Chapman's battery (four

Napoleons) and two guns (3-inch rifles) of Bryan's battery accompanied the two remaining brigades of infantry to the main line. The infantry was posted in rear of the centre. In the meantime Crook's corps and the cavalry divisions of Merritt and Averell had prepared to attack our left front, flank, and rear. I take from my diary, with slight verbal changes, the account of the next half-hour, written on the following day. "Chapman's battery and the first and third guns of Bryan's battery moved into the space between Nelson's and Braxton's battalions,—Nelson on the right and Braxton on the left. * * * Our lines were now contracted until the army was one solid line of battle [?]. The line formed a gentle curve around the east and north of Winchester, a few hundred yards from the town. Bryan's two guns were in position on the left of Nelson's battalion, and Chapman's battery was advancing past us on the left in column of sections, when a tremendous yell began on our left and left rear. The divisions of Merritt and Averell had formed a junction and were charging on our left flank and penetrating to our rear. Our cavalry fled in wild confusion before the enemy, and abandoned to them the second gun of Bryan's battery. Terrible disorder followed this charge of the Federal cavalry. Wagons, ambulances, caissons, and supernumeraries fled in the wildest disorder into Winchester, and intermingled with this heterogeneous mass were to be seen fleeing cavalry-men, while ever onward rushed the blue cloud of Federals; and to add to the scene, Chapman's and Bryan's guns were faced to the rear, and moving rapidly in that direction a short distance, wheeled to the right at a gallop, thus confronting the enemy, who was by this time getting quite near. * * * As Chapman's battery came into action, which it did before Bryan's, as it was on the pivot of the wheel, General Breckinridge led out a column of infantry [to the rear of, and at right angles to the left wing] behind the artillery; and no sooner had the artillery opened and a line of infantry fifty yards long been formed, than the enemy retired". The movement of Breckinridge to the rear with Wharton's division was mistaken for a retreat by the rest of the army and in consequence the onset of Crook's corps, and the advance of the whole Federal line, were not firmly resisted. First Gordon's division gave way, and then the whole line except Wharton's men supporting King's artillery. Ramseur's division on the right fell back merely to keep in line with the rest, but was mistaken for a force of the enemy, and General Early ordered a retreat. The error was immediately discovered and the order countermanded, but, with the exception of Wharton's two brigades, at right angles to the left wing, very few men returned to the line. A bare skirmish line now remained with the artillery along the main front, and yet, in spite of repeated flank and rear charges of cavalry, constant pressure of infantry, and heavy fire of artillery, the position was held fully an hour, and then, many guns having exhausted their ammunition and left the field, the rest, drawn in still closer to the town, held back the Federal army another hour, giving time for the removal of all the trains and such of the wounded as could bear moving. It must have been 5 p.m. when, being flanked around the left of the perpendicular short line and almost hopelessly cut off, the artillery withdrew into Winchester, leaving behind only two pieces (whose horses were killed) in addition to the gun captured earlier in the day. The position was such during the last two hours of the battle, that the artillery had to cover three quadrants with its fire, and the number of men it was resisting must have amounted to 700 or 800 to each gun. Both our lines were exposed to a direct, a front oblique, an enfilading, and a rear oblique fire of artillery and musketry. The mortality, especially at the angle where the two lines joined, was, of course, very great; but, in battles, such things must sometimes be, and besides we inflicted equally heavy losses. There is no doubt that if our artillery had been so extended that the whole attacking force could get at us without forming uselessly and dangerously dense masses, we should have been overpowered in a few minutes. On the other hand, it must be conceded that if the intact corps had been on the Federal left or could have been transferred unseen to that wing, which overlapped the Confederate right about a mile and threatened the only line of retreat, a complete route of our army with the capture of all our guns, would have resulted from an attack such as was made on our left. It would seem unsafe, therefore, to conclude from this instance, that massing all the artillery at one point *necessarily* secures the best results.

We now come to the one instance in which I have seen artillery suddenly massed at a crisis, and the last case I shall cite. A preliminary remark seems necessary. The facts of a battle are proverbially difficult to establish. It usually happens that, when several men, trying to tell the truth, have described even an isolated scene in a battle (to say nothing of the whole engagement), their accounts differ so widely that they are not recognizable as portrayals of the same scene. What confidence, then, can be placed in my version of the event now to be narrated? I will state candidly that, while nothing was found in the official reports positively contradicting what I have to say, still the matter is passed over in silence by some commanders, and others do not seem to attach great importance to it. In the proper place, therefore, I shall again quote from my diary an account written on the next day, and along with it the appropriate part of Early's account as given in his Memoir.

At daylight on Oct. 19th, 1864, Early attacked Sheridan's army at Cedar Creek in the Valley of Virginia. The nineteenth corps and the Army of West Virginia (Crook's corps) were soon routed. The sixth corps was still in great part intact. To follow the details here is impossible; but if the reader will examine the Atlases that accompany the "Records of the War of the Rebellion," published by the government, he will see, Atlas 20, Plate xcix, 2, a position occupied by the sixth corps at 8 a. m., and Atlas 17, Plate lxxxii, 9, the "second position" of the sixth corps. The corps, it will be seen, was about 800 yards west of the main road, and the second division was parallel to and facing the road. The maps differ considerably from each other, but, at least as to the position of the Confederate artillery, they both differ still more from the reality, though the general position of the sixth corps is correct. Just before the attack, the Confederate artillery had been placed in readiness to move, and had been massed on Hupp's Hill, a mile or more from the Federal works, during the first violent fighting. Bryan's battery was the last to reach this park, but moved straight forward and became the front of the column which now advanced at a trot. As we crossed the creek and ascended from the deep ravine to where the Federal fortifications were, a dense fog arose. Leaving the rest of the artillery behind, our battery advanced along the road nearly to Middletown. Overtaking and passing some infantry, we were halted a little to the right of the road and ordered to fire to the left. The fog was too dense to see what we were shooting at; but some artillery was firing at random in our direction from the quarter at which we were to direct our shots. I now quote from my diary, omitting what is personal: "We moved into battery and opened. * * * The infantry marched over our battery and advanced upon the enemy [the line being parallel to the road]. It was still difficult to see the Federals on account of the rising mists. * * * Soon the mists were dispelled. * * * Our battery limbered up, crossed the road, and again went into battery, and opened upon the enemy's now visible *line*. * * * We fired from this position until some other guns passed us on the left, advanced to our front and left, and went into battery. It was about this time or a little before that Wharton's division charged the Federal line and met with a serious repulse with heavy loss. Other commands that were in reach were already too much exhausted and confused by the vigorous assaults they had before made, to undertake another charge; and as the as yet intact Federal cavalry was moving around our right towards our rear (as we now stood), a crisis had been reached and all depended upon the ability of the artillery to promptly disperse the infantry line. * * * Our battery galloped forward into line with the guns that had passed us, and went into battery on their right. We were then within 300 or 400 yards of the Federal line. On our right another battalion took position, so that the entire artillery mass amounted to, I think, nineteen guns. All the guns opened at nearly the same time. The cannonade was terrific. Though the firing of each gun was unusually rapid, the accuracy was great on account of the short distance, and the effect was terrible. At last the enemy's line broke and fled over the summit of a slight ridge, and then the men ran in the direction of their left flank [i. e., their right, as they faced to the rear]. * * * During this exciting conflict *I did not hear any bullets or other projectiles of the enemy fired at us.*" I now give an extract from

Early's account: "There was now a heavy fog, and that, with smoke from the artillery and small arms, so obscured objects that the enemy's position could not be seen; but I soon came to Generals Ramseur and Pegram, who informed me that Pegram's division had encountered a division of the sixth corps on the left of the Valley Pike, and, after a sharp engagement, had driven it back on the main body of that corps, which was in their front in a strong position. They further informed me that their divisions were in line confronting the sixth corps, but that there was a vacancy in the line on their right which ought to be filled. I ordered Wharton's division forward at once, and directed Generals Ramseur and Pegram to put it where it was required. In a very short time, and while I was endeavoring to discover the enemy's line through the obscurity, Wharton's division came back in some confusion, and General Wharton informed that in advancing to the position pointed out to him by Generals Ramseur and Pegram, his division had been driven back by the sixth corps, which, he said, was advancing. He pointed out the direction from which he said the enemy was advancing, and some pieces of artillery which had come up were brought into action. The fog soon rose sufficiently for us to see the enemy's position on a ridge to the west of Middletown, and it was discovered to be a strong one. After driving back Wharton's division he had not advanced, but opened on us with artillery, and orders were given for concentrating all our guns on him. In the meantime, a force of cavalry was advancing along the Pike and through the fields to the right of Middletown, thus placing our right and rear in great danger, and Wharton was ordered to form his division at once, and take position to hold the enemy's cavalry in check. Wofford's brigade of Kershaw's division, which had become separated from the other brigades, was ordered up for the same purpose. Discovering that the sixth corps could not be attacked with advantage on its left flank, because the approach in that direction was through an open flat and across a boggy stream with deep banks, I directed Captain Powell, serving on General Gordon's staff, who rode up to me while the artillery was being placed in position, to tell the General to advance against the enemy's right flank and attack it in conjunction with

Kershaw, while a heavy fire of artillery was opened from our right; but as Captain Powell said he did not know where General Gordon was, and expressed some doubt about finding him, immediately after he started I sent Lieutenant Page, of my own staff, with orders for both Generals Gordon and Kershaw to make the attack. In a short time Colonel Carter [Chief of Artillery] concentrated eighteen or twenty guns on the enemy, and he was soon in retreat. Ramseur and Pegram advanced at once to the position from which the enemy was driven, and just then his cavalry commenced pressing heavily on the right, and Pegram's division was ordered to move to the north of Middletown, and take position across the Pike against the cavalry. Lieutenant Page had returned and informed me that he delivered my order to General Kershaw, but the latter informed him that his division was not in a condition to make the attack, as it was very much scattered, and there was a cavalry force threatening him in front. Lieutenant Page also stated that he had seen Gordon's division in Kershaw's rear reforming, and that it was also much scattered, and that he had not delivered the order to General Gordon, because he saw that neither his division nor Kershaw's was in a condition to execute it." In other words, but for this concentration of artillery, the complete route experienced by the Confederates late in the afternoon of that day would probably have occurred at 8 o'clock in the morning. Some of the Federal official reports, though describing the cannonade, state that the line was ordered to retreat because a Confederate force was getting in its rear on the right. This, of course, I do not question; but that movement must have been a very insignificant one, and no one who saw the affair from our side can doubt that the retreat was, in any case, a question of only a few minutes. Our whole army, so far as I can learn, always supposed that the artillery drove at least the second division away. This division, which claimed with seeming justice, that it remained the best organized, if not the only organized, part of the infantry after the morning's conflict, nevertheless wavered in a marked manner when the general advance was made in the afternoon. The infantry confronting it was little more than a skirmish line, and the artillery bearing upon it consisted of about nine pieces, only five of which had a good view of the situation, which was a part of the Federal line that extended from the turnpike westward through open fields to a woodland. May not this flinching of the afternoon, which seems to have puzzled the division and brigade commanders, have been due to reluctance on the part of the men to undergo what seemed to them likely to prove a repetition of the morning's ordeal? This flinching threatened the whole Federal force with final disaster, and that part of the line was held back until some of the Confederate artillery (Bryan's battery, now three guns) was withdrawn to be replenished with ammunition which had been captured. On returning to a point near its original position, this battery was instantly ordered from the field to escape capture, and I did not get to see just what the situation was. It may be added that the failure of this portion of the Federal line to advance was no part of Sheridan's attempt to hold his left back so that his right might get behind that of the Confederates. All that I have here said I find fully confirmed by Federal accounts, except as to the character of the Confederate force at the point concerned. But whether the demoralization in the sixth corps at this time was due to the cause suggested or not, the powerful effects of the concentrated fire in the morning were obvious. Parallel incidents during our war are not numerous, but the reader will no doubt recall the scene at the battle of Chancellorsville, where Lee, observing a large column of his own artillery passing by at a critical moment, contrary to his custom assumed direct command of it and turned its fire upon the Federal lines with results now passed into history.

Attention is invited to a subject suggested by the concentration of Early's guns at Cedar Creek. As is shown by my diary and is still distinct in my memory, I did not, during the cannonade, hear any projectiles from the Federals, nor see any sign that they were firing. Capt. Bryan's attention was called to this fact, as soon as the Federal line retired, and he, without claiming to have heard any projectiles, pointed to the dead scattered over the ground as an evidence that we had been under fire. These dead, I am satisfied, all belonged to Wharton's division, and were killed before the cannonade. It is certain that, although we were within fair musket range, neither man nor horse in

Bryan's battery received a scratch after we moved close to the Federal position. There is no evidence that the sixth corps was out of ammunition; and if it had been, it is hardly to be supposed that it would have attempted to hold the position. The question, therefore, is suggested whether infantry, each man remaining at his post and not seeking shelter, may not be dazed into passive inactivity by a concentrated fire of artillery. Something very analogous to this happened on a much larger scale at the battle of Moscow.

Now that the range of artillery is so much longer and the accuracy so much greater than formerly, it may be worth while for artillerists to consider the question whether the improvements do not call for corresponding modifications in the disposition of guns on the battle-field. It being granted that a concentrated fire of artillery upon certain points is desirable, the question arises how this can best be obtained. If artillery is massed at or before the beginning of a battle, it may turn out to be in the wrong place, and surely will so turn out, if the enemy discovers where it is before it is too late to modify his plans. At Fisher's Hill on September 22nd, 1864, our artillery, though not literally massed, was almost entirely on the right. This was rendered necessary, perhaps, by the topography, but that does not affect the question. The battle was lost and won on our left where we had no guns and the reluctance of the artillery to retire without participating in the final struggle led to the capture of eleven pieces. Again, if the artillery is distributed along the line with a view to massing it subsequently as occasion may require, valuable time is lost in making the movement, and at the points from which it is removed, the enemy is encouraged when he sees it withdraw. Cases have occurred where the attempt to shift guns from one point to another virtually excluded them from participation in the battle, and greatly weakened one point without strengthening the other. This is well illustrated by our experience at the battle of Cloyd's Farm mentioned above. It seems worth while, therefore, to consider whether, with the increased range and accuracy of cannon, a sufficient concentration of fire on any desired point without actually massing the pieces, could not at any time be secured by appropriate organization and instruction. Without such organization and previous instruction it would be found impracticable. It is hard to induce artillerymen to leave unmolested the body of the enemy that is annoying them, and direct their fire at some other object. The Confederate artillery, however, sometimes did this. At Fisher's Hill, where the supply of ammunition was very short, we were required to cease firing at artillery and reserve our fire for advancing masses of infantry,—a circumstance which led some Federal artillerists to believe (as shown by their reports) that they had silenced us. To make the plan suggested entirely safe would require good discipline, careful instruction, and training of officers in the use of signals. The only instance of signaling I have ever witnessed on the battle-field was between parts of Bryan's battery, when they were posted at a distance from each other. Early in the war, as much for amusement as anything else, I selected some personal friends as a "signal corps," of which I was the "sergeant." I devised a system which we thoroughly practiced, and Capt. Bryan, seeing that our ability to communicate with each other at a distance could be turned to use, joined the corps as a private. We were all pledged to secrecy; but, as that pledge may be regarded as having expired, and as the subject of signaling has been referred to in a recent number of this Journal, the system we used may appropriately be explained. Being familiar with Morse's telegraphic alphabet, and observing that pauses were introduced into some letters only because the dash required more time than the dot, while in signaling a motion to the left takes no more time than one to the right, I adopted that alphabet, modifying *l* and the letters containing pauses, by a more free use of the dash. Letting 1 denote a motion to the right and 2 a motion to the left, the system was as follows:

a 1 2	h 1 1 1 1	o 1 1 22	v 1 1 1 2
b 2 1 1 1	i 1 1	p 2 2 2	w 1 2 2
c 1 2 2 2	j 2 1 2 1	q 1 2 1 1	x 1 1 2 1
d 2 1 1	k 2 1 2	r 2 1 2 2	y 2 2 1 2
e 1	l 2 2 2 2	s 1 1 1	z 2 2 2 1
f 1 2 1	m 2 2	t 2	Numerals
g 2 2 1	n 2 1	u 1 1 2	1=2112, etc

"Attention" 1 2 1 2 1 2 indefinitely. "Ready" 2 2 1 1 2 2 1 1 indefinitely. "Repeat" 1 2 1 2. "Stop" 2 2 1 1.

In addition to the flag by day and the torch by night, we used (in practicing) any combination of movements or sounds, such as moving the hands alternately, and whistling or sounding on a bugle high and low notes. On several occasions we made useful practical application of the system. Of course the details of any method would have to be secret, and it would sometimes be found necessary to change those details, to keep the enemy in ignorance of them. The systems used by both the Federal and the Confederate signal corps was, as I afterwards observed, practically the same as ours. Every movement of the signal flag corresponded with some letter or numeral in our system, but each letter in one was not the same as in the other. I was informed by a signal sergeant in 1864 that the corps had been compelled twice to make "pie" of its alphabet and relearn it. But this is digressing. For the special purpose of controlling the artillery fire of an army, a more concise system, in which some whole words could be represented as briefly as some letters are in the above system, might very well be devised.

How near guns may be brought to each other in massing is a question on which I cannot throw any light. I only know that, during the battle of Cedar Creek, we placed two guns side by side in a narrow lane, and soon found that it was impossible to use them with any comfort or efficiency. Though it does not seem reasonable, the chief trouble was that each gun, when discharged, shocked the men at the other gun, so that they were kept constantly uneasy. An explanation of this perhaps belongs to psychology.

The point upon which a fire is to be concentrated will, of course, be determined by the commanding general, either according to a plan previously formed, or as exigencies require. The former case does not belong here, and the latter has already been illustrated as far as my observation furnished examples. There is, however, one further aspect of the subject to which attention may be directed. I am inclined to think that the habit of the Confederates to shell severely from a distance the point of attack before charging with infantry, has been exaggerated;

still there is some truth in the common belief. The object of this concentrated fire was, presumably, to disorganize and demoralize the troops to be attacked. To this end it did, no doubt, contribute something; but the question may well be raised whether this advantage is not more than counterbalanced by disadvantages. These would seem to be chiefly the following: 1) If the plan has become habitual, the shelling warns the enemy to be ready for the charge. 2) It in any case attracts a large force of hostile artillery which begins to inflict most serious damage upon the attacking column just at the time when the supporting artillery must cease firing. 3) The disorganization produced among stationary troops by distant shelling is, after all, very slight, if they are entrenched or for any cause do not actually flee, and any demoralization they may have suffered from the natural dread of infantry for artillery is counteracted by the sense of relief experienced when the shelling ceases; so that they have been rather inured to danger, and are mentally in as good plight for musketry as they were before the cannonade, if not actually less liable to panic. I am not sure that the facts will sustain this last objection. To illustrate the other two, it is sufficient to refer to the battle of Gettysburg.

ARTILLERY PROJECTILES AND THEIR PENETRATION.

By HERMAN C. SCHUMM, First Lieutenant, Second Artillery, U. S. A.

From time immemorial man's main efforts have been directed towards the improvement of his weapons and then his defenses. The rivalry of the present day between projectile and armor began long ago when the arrow and the shield were yet their representatives. In this race for predominance, it at times was the projectile and then again the armor that was ahead. It was oftener that the projectile took the lead, but at the present time it is a mooted question as to which is the more powerful. However, under such conditions of rivalry, it was but natural that the improvements in these implements of war kept pace with the general advance in civilization and consequent mechanical and technical improvements, that it is not surprising to find the change from projectiles heretofore used in actual war and those now required in modern gunnery very great.

Projectiles used in rifle guns are shot, shell and shrapnel. For use in B.L.R. a rifled canister has been devised, but shrapnel having its fuse set at zero will probably be entirely used instead.

The materials used in the fabrication of projectiles are cast-iron and steel; but with the increase of the facilities for manufacturing steel, the tendency is to pass into the epoch of steel projectiles, retaining those of cast-iron only for target practice. Another reason for discarding those of cast-iron in actual service is found in the fact that they had a tendency to break up in the gun, on account of the high pressure exerted on the base.

Armor piercing projectiles represent the best work of the projectile manufacturer. Different makers apply different methods and also use different compositions, but these are all trade secrets. The general problem confines itself to the selection of a steel with a view of harmonizing the conflicting properties required by the work the projectile is expected to do. The steel must be hard enough and have sufficient resistance to crushing force not to upset, and still not be brittle enough to break up on impact with the armor.

In order to obtain the requisite hardness chrome steel is now used by all manufacturers of armor piercers. A good deal of skill and attention are naturally required in tempering these projectiles. Those of chrome steel are hardened in cold water and only tempered by heating in boiling water, after which they are again plunged into cold water. As for the composition of the steel used different authorities express as many different opinions. Some believe that the addition of ferro-silicon and ferromanganese better assures the prevention of blow holes and permits of the metal being more easily forged, while others assert that chromium alone accomplishes all this. As a general rule it may be laid down that the amount of chromium should not exceed 2% ; nevertheless, in a steel given as a type of that now used in the manufacture of armor piercers the following percentages are given: Carbon 1.25 Silicon .25 Manganese .29 Chromium 2.7.

In the manufacture of the Hadfield projectiles, the inventor uses chromium varying from 1.25% to 2%.

It must be borne in mind that all energy that is expended in deforming an armor piercing projectile is just so much taken away from the effective work that it ought to do. Hence the object is to manufacture one that can resist such deformation. How well chrome steel projectiles accomplish this object is illustrated by the following tests: A number of 65mm chrome steel projectiles weighing 8.8 lbs. fired with a velocity of 1279 f.s., giving a striking energy of 100 tons per square inch, were fired against a plate 2¾ inch thick; the energy was 17% more than that just necessary to perforate wrought-iron of the same thickness. Nine shots at each plate failed to perforate, but they had almost completely resisted deformation, as no appreciable difference could be noticed. The St. Etienne works in France have a 13".4 chrome steel projectile which has pierced a 15".7 iron plate obliquely, without showing any appreciable deformation.

England was for a long time committed to the Palliser cast-iron shot. In manufacturing these, the mould used for the solid head was of cast-iron so as to give a chill for the special hardness required, while the hollow body was cast in a sand mould in order to give greater toughness. Their use, however, was to be confined against vessels not protected with armor of a sufficient thickness to warrant the use of steel projectiles, but which required something stronger than common shell. It was claimed that the Palliser shell was far more destructive to life than one of steel, because the cast-iron would break up into a greater number of pieces; but to-day, a steel projectile, on account of the greater strength of steel, is made with thinner walls and thus allows a greater bursting charge to be used. For example, the steel shell for the 110 ton gun will hold 193 pounds of powder and that for the 67 ton gun 87 pounds.

Formerly, when soft wrought-iron armor was in use, chilled iron shot got their points into the armor and then received support laterally before they met with sufficient resistance to break them up; consequently, at that time, their brittleness did not tell so much against them, while at the same time their great hardness enabled them to pierce the armor. But as soon as steel faced and solid steel armor came into use their want of tenacity caused them to break up before they could deliver a requisite proportion of their energy at the point of impact.

To obtain a good racking effect, large chilled iron projectiles, with low striking velocities, would answer very well, but it is very improbable that in the future chilled iron shot will again be employed against armor.

Originally England, in the Whitworth shot and shell, possessed a steel projectile that was regarded as the standard of excellence; but because that country for so long a time persisted in using chilled iron shot and shell, no encouragement was lent to the manufacturers of those of steel, so that soon it found itself far behind other European countries that had developed an efficiency far in advance of anything known anywhere else. So that to-day England derives most of its supply from Holtzer, Firminy and St. Chamond works. It is true that Hadfield projectiles have been manufactured with some success for more than ten years, and recently these have obtained so high a degree of efficiency that it is probable that they will hereafter be extensively used.

Within recent years there have been a number of exhibits of war material and it is intersting to note the display made of projectiles. In the summer of 1891 the English Ellswick firm had a complete group ranging from the 2000 lb. shell for the 110 ton gun down to the one pounder Hotchkiss. Four kinds were displayed representing those used in the English naval service, namely: Steel armor piercing shot, Palliser chilled shot, common shell, and shrapnel shell. The shrapnel shell for the 110 ton gun contains 2330 bullets, that for the 67 ton gun contains 1367 bullets. It is contemplated to make use of these only against troops in the open or a flotilla of boats. On account of the terrific effect produced by the explosion of a shell of this kind, it is claimed that the casualties of crews of vessels will be so great that it will be likely that many of the belted iron clads will be put *hors de combat* simply from the destruction of their personnel. For it must be remembered that on account of the enormous weight of armor that would be required, adequate protection aboard modern iron clads can be given to comparatively a small portion of the crew only, *i. e.* to those serving the heavy guns in the turrets and in barbette. The ordinary gun crews will have very little protection and will readily become the targets of flying splinters and pieces of shell. Moreover the smoke and powder gases evolved by the bursting of such a shell between decks would tend to suffocate every man who had escaped being actually hit.

In an exhibit made by the St. Chamond Company of France, an extensive series of projectiles of various weights and calibers was shown. There were shells for the French service of from 3".15 to 16".54 diameter; others, such as supplied to the British Admiralty of 6", 9" and 13".15 diameter; some of 11" and 12" diameter made for Russia, and finally some of 8" and 10" diameter made for our navy. One series of shell illustrated a method of manufacture peculiar to this company; they were forged hollow out of a block and shaped in a hydraulic press; the rear of the shell was then closed and made solid by means of the same power. This display also included a series of projectiles of various sizes that had been fired at armor plates, and which, in spite of the severe tests to which they had been subjected, had suffered very little deformation. The largest was a shot 16".54 in diameter which had penetrated a plate 19".69 thick; another projectile 13".39 in diameter, had passed through a steel plate 15".75 thick. Besides there were groups of smaller projectiles which had successfully passed through equally severe tests.

The exhibit made by Fried. Krupp at the World's Columbian Exposition at Chicago last year, represented every kind of projectile manufactured at his works. Besides the projectiles that were shown with the different kinds of guns for which they were intended there were displayed different kinds of steel armor, steel fuse, mine and cast-iron fuse shells, shrapnel and case shot, making a lot of 58 different projectiles. The steel armor shells have no fuse and are to be used only as armor piercers. In Germany these have now almost completely displaced the chilled armor shell which were formerly used for this purpose. The steel fuse shells are intended to have the greatest possible explosive effect at the target; their walls are therefore made thin so as to allow the largest possible bursting charge to be used, and this latter is caused to explode on graze by means of a fuse. These projectiles are chiefly used for firing at earthworks.

The mine shells belong to the same class of projectiles but differ from the steel fuse shell by having a still smaller thickness of wall and greater length of projectile; this arrangement permits a still larger quantity of the explosive charge to be used. They are fired only at low velocities from strong guns with highly curved trajectories. The cast-iron fuze shells exhibited were partly ordinary shells and partly ring shells; they had bursting charges and fuses. The ordinary ones have but one wall and are designed mainly for firing at resisting objects and are cast in one piece. The ring shells are mainly intended for firing at animate objects and for this purpose are so constructed as to produce the greatest possible number of fragments on bursting. They consist of a number of superposed rosette shaped rings, perforated centrally for the reception of the bursting charge, about which a shell is cast. The shrapnel is intended for use against animate objects and is filled with balls, having a bursting charge in the base; a combination time and percussion fuze is used with this shrapnel. The case shot were sheet metal cases filled with balls: neither a bursting charge nor a fuze is used. The sheet metal case is broken in firing while still in the bore and the balls are expected to diverge immediately on leaving the gun.

In addition to those firms who make a specialty of manufacturing projectiles, most of the well known gun manufacturers make projectiles for use with their own guns. The Hotchkiss company thus supplies shells, shrapnel and canister. Their shells are of three kinds: armor piercing, made of steel, common cast-iron and segmental. The difference in appearance between common and armor piercing consists in the former being truncated while the latter is pointed. The rifling band of all Hotchkiss projectiles is made of brass, is quite wide and is carried well forward from the base. All of their naval shells have base percussion fuzes. In the common and segmental shell, the base is in one with the body, being pierced by a fuze hole, the fuze screwing in from the outside. The steel shell has a separate base, which screws into the body of the shell. The interior of this base has a seat for the fuse which screws into it, thus leaving the base solid and the fuze entirely within the shell, so that on exploding the fuze cannot be blown out before the wall of the shell breaks up. The segmental shell is similar to the German ring shell, its case consisting of a number of superposed hollow discs over which is cast a light body. The shrapnel has a cast-iron head or grenade, which forms the magazine. The body is of thin steel or wrought-iron tubing, weakened longitudinally by six grooves on the inside. Within this body are packed lead balls in layers, separated by cast-iron separator discs. These discs are so shaped as to completely fill all interstices between the balls, and at the same time they are so weakened as to break up into regular fragments on explosion. A solid disc comes under the rifling band to support the thin wall at that point. The base of the shrapnel is a single steel disc, which screws into place and holds the balls and discs rigidly in place. The weight of the balls and separation discs is sixty per cent of the total weight of the projectile. A combination time and percussion fuze is placed in the shrapnel's nose.

The canister is made of a thin brass case lined with wrought-iron strips and filled with lead bullets. In the larger calibers this projectile has a wooden head fitted with a false point in order to keep the same total length of cartridge as with shell and shrapnel.

The efficiency of Hotchkiss projectiles is well illustrated by the following trial which took place at Spezzia, Italy. A 6-pdr. Hotchkiss armor piercer was fired at an iron target 6″ thick, bolted to an oak backing. The point did not go through but the plate was cracked wide open ; the base of the shell broke off at the face of the plate. When fired at a Creusot steel plate 4″ thick, the projectile pierced the plate and went 4″ into the backing. Moreover in the trials with the 47mm. Hotchkiss revolving cannon, the great number of fragments of shell found proved the fatal character of the projectile. These results are borne out by actual service ; for instance, during the last Tunisian campaign, while bombarding Sfax, the Hotchkiss guns were directed against some shore batteries, and the projectiles, striking the oblique cheeks of the embrasures, were seen bursting in the interior of the batteries and completely prevented the enemy from serving his guns.

For use with the Canet rapid firing guns four classes of projectiles are used : 1st. A steel shell with a bursting charge and combined time and percussion fuze; 2d. Common cast-iron shell with bursting charge and percussion fuse ; 3d. Case shot filled with hardened lead bullets, a bursting charge and combination fuse ; 4th. A case shot with zinc shell and wooden base. The shells have a copper band to take the rifling and are set in brass cartridge cases of such form as to warrant perfect obturation. The projectiles for the 47mm. and 57mm. guns are regular armor piercers and are calculated to be formidable against armor plated vessels.

For the DeBange guns, projectiles of various weights and diameters are also manufactured. The 3″.15 field guns use a shrapnel weighing 13.2 lbs. and a case shot consisting of a steel plate shell filled with hardened lead balls separated by cast-iron discs which break up on striking. In the head of this projectile is a double action fuze, timed for 13 seconds—corresponding to a range of 4375 yards. The total weight of this shot is 10.9 lbs. The mitraille case shot consists of a zinc shell filled with balls of hardened lead, the spaces between them being filled with sulphur: the number of bullets is 85 and the total weight of the shot is 12.21 lbs. The projectiles for the 4".72 siege gun are common shell and shrapnel; the former is of cast-iron with a percussion fuze in the head; its total weight is 39.6 lbs. The projectiles used for coast defense are those for the 6".1 (155mm) gun weighing 110 lbs., for the 10".63 (270mm) howitzer and mortars, weighing 374 lbs., for the 6".1 howitzer weighing 88 lbs. and those for the 12."6 (320mm) guns, weighing 880 lbs.

A few general remarks on the subject of field artillery projectiles may not be devoid of interest. It will be noticed that different artillerists hold different opinions as to the use of special projectiles for special occasions. For example, the English use a forged steel shell, containing 2 lbs. of powder for ranging purposes, the Germans until very recently used for this purpose their cast-iron ring shell containing a bursting charge of 6 oz. of powder, but now use a shrapnel fitted with a double action fuze and capable of giving on explosion about 300 pieces. The French also employ a shrapnel, holding 2 oz. of powder and the United States use a percussion shell, that for the 3".6 gun having a charge of 14.5 oz. of powder and that for the 3".2 gun 7.25 oz. The English shell is intended to be used against field intrenchments and for that reason a larger bursting charge is used. France and Germany have combined ranging and man killing in one projectile and against this combination it is argued that observation will be rendered more difficult on account of the less quantity of smoke that will be given off. The English and French both place the bursting charge in the head of the shell, while most other nations place it in the base, in which case it is connected with the head by a tube passing down the center of the shell. The reason given for placing it in the head is, that when used with a percussion fuze, the shell shall burst on graze. For the French this is necessary, since they use shrapnel for ranging purposes. The English have a different reason, for their common shell not being a man-killing projectile, they have to trust to percussion shrapnel in cases when there is no time for setting the time fuze. They claim that a shell having the bursting charge in the base would be less effective with a percussion fuze, because during the time the flash is being conveyed from the fuze to the charge, the shell would rise some distance from the ground and the bullets would then be thrown over the heads of the enemy. A reason against carrying the bursting charge in the head is that it diminishes the velocity and increases the dispersion of the bullets. When in the base an opposite effect is attained. During the Franco-Prussian war, the German army, with the exception of the Bavarians who had a very inferior shrapnel, practically possessed but one projectile and but one fuze—the percussion fuze. They did have some case shot, but the non-use of it is illustrated by the fact that during the whole war the Artillery of the Guard expended about 25000 shells and one case shot and the latter was broken in transportation. The French had a shrapnel in addition to a common shell, but for the greater number of projectiles used a time fuze, which, absurd as it may appear, acted only at two ranges, namely, at 1500 and 3000 metres, so that for other distances the shell practically became solid shot. The shell used by the Germans at this time gave about 30 or 40 splinters at its burst; their ring shell, which has recently been replaced by shrapnel, gave from 150 to 180 splinters, and as already stated, their new shrapnel gives about 300 pieces.

Before the present high efficiency of steel projectiles was reached, manufacturers had much difficulty in producing solid projectiles on the molecular stability of which reliance could be placed. Many failures preceded the successful outcome in this respect, and it was no unusual sight to see at works where chrome steel projectiles were being manufactured, a large number of projectiles which had sustained spontaneous fracture. The successful manufacture of hardened chrome steel armor piercing projectiles by various manufacturers is therefore a good illustration of the control which has been acquired over the treatment of the steel, and especially over this chrome steel to which an exceptional degree of hardness may be imparted without detriment to tenacity.

As has already been stated, the problem in making a shell for armor piercing purposes is, then, to select a grade of steel with a view to its possessing a very hard point and whose walls shall not be so hard as to crumble on striking a heavy mass. Hence the metal selected is in the nature of a compromise in the endeavor to procure a metal which will give as hard a point as possible under the circumstances.

In following the various steps of manufacture of a projectile, it is noticed that, as a general mode of manufacture, the metal is first rolled or forged into a solid blank. After this it is placed in a lathe, turned off accurately on the outside and then the powder chamber is bored in the axis of the shell from the base. The opening in the base is then closed by an accurately fitting screw plug in the center of which is the threaded tube for the percussion fuse. A groove for the rotating band is next turned on the outside, near the base, and this is roughened so as to prevent the rotating band from slipping on taking the rifling. The shell is then hardened by one of the secret processes, after which the copper band is forced into place by hammering or hydraulic pressure and then turned off true to gauge. The position of the band is not fixed at random; for ease in loading the difference in diameter between the front bearing of the projectile and the bands is made as small as possible, but some difference must exist, and unless the band is properly placed the propelling gases may set up an oscillating motion during the projectile's passage through the bore. This action might not only damage both gun and projectile, but would be doing an amount of harmful work at the expense of the good work that should be stored in the projectile. To diminish this effect, the front and rear bearings should be made the base of conjugate axes of suspension and oscillation. When the position of the front bearing is determined by the shape of the projectile, this can be accomplished by swinging the projectile as a pendulum on a diameter of the front bearing and ascertaining the time of one vibration. Then the distance l that the band should be placed from it is found from from the equation

$$l = g\left(\frac{t}{\pi}\right)^2,$$

The width of the band is usually taken at about one-tenth of the caliber.

In the case of common shell, made either of steel or cast-iron, the castings, as soon as received at the foundry, are carefully calipered on the inside by a skilled operator who uses a star gauge. It is then placed in the hands of a machinist who places it in a lathe excentrically so that the outside will be turned true with the inside. It is then fitted with a rotating band and a fuze, but is not hardened.

For shrapnel, the head of the base is screwed on after the body of the shell has been filled with bullets and the matrix.

The projectiles made for the United States government by the Carpenter steel works are cast in moulds which are twice the size of the finished shell. Then they are hammered into shape in dies after which they are machined. Next they are hardened by the Company's secret process and finally are finished to exact dimensions. The base of the chamber is bored out and a plug is accurately fitted into the opening to close up the projectile. In testing the shells, after they have been found to be truly concentric and balanced, two of each lot are fired at a hardened steel plate, backed by three feet of oak backing, the plate being one and one-fourth times the thickness in calibers, of the shell fired. If the shell penetrates the plate and the backing without itself receiving any injury, its lot is accepted. The Company for these projectiles uses a special chrome steel of high tensile strength; frequently pieces average 110 tons to the square inch with about 7% elongation.

Very recently a machine has been devised which is under the complete control of an operator who works it by an hydraulic press; this machine rolls projectiles so accurately that they are well adapted for the best marksmanship. It is so designed that two projectiles can be formed at a time. The metal is treated while hot, and the ingot, which is cylindrical, is prepared for the machine by somewhat reducing the center in order to prevent too much metal becoming crowded toward the shoulders of the projectiles. It is expected that a great reduction in the cost of heavy gun projectiles and mortar shells will be effected by this machine.

One of the most interesting processes of the manufacture of projectiles is that followed by the American Projectile Company; this company uses the electric welding process and claims that the cost of manufacture is so much reduced by this method that forged steel projectiles can be produced by them at the cost of ordinary cast-iron projectiles. In this method, instead of solid, rough forged ingots, three component parts are used which, when welded together, form the projectile. Each piece is previously finished to exact size, except that a little extra length is allowed for the take up in moulding. The head and base pieces are forged in dies to shape. In the case of shell, the central portion is simply a piece cut from a length of solid drawn steel piping. It is claimed thus to have all the additional strength due to the fibrous skin inside and outside caused by the drawing process. To join these three pieces they are clamped into a form of electric welding machine and in less than a minute all are joined together and made a homogeneous mass. It only remains to grind off the burrs and cut in the groove for the rotating band. The front burr is used as a bourellet which supports the front portion of the shell in the bore of the gun, the other end being supported by the rotating band. The other burr is removed at the same time that the groove for the rotating band is cut in. The fuze hole has previously been cut and threaded in the base piece. In this shape the shell is ready for the hardening process. At the points of welding the metal appears to have been strengthened. For common shell, cast-iron or low carbon steel tubing, stamped or cast heads and bases may be used, the three parts then being welded together electrically. In the case of shrapnel, the heads and bases are steel castings which have been heated and compressed for the purpose of giving them density. The body is drawn steel tubing one-fourth of an inch thick. This projectile is built up as follows: The head is first welded into the body and then the brass tube which carries the flame from the fuze to the powder chamber at the base is crimped in at the upper end. The half formed projectile is now inverted and the bullets are placed within after which the matrix is poured about them. Next the diaphragm which forms the front end of the powder chamber is put into position and then the other end of the brass tube is crimped in. The shell is now ready for the final weld; the base piece is provided with a shoulder which, after the weld is made, will press closely upon the diaphragm and support it against the shock of discharge. After this second weld, the projectile is ready to be supplied with its rotating band and its fuze. It is thus seen that in the electric welding process an armor piercing point for the shell is made of hard steel, shaped in the ogival form suited for the purpose; to this is attached a tube of mild steel to form the chamber; the base is of a mild steel somewhat harder than that forming the walls of the chamber and is shaped to a cup form by hydraulic pressure.

So far the largest shell manufactured by this process is the 6″ naval common shell, weighing about 94 lbs. and having an outside diameter of 5″.96 with a thickness of wall of .95 inch. It is expected that larger projectiles will soon be manufactured, the difficulty of obtaining the necessary tubing having been overcome, so that even a 12″ shell will be formed by the electric welding process.

The shape that should be given to the head of a projectile is a study that probably has received more time and attention than any other one part of the projectile. Ordinarily it is that of an ogive varying from 1½ to 2 calibers, but then there are those of other radii, in addition to the flat headed and blunt trifaced ones. To determine the best form for armor piercers, England, some years ago, carried on a series of extensive experiments. The heads of projectiles experimented with varied from an ogive of 1½ to one of 3 calibers; some with flat heads were also used. On the whole it was found that the one whose radius was 2 calibers gave the best result; one of a sharper point gave a greater penetration with front fire, but less with oblique fire. It was not considered that the flat headed projectiles had stood the test, but they were found to penetrate water without deflecting and also to bite a plate at a smaller angle than an ogive, when fired obliquely. On the other hand it was demonstrated experimentally at the Indian Head Proving Ground that the flat headed projectile is the superior of all others against armor inclined at small angles to the line of fire; this for short ranges only. This however would recommend them for the Naval service and it might be advantageous to have a small supply on hand for short range use in sea coast defense. The blunt trifaced projectile is considered by some writers on the subject to have all the good qualities of the ogive of 2 calibers radius and, in addition, to bite at a less angle. The three faces, on account of their wedging and splitting action, start cracks radiating from the point of impact in all directions. Experiments have been conducted with these projectiles, but it is not known that any have been adopted for service use.

In considering the weight of a projectile it is usual to ascribe a numerical value to $\frac{w}{d^3}$, in which w is the weight of the projectile and d the diameter of the gun for which it is intended. The considerations which enter the determination of a proper value for the above ratio are found in the fact that a greater muzzle velocity and hence a flatter trajectory is obtained with a light than with a heavier projectile, the charge being constant. This increases the chances for hitting at short ranges. On the other hand, for long ranges, a heavier projectile would land more energy, since, though the muzzle velocity is less, the resistance of the air effects it less. It has been suggested to use projectiles of different weights for long and short ranges in order to comply with these considerations, but that would be a doubtful experiment on account of its adding to the complexity of the already intricate military machinery. The value for $\frac{w}{d^3}$ has varied at different times. For the new U. S. field guns it is about .45, for the 5″ siege gun .36, and for the coast defense guns about .57.

Passing on to the use of high explosives as bursting charges for shells, it may be remarked that this use is still more or less in the experimental state, especially when applied to armor piercers. Many experiments have been conducted in firing shells charged with gun cotton from modern high power guns. The French and Germans have adopted high explosives for use with common shell, but so far no satisfactory results have been obtained from their use as armor piercers. The French use mélinite with a common steel shell four calibers in length; the shell has a percussion fuze and is intended to destroy earthworks and similar obstacles. The German shell is filled with wet gun cotton and is intended to be used with a time fuze against bodies of troops. Other European countries have also adopted some high explosive for use with common shell; England and Italy use lyddite, Russia wet gun cotton, Sweden bellite and Austria ecrasite. In the United States experiments have been conducted using dynamite No. 1, explosive gelatine and forcite, the last two having been recommended for use in the army.

Trials conducted in England with the Snyder dynamite projectile were not successful. They used the 7″ and 6″ guns, discharging the projectile which was 2 feet long and which contained a charge consisting of 96% of nitroglycerine in a gelatinized form and 4% of other ingredients. An india rubber buffer was inserted between the projectile and charge; this was fastened to the projectile by a brass case, but was made so as to leave the projectile a short distance from the muzzle. The 7″ projectile weighed 229 lbs. including the bursting charge of 10 lbs. weight. Although the guns were not injured the projectiles themselves gave no satisfactory results.

The Rapieff shell is one of the most recent for use with the pneumatic gun; this shell for the 15″ gun is 10 feet long, including tail and wings. The extreme length of the head is 91 inches. The front of the head is cast bronze, the middle cylinder is of wrought iron and the base is of cast bronze; the tail is a 6″ bronze tube 34½ inches long. The head contains the charge consisting of 500 lbs. of wet gun cotton. The shell has 12 helical wings at the extremity of its tail piece to give it rotation. In the full caliber projectile, every second wing carries a little block of fiber to center the rear and to prevent the wings from touching the walls of the gun. A 1½ inch oak disc is attached to the rear to protect the wings, but these drop off when the projectile leaves the gun. At the base of the head is the gas check; a number of small blocks of fiber encircle the head in order to hold it in an axial position. The front is centered by four oak sabots which are displaced by the blast of air when the projectile emerges from the gun, so that in all cases the projectile's flight is accomplished without any impediments. To explode it, the mechanical details are so arranged that when the projectile strikes the water or soft earth the retardation of its speed causes a little ball to strike a firing pin which explodes a fulminate which in turn sets on fire some slow burning composition so that the explosion cannot take place until the projectile has penetrated the water or earth to some distance. On the other hand, when it strikes the side of an iron clad it is so arranged that the charge of gun cotton is at once exploded.

Recently small caliber projectiles have been subjected to treatment by the Harvey process and it is reported that the experiment has proved very successful; but as far as known no official trials have as yet been conducted with such projectiles against Harveyized armor.

For the purpose of securing a supply of armor piercers Congress some years ago appropriated $100,000 for the purpose of stimulating American steel manufacturers and to determine whether shot and shell could be made in the United States equal to those made in Europe. The requirements of the ordnance bureau are based on foreign tests. The 10″ shot is to be fired at a velocity of 1625 f. s. and must pierce a steel plate 11.2″ thick, entering without crack or other material deformation. The 8″ shot is subjected to similar conditions, the plate that it must pierce having a thickness of 9″.

In following through the process of manufacture of armor piercers it may readily be concluded that their cost is quite expensive.

Bids for armor piercers, opened by the War Department in 1890, were as follows:

Carpenter Steel Co.—for 8″ projectiles, $150; 10″—$285
Midvale Steel Co.—for 8″ projectiles, $150; 10″—$287
Sterling Steel Co.—for 8″ projectiles, $300; 10″—$575

The bid of the Carpenter Co. was at the rate of 50 cents per ℔; at present their price is graded from 50 cents for 4″ projectiles to 38 cents for 10, 12, and 13″ shell.

In passing on to the second part of this paper, it is evident that the resistance to penetration depends upon so many factors that it is practically impossible to deduce a reliable penetration formula. Among these factors the armor itself, the resistance the projectile offers to its own deformation, the form of the projectile's head and the striking energy are the most important. Hence empirical formulas, based on actual trials, have been worked out and brought into use. Lieutenant E. M. Weaver of the army discusses this subject in detail in an interesting article published in No. 4, Vol. II, of the *Journal*, and on page 505 a great number of formulas are given. It will therefore suffice to give only Lieutenant Weaver's formulas in this paper, especially as he appears to be the only authority on the subject who up to this time has worked out formulas for the penetration of nickel steel and Harveyized plates.

The following are his formulas:

For compound plates.

$$(a)\ E = 0.64\ n^2d^2t$$

For Creusot plates, standard of 1890 and nickel steel plates.

$$(b)\ E = 0.7312\ n^2d^2t$$

For Harveyized plates.

$$(c)\ E = .7312\ \lambda\ n^2d^2t$$

In which

E = striking energy necessary for complete perforation in foot-tons.

n = coefficient depending on metal of plate, for steel and compound armor $= 3.125 + 0.11\ (t-d)$

d = diameter of projectile in inches

t = thickness of plate in inches

λ = coefficient depending on effect of Harvey treatment $= 1.535 + 0.035\ (10-t)$

For all ordinary cases, the formulas may be written in the following simple forms:

$$(a)\ E = 5.5\ d^2t \text{ when } d>t$$
$$E = 7.7\ d^2t \text{ when } d<t$$

$$(b)\ E = 6.6\ d^2t \text{ when } d>t$$
$$E = 8.8\ d^2t \text{ when } d<t$$

$$(c)\ E = 11\ d^2t \text{ when } d > t$$
$$E = 13\ d^2t \text{ when } d < t$$

When $d = t$, the coefficient will be the mean of the numbers given in each case.

For Harveyized plates the following values for λ have been worked out:

3″ plate $\lambda = 1.780$
4″ plate $\lambda = 1.745$
5″ plate $\lambda = 1.710$
6″ plate $\lambda = 1.675$
7″ plate $\lambda = 1.640$
8″ plate $\lambda = 1.605$
9″ plate $\lambda = 1.570$
10″ plate $\lambda = 1.535$
11″ plate $\lambda = 1.500$
12″ plate $\lambda = 1.465$
13″ plate $\lambda = 1.430$
14″ plate $\lambda = 1.395$
15″ plate $\lambda = 1.360$
16″ plate $\lambda = 1.325$
17″ plate $\lambda = 1.290$
18″ plate $\lambda = 1.255$
19″ plate $\lambda = 1.220$
20″ plate $\lambda = 1.185$
21″ plate $\lambda = 1.150$
22″ plate $\lambda = 1.115$

The above formulas are based on the present form of armor piercing projectiles, and apply only when complete perforation takes place without seriously cracking the plate and without seriously deforming the projectile.

To thoroughly comprehend the power of the latest and best armor piercing projectiles the following reports of trials with Carpenter armor piercers, which the Carpenter Steel Works kindly furnished for the writer's use, are hereunto appended:

RECEPTION TEST OF CARPENTER 6″ ARMOR-PIERCING PROJECTILES, AT THE NAVAL PROVING GROUND, MAY 18, 1895.

The following report is respectfully submitted of the test this day, of Carpenter 6-inch steel A. P. projectiles.

Plate:—All steel Schneider, 6'x8'x6''. Previous impact on plate 7. Plate in condition shown in photograph No. 1, accompanying N. O. P. G., No. 81, of April 25th.

Backing, 36'' oak secured to the center of target structure. Backing and both inner uprights damaged by previous impacts.

Line of fire to center of plate, normal to plate.

Gun, 6-inch B. L. R., No. 88, (35 calibers).

Charge, 30 pounds. Index 90.

Muzzle velocity, 1679 f. s.

Striking velocity, 1659 f. s.

Projectile weight, 100 pounds.

Marks, 288 K. N. C. Ord. Dept. C. O'N. J. R. S.

Points of impact, 3' 8'' from top; 14½'' from left edge.

All parts of projectile penetrated plate, backing and part of inner upright. Struck and broke one of the bolts of angle iron, and lodged about five feet in the sand between diagonal struts.

Projectile entire. Point in condition. No cracks.

Total length shortened, 0''.23.

Diameters enlarged:	At bourellet.	Between bourellet and band.	Below band.
	0''.04	0''.155	0''.

The shortening was almost entirely between upper part of bourellet and rotating band.

Plate:—Wide through crack 10'' long up and to left to old crack.

Partially through crack down and to left 11'' long.

Through crack down and to right to No. 5 (Holtzer), impact 22'' long.

Surface crack 10'' up and to right.

Continued crack from No. 5 to No. 7.

Diameter of perforation, 6½'', of front bulge, 12''.

Height of fringe above surface of plate, 2½''.

Fringe scaled off for one-half the circumference.

In the opinion of the inspecting officer, the distortion was not serious—and by the conditions of the specifications the second round was not required.

It is recommended the lot represented be accepted.

RECEPTION TEST OF CARPENTER 8'' ARMOR-PIERCING PROJECTILES, AT THE NAVAL ORDNANCE PROVING GROUND, JULY 1st, 1891.

The following report is respectfully submitted of the test, on the 27th ultimo, of Carpenter 8'' A. P. projectile.

Plate:—All steel Schneider, 6'x8'x8''. Previous impacts, two. Plate in condition shown in photograph No. 1, accompanying N. O. P. G., 101-91.

Backing, 36'' oak, damaged by previous perforations.

Gun, 8'' B. L. R., No. 16, mounted on velocity platform.

Angle of line of fire to center of plate, 2° from normal.

Charge, 65 lbs. U. T.-1.

Muzzle velocity, 1621 f. s.

Striking velocity, 1606 f. s.

Projectiles weighed 251½ pounds on the proving ground scales.

First round.

Marks on projectile, 166 K. N. W. N. Y. 1891. C. O'N. J. L. C.

Point of impact, 21'' from right edge, 24'' from top.

All parts of projectile penetrated plate and backing. Took a turn up and passed out of the butt, landing in the creek. Could be seen in the air turning end over end, and was apparently whole. Has not been recovered.

Plate:—In the condition shown in enclosed photograph No. 1. The absence of the center row of bolts allowed fragments to drop to ground.

Second round.

Marks on projectile, 203 K. N. W. N. Y. 1891. C. O'N. J. L. C.

Point of impact, 25'' from left edge, 2'' above center, 17'' from any old crack.

All parts of projectile penetrated plate and backing, a number of braces of target structure, and landed between two right bed timbers, 25 feet from backing.

Projectile entire. Point in good condition.

A parabolic crack extending from lower part of bourellet on one side to 4'' above bourellet on the other, with the vertex 3'' from point of shell. Small portion of metal scaled out of crack at vertex. Four short longitudinal cracks on bourellet—all on one side, and between legs of parabolic crack.

Total length shortened, 0''.45. (About half above and half below bourillet).

Diameters enlarged:	At bourellet.	Between bourellet and band.	Below band.
	0''.13	0''.13	0''.

Plate:—In condition shown in photograph No. 2—large portions having dropped to ground.

It is recommended that the cracks and distortion be considered as not serious, and that the lot represented be accepted—with the understanding, however, that this shall not necessarily be considered as a precedent when more extended experience has been obtained in manufacture.

There was considerable difference in hardness in the bodies of the two shells, the first fired being harder than the second.

RECEPTION TEST OF CARPENTER 6'' ARMOR-PIERCING PROJECTILES, AT THE NAVAL ORDNANCE PROVING GROUND, OCTOBER 7, 1891.

The following report is respectfully submitted of the test of Carpenter 6'' A. P. projectiles, representing lot 6.

Previous impacts, two. Plate in condition shown in photograph No. 1, accompanying N. O. P. G., 142-91.

Backing, 36'' oak, secured to center target structure. Backing injured by previous rounds.

Gun, 6'' B. L. R., No. 103 (calibers length 30).

Line of fire to center of plate, normal to plate.

Distance from muzzle to plate, 263 feet.
Powder, Index 90.
Charge, 33 pounds.
Weight of projectile, 100 pounds.

First round.

Projectile marks, 671 K. N. 6 Ord. Dept. W. N. Y. 1891. J. L. C.
Muzzle velocity, 1699 f. s.
Striking velocity, 1676 f. s.

Point of impact, in upper portion, detached from remainder of plate by through crack, 18'' from left edge, 20'' from bounding crack, 15'' below No. 2 perforation.

All parts of projectile penetrated plate. Head went through backing, struck angle iron of target structure and broke it off, then rolled down between two of the diagonal struts. Base had broken off—break diagonal through score for rotating band, longest side 6¾'', shortest, 1½''. This portion was found in the hole in backing made by the shot, base square and away from gun (as if shell had entered from rear), 5½'' from rear face of backing.

The point of projectile was in good condition. One crack on head above bourellet. The head much more set up than usual when the parts were placed together.

Total length shortened, 0''.48.

Diameter enlarged:	At bourellet.	Between bourellet and band.
	0''.33.	0''.36.

Plate:—The section in which shot struck was badly cracked, 4 pieces fell to the ground. The largest of these pieces—the upper left hand corner, 18'' on top, 46'' on left edge—was thrown 38 feet to the left. Upper left hand bolt parted. The condition of this part of plate after this round is well shown in photograph No. 1, as it was but little affected by the second round.

Second round.

Projectile marks, 555 K. N. 6 Ord. Dept. W. N. Y. 1891. C. O'N. J. L. C.
Muzzle velocity, 1690 f. s.
Striking velocity, 1668 f. s.

Point of impact, in lower portion, 23'' from right edge, 25'' from bottom, 23'' from bounding crack.

All parts of projectile penetrated plate and backing, and shell was found about 4 feet in butt.

Projectile entire. Point in good condition. No cracks and no material distortion.

Total length shortened, 0''.27.

Diameters enlarged:	At bourellet.	Between bourellet and band.	Below band.
	0''.03	0''.13	0''.

Plate:—One new through crack, jagged in appearance, and extended from perforation to bounding crack above.

It is recommended the lot represented be accepted.

WRECK OF MONTEREY 13'' PLATE.

The projectile was a Carpenter A. P. shell, No. 33. Striking velocity, 1526 f. s. Point of impact, on the center line of plate, and 26'' from the bottom. The shell penetrated about 14''.5, rebounding entire to a distance of 25 feet, a third of the band being torn off. The plate was shattered, and fragments were thrown to right, left and front. All armor bolts were broken, except three in the lower row, which still hold fragments to the backing. These three fragments were the only parts of the plate that remained against the backing, and these were twisted and wrenched out of position.

Fragment 1 was thrown 15 feet to the right. Fragment 2 was thrown to the front, turned completely over, and fell 1 foot away from the backing. Fragment 3 was thrown 40 feet to the left. Fragment 4 was thrown 30 feet to the right. Fragments 5, 6 and 7 remained still against the backing. Fragment 8 is the envelope, about 5'' thick, surrounding the impact of shot No. 2 of the official trial. It fell 20 feet to the left.

The projectile was shortened .32'', and its point was bent 1.7'' to one side of the axis. The bourellet was increased in diameter .09'', and the body of the shell .19''. A piece of the head, 5'' long, 1.25'' wide and .05'' thick, scaled off about an hour after the shot was fired. The fine longitudinal cracks take their origin in this break, and extend half the length of the body of the shell. The performance of this shell was much better than that of the Firth shell, fired at the left hand portion of the plate.

The backing was somewhat shattered, but still held solidly together, and the structure was not hurt.

On the 15th inst., a fourteen-inch nickel steel plate was tested at Indian Head. Five ten-inch Holtzer shells were fired into it, all of which rebounded, and were markedly bulged above the bourellet. The sixth shell fired was No. 78 Carpenter, inspected March 22, 1892, and which was hardened about an inch or a trifle more above the bourellet. This shell rebounded, but was markedly less distorted than any of the Holtzers. In fact, this distortion was not perceptible, and could only be found by measurement.

RECEPTION TEST OF CARPENTER 10'' ARMOR-PIERCING PROJECTILES, AT THE NAVAL PROVING GROUNDS, NOVEMBER 8, 1892.

The acceptance of 10'' shell, lot 1, manufactured by the Carpenter Steel Works, Reading, Pa., was recommended, the representative shell having passed the test in a very satisfactory manner. The shell, No. 213, was fired at a 10'' plate, with striking velocity of about 1400 f. s., the charge being 140 pounds of powder, U. F. 20. The shell passed through the plate, 36'' of live oak backing, and about 12 feet of loose sand behind the backing. It was recovered entire, slightly set up, but with two fine circular cracks around the ogival, about 5'' and 8'' from the point. The shell was shortened .58''. The bourellet was increased .09''. Body increased back of the bourellet, .16''. Body increased about the middle of its length, .22'' (maximum), and .01'' just forward of the band. The plate was cracked radially in three directions, and is unfit for further use.

RECEPTION TEST OF CARPENTER 8″ ARMOR-PIERCING PROJECTILES, AT THE NAVAL ORDNANCE PROVING GROUNDS, FEBRUARY 27, 1893.

The shell, No. 902, was fired against the 9″ steel plate. It was fired with a small charge, as the resisting qualities of the plate were not well known, and it was important that the shell did not get away.

The shell penetrated the plate and two tiers of the backing, being stopped by the last tier. It was recovered entire. Shortened .02″. Bourellet unchanged. Body increased .01″ in diameter.

Shell No. 1158 was fired, penetrating plate and backing, 28″ of blocking behind, and about 9 feet into the butt, whence it was recovered entire. It shortened .06″. No increase in diameter. It was easily put into the muzzle of the gun again.

RECEPTION TEST OF CARPENTER 10″ ARMOR-PIERCING PROJECTILES, AT THE NAVAL PROVING GROUNDS, MAY 29, 1893.

These shells were fired at the remains of the 14″ nickel steel plate of the *Oregon*, with a striking velocity of about 1350 f. s., and a charge of 140 lbs. U. F.-27. This is the same charge as was used in the test of the last four lots of 10″ A. P. projectiles against this same plate.

Shell No. 706, lot 14, struck the center of a fragment of the plate, the point of impact being about 2 feet distant from the sides or edges of the fragment. The shell broke the section of plate into three pieces in passing through it; thence it penetrated the backing, and ten feet into the earth beyond. It was recovered entire, without cracks, shortened .14″, bourellet increased .02″, body increased .04″ at 12″ from the base.

Shell No. 646, lot 15, was fired at another piece of the plate, striking about 18″ from its edge. This shell penetrated until its point was just through the back of the plate, and rebounded, entire and without cracks. It was shortened .69″, bourellet increased .12″, body increased .28″ at 10.5″ from the base. Test satisfactory and shells recommended for acceptance.

RECEPTION TEST OF CARPENTER 12″ ARMOR-PIERCING PROJECTILES, AT THE NAVAL PROVING GROUNDS, JULY 6, 1893.

A Creusot steel plate, 6′x 8′x 12″, was mounted in the usual manner, with an oak backing, 36″ thick.

First round.—Charge, 203 lbs. V. Y.-6. Striking velocity, 1300 f. s. Projectile No. 20, lot 1, weight 850 lbs. (dimensions given below), struck the plate 21″ from bottom and 21″ from left edge. Projectile penetrated plate and about 16″ of the backing, and rebounded 48′ to the front and 12′ to the right of target, entire uncracked, walls and base of projectile somewhat bruised by striking edges of holes, and a piece of the band broken off. The lower left hand corner was set away from the rest, and wide through cracks ran to the left edge and top of the plate. A very fine through crack ran from the impact upward and to the right, striking the top of the plate about 46″ from the right edge. Fringe and bulge were not apparent.

Dimensions of Shell No. 20, Lot 1.

	ORIGINAL.	AFTER TEST.	DIFFERENCE.
Length	36.15 ins.	35.92 ins.	.23 ins.
Bourellet	11.94 ins.	11.96 ins.	.02 ins.
Body 1	11.91 ins.	11.92 ins.	.01 ins.
Body 2	11.91 ins.	11.99 ins.	.08 ins.
Body 3	11.91 ins.	11.92 ins.	.01 ins.
Band	12.14 ins.	———	———
Rear	11.86 ins.	11.86 ins.	———

Maximum diameter and maximum increase about 10.5″ from base. Shell uniformly set up about body, and symmetrical.

Second round.—Charge, 210 lbs. V. Y.-6. Projectile No. 10, lot 1, weight, 850 lbs. (dimensions given below), striking velocity, 1325 f. s., struck the plate 30″ from bottom and 24″ from the right edge, penetrated plate, backing, about 12″ of blocking and oak strut, and 8′ into the earth. The projectile was recovered entire and uncracked; the plate badly wrecked and unable to receive another shot, though pieces were still held to the backing by the bolts. One piece, weighing about 1.5 tons, was broken out of the right side, and thrown about 20′ to the right. The fringe was chipped off. The front bulge was very slight, and the rear bulge, as estimated from the pieces of the plate, was about 3″.

Dimensions of Shell No. 10, Lot 1.

	ORIGINAL.	AFTER TEST.	DIFFERENCE.
Length	36.12 ins.	35.42 ins.	.70 ins.
Bourellet	11.94 ins.	12.05 ins.	.11 ins.
Body 1	11.89 ins.	11.98 ins.	.09 ins.
Body 2	11.905 ins.	12.11 ins.	.205 ins.
Body 3	11.905 ins.	11.93 ins.	.025 ins.
Band	12.14 ins.	———	———
Rear	11.85 ins.	11.85 ins.	———

Maximum diameter and maximum increase about 10″ from base. Shell uniformly set up about body, and symmetrical. Shells recommended for acceptance.

TEST PLATE INDIANA'S BARBETTE ARMOR—17″, AT THE NAVAL PROVING GROUND, JULY 12, 1893.

The plate, curved to a radius of about 15′, 17″ thick, and measuring on front face 12′x 8.5′, was fastened to 36″ oak backing filled out on front face to fit the hollow of plate, and held to backing by twenty-four 3⅛″ armorbolts. 12″ B. L. R. No. 4, on hydraulic turret mount, and Carpenter A. P. shell weighing 850 lbs. each, were used. Distance of plate from muzzle of gun, 318 feet—upper part normal to the line of fire.

Round 1. Charge, 210 lbs. V. Y. 5. Index No. 168. Carpenter A. P. shell No. 19, lot 1. Striking velocity, 1322 f. s. Striking energy, 10312 f. t. Projectile struck plate 42″ from upper and 42″ from right edge. Angle of impact, 90 degrees. Penetrated 16.5″ and rebounded 78 feet, entire and uncracked, but set up. No cracks were developed in the plate. Fringe regular and 3.5″ high. Front bulge 2.9″ high, and about 40″ diameter. Shot hole smooth and without cracks. One armor bolt nearest impact driven back 18″. Shell shortened .37″; bourillet increased .03″; body increased .15″.

Round 2. Charge, 257 lbs. V. Y. 5. Index No. 168. Carpenter A. P. shell, No. 23, lot 1. Striking velocity, 1495 f. s. Striking energy, 13188 f. t. Projectile struck plate 37.5″ from bottom and 67.5″ from left edge of plate, and about 3½ calibers from first shot hole. Axis of shell inclined, in vertical plane, to surface of plate at impact about 85 degrees. Penetration 20″. Shell rebounded 81 feet, entire and uncracked, but set up. Fringe regular, 3.3″ high. Front bulge, 3″ high. Diameter, 40″. One long longitudinal crack in shot hole and six smaller ones. Back bulge fractured, point of projectile just getting through plate. A small face crack about 7″ long ran from right and downwards from right lower side of impact, otherwise plate was uncracked. One bolt directly below point of impact was driven back about two feet. Whole structure set back about 2″, but backing and structure sound. Shell shortened .38″; bourellet increased .02″, and body .19″.

Round 3. Charge, 377.3 lbs. V. Y. 5. Index No. 168. Carpenter A. P. shell, No. 9, lot 1. Striking velocity, 1858 f. s. Striking energy, 20370. f. t. Projectile struck plate in upper left hand quarter, about 3½ calibers from shot hole of last round—40″ from left edge and 43″ from top. Angle of impact, 90 degrees, approximately. Penetrated plate, 40″ of backing, 24″ of oak struts, 10 feet of rammed earth, and was lost in the river down the range. Plate remained uncracked. Fringe regular 3.3″ high. Front bulge 3.5″ high and 45″ diameter. Back bulge fractured, pieces falling into hole, and one small piece weighing about 50 lbs. thrown about 10 feet to the front. Estimated height of back bulge, 8″. Shot hole, smooth; diameter, 12.5″. Structure set back one inch more.

The charges used in the rounds fired were determined from the following chronograph records:

POWDER.	CHARGE.	M. V.
V. Y. Index No. 168,	240 lbs.	1443 f. s.
V. Y. Index No. 168,	360 lbs.	1816 f. s.
V. Y. Index No. 168,	325 lbs.	1700 f. s.

The Board is of the opinion that this plate has passed the acceptance test according to the contract, and recommends the acceptance of the group represented.

RECEPTION TEST OF CARPENTER 10″ ARMOR-PIERCING PROJECTILES, AT THE NAVAL PROVING GROUNDS, JULY 27, 1893.

A 10″ nickel steel plate, 10′ 3½″ x 6′ 1″ x 10⅛″, representing the second half of plate for *New York's* barbette armor, was mounted as usual against the butt, 138 ft. from the muzzle of the gun, with the line of sight prolonged at level, striking about 2 ft. above the upper edge of plate. 10″ gun, No. 11, 30 calibers, on hydraulic recoil mount was used.

The first shot got away, and fell in the water about 600 yards away, and not far from the beach, and could not be found at first, so the second projectile of lot 17 was fired. The lost projectile was found the next day, and its dimensions are embodied in the report also.

First round.—Charge, 136.8 lbs. U. F.—27. Index, No. 159. 10″ A. P. shell, No. 858, lot 17, weight 500 lbs. Striking velocity, 1351 f. s. Gun depressed, 2,20′. Projectile struck plate about 28″ from right edge, and also from top of plate; penetrated plate, 36″ oak backing, 4′ loose oak timbers, and 5′ of earth; left the butt, rising high in the air; deflected to an angle of about 15′ to the left of the line of fire; dropped into the river about 600 yards away and near the beach, and was not found until the following day, when it was found to be free from cracks, but set up. Dimensions of projectile are given below. The fringe on plate was about 2″ high in the upper left hand quadrant, the rest was chipped off, leaving a fairly smooth bevel edge. The front bulge was 1.8″ high and about 22″ in diameter. Back bulge, to a depth of one-half the plate (5″), was broken off in large slabs, leaving an irregular, dish-shaped cavity in back of plate. No visible cracks on the surface of the plate, although a temper crack could be predicted, running downward to the left. (Photograph No. 136.)

Second round.—Charge 123 lbs. U. F.—27. Index, No. 159. 10″ A. P. shell, No. 957, lot 18, weight 500 lbs. Striking velocity, 1300 f. s. Gun depressed, 2,50′. Shell struck plate about 28″ from bottom and 62″ from left edge of plate; penetrated plate, backing, 6″ loose oak blocking and about 12′ of earth; and, on being recovered was found to be free from cracks, but slightly set up. Dimensions given below in table. Fringe about 2″ high, with lower left hand quadrant chipped off, leaving a bevel edge as in first round. Front bulge, 1¾″ high and 24″ diameter; back bulge broken off. Cracks developed in plate as shown in photograph No. 137. On examining this shell after recovery, several marks or grooves were found on one side of the body in rear of the band (see photo No. 140), which might have been caused by the rifling, although no marks can be found in the gun. The usual difficulty was found in loading the A. P. shell in the second and third rounds, although they were both finally gotten home, after several hard blows with the rammer.

Third round.—Charge, 128 lbs. U. F.—27. Index, No. 159. 10″ A. P. shell, No. 817, lot 17, weight 500 lbs. Striking velocity 1300 f. s. Depression of gun, 3,10′. Projectile struck plate 49″ from top and 28″ from left edge, penetrated plate, oak backing, 12″ oak strut, about 3 feet earth; was deflected out of butt and landed 100 feet to the left and 150 feet to the rear of the target, uncracked, but slightly set up. Fringe, 2″ high. Front bulge, 2″ high and 2′ in diameter; back bulge broken off similar to those in rounds 1 and 2. New cracks developed as shown in photograph No. 138.

Dimensions of Shell No. 858, *Lot* 17.

	BEFORE.	AFTER TEST.	DIFFERENCE.
Length	30.59 ins.	30.25 ins.	.34 ins.
Bourellet	9.94 ins.	9.97 ins.	.03 ins.
Body 1	9.91 ins.	9.94 ins.	.03 ins.
Body 2	9.91 ins.	10.02 ins.	.11 ins.
Body 3	9.90 ins.	9.91 ins.	.01 ins.
Band	10.14 ins.	———	———
Rear	9.86 ins.	9.86 ins.	———

Maximum diameter and maximum increase 8.5″ from base, Shell symmetrical and uniformly set up.

Dimensions of Shell No. 957, *Lot* 18.

	BEFORE.	AFTER TEST.	DIFFERENCE.
Length	30.61 ins.	30.49 ins.	.12 ins.
Bourellet	9.94 ins.	9.94 ins.	———
Body 1	9.91 ins.	9.91 ins.	———
Body 2	9.91 ins.	9.96 ins.	.05 ins.
Body 3	9.91 ins.	9.91 ins.	———
Band	10.13 ins.	———	———
Rear	9.86 ins.	9.86 ins.	———

Maximum diameter and maximum increase 9.5″ from base. Shell symmetrical and uniformly set up.

Dimensions of Shell No. 817, *Lot* 17.

	BEFORE.	AFTER TEST.	DIFFERENCE.
Length	30.61 ins.	30.21 ins.	.40 ins.
Bourellet	9.94 ins.	10.01 ins.	.07 ins.
Body 1	9.91 ins.	10.03 ins.	.12 ins.
Body 2	9.91 ins.	10.11 ins.	.20 ins.
Body 3	9.91 ins.	9.92 ins.	.01 ins.
Band	10.14 ins.	———	———
Rear	9.86 ins.	9.86 ins.	———

Maximum diameter and maximum increase 10.5″ from base. Point slightly distorted from original axis. Slight ridge running round shell about 2″ below bourellet at limit of hardening.

As these shells passed the test satisfactorily, they were recommended for acceptance.

RECEPTION TEST OF CARPENTER 8″ ARMOR-PIERCING PROJECTILES, AT THE NAVAL PROVING GROUNDS, AUGUST 1, 1893.

Gun used, No. 15, B. L. R., 30 calibers, on C. P. carriage, No. 15. Fired against second half of a 10″ nickel steel plate, representing barbette of *New York*, which had already been attacked by three 10″ A. P. shells and one 8″ shell. Plate distant from muzzle of gun, 144 feet. Line of fire slightly inclined to plate. Charge, 65.7 lbs. U. T.—18. Index, No. 157. 8″ A. P.

shell, No. 1619, 2—B., weight, 250 lbs. Striking velocity, 1450 f. s. Impact, about two and one-half calibers from any edge or crack, 22″ from bottom, and 24″ from right edge. Projectile penetrated plate and about 3″ of backing, turning slightly upward and to the right, forcing off part of plate between impact and a crack which was above; rebounded about 6 feet, entire and uncracked. An examination of the fragments of the plate in the middle of the fracture showed some blow-holes and coarse steel crystals, evidently due to imperfect welding.

Dimensions of Shell No. 1619, 2—*B.*

	BEFORE TEST.	AFTER TEST.	DIFFERENCE.
Length	24.57 ins.	24.11 ins.	.46 ins.
Bourellet	7.94 ins.	8.01 ins.	.07 ins.
Body 1	7.91 ins.	7.98 ins.	.07 ins.
Body 2	7.91 ins.	8.14 ins.	.23 ins.
Body 3	7.91 ins.	8.00 ins.	.09 ins.
Band	8.12 ins.	———	———
Rear	7.88 ins.	7.88 ins.	———

Maximum diameter and maximum increase, 6.5″ from base. Shell symmetrical and uniformly set up.

As this projectile has passed the test satisfactorily, the lot was recommended for acceptance.

RECEPTION TEST OF CARPENTER 12″ ARMOR-PIERCING PROJECTILES, AT THE NAVAL PROVING GROUNDS, SEPTEMBER 2, 1893.

12″ B. L. R., No. 4, on hydraulic recoil mounted (*Puritan's*), was used, and the target was *Indiana's* 17″ barbette nickel steel plate. Used new experimental pad and steel discs (narrow front disc). Gun, breech mechanism, hydraulic gear, etc., worked very well indeed, the shell loading easily, using long wooden trough; and the pad and discs working nicely, with no stick or gas escaping. Friction primer was used. Recoil 33″. Projectile weighed only 845 lbs. Two wrenches were broken in trying to start breech-plug, so as to fill to weight, and shell was finally fired short weight. Barometer 30.01″. Thermometer, wet, 58, dry, 58 degrees. Wind, 3 mile per hour.

Charge, 231 lbs. V. Y.—5. Index, 169. Shell, Carpenter A. P. 12″, No. 59, lot 2, 845 lbs. weight. Band, 12.14″. Bourellet, 11.94″. Body, 11.90″. Striking velocity, 1400 f. s. Striking energy, 11,494 foot tons. Projectile struck plate in lower left-hand corner, 26¼″ from the left edge, and 30″ from bottom, at an angle of 5 degrees with the normal, penetrated 17.5″—not quite through back bulge—and rebounded to the front about 70′, entire and uncracked, but shortened and set up, as per table below. Fringe regular: maximum height, 4.7″ at bottom and 2.7″ at top. Front bulge, 4.3″ to 2.5″ high, and about 48″ in diameter. Estimated back bulge, about 5″ high. This shot developed a through crack to left edge of plate, about ¼″ wide, and partly through cracks between Nos. 2 and 3 shot holes of ballistic test of plate, and also one from No. 3 of same to impact of to-day. Interior of shot hole fairly smooth, a crack running around inside from edge toward apex, and a number of smaller cracks, but wood of backing not showing. Left edge of target and structure set back about 2″, and backing crushed on that edge, but not disabled. Duplicate copies of photograph are forwarded herewith, with the impact marked No. 4.

Dimensions of Shell No. 59, *Lot* 2.

	BEFORE TEST.	AFTER TEST.	DIFFERENCE.
Length	[illegible]08 ins.	35.77 ins.	.31 ins.
Bourellet	11.945 ins.	11.96 ins.	.015 ins.
Body 1	11.91 ins.	11.93 ins.	.02 ins.
Body 2	11.91 ins.	12.15 ins.	.24 ins.
Body 3	11.91 ins.	11.93 ins.	.02 ins.
Band	12.14 ins.	———	———
Rear	11.91 ins.	11.91 ins.	———

Maximum diameter and bulge 10.5″ from base. Shell symmetrically and uniformly set up.

As this projectile has passed a very satisfactory test, the lot was recommended for acceptance.

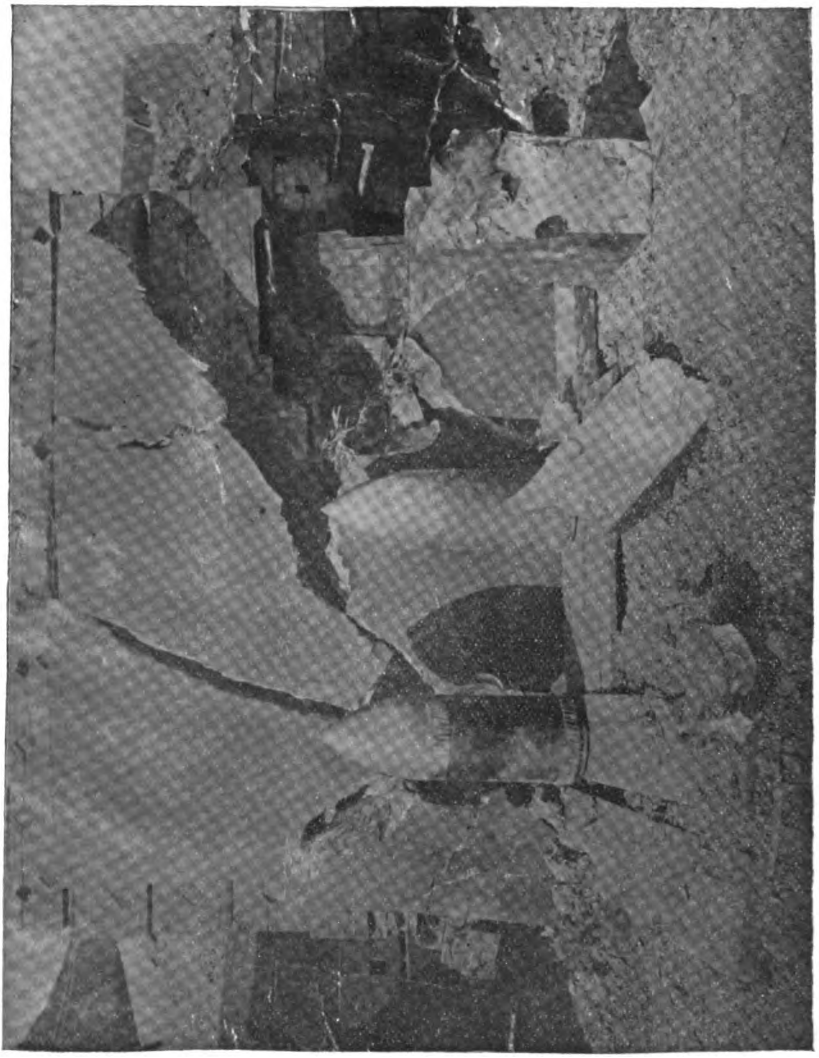
RECEPTION TEST OF CARPENTER 6″ ARMOR-PIERCING PROJECTILES, AT THE NAVAL PROVING GROUNDS, SEPTEMBER 15, 1893.

The test was made by firing against a fragment of the 10″ nickel steel plate, second half *New York's* barbette armor. 6″ B. L. R., 30 calibers, No. 125, on C. P. carriage, No. 97, was used. Charge, 29.5 lbs. S. M. A. 42. Index, 143. Carpenter A. P. shell, 6″, No. 2157, lot 2—B. Striking velocity, 1550 f. s. Striking energy, 1667 foot tons. Distance of plate from gun, 145 feet. Line of fire inclined about eight (8) degrees with the normal at point of impact. Projectile struck plate 17.5″ from left edge, 31″ from top, and 12″ from old crack in plate. Shell penetrated about 10″ on line of impact, and about 9.1″ on normal line; rebounded four feet, and dropped in front of plate, uncracked, and very little set up. Shell entered muzzle of gun easily after recovery. (See dimensions below.)

Plate cracked through downward and to right to old crack, and upward and to left from impact almost to left edge. Fringe 2.5″ high on right edge of shot hole, there being none on the left. Front bulge 2″ high and 21″ diameter; back bulge forced away from plate into backing, but wood not showing.

Dimensions of Shell No. 2157, *Lot* 2—B.

	BEFORE.	AFTER FIRING.	DIFFERENCE.
Length	17.53 ins.	17.41 ins.	.12 ins.
Bourellet	5.945 ins.	5.98 ins.	.035 ins.
Body 1	5.91 ins.	5.94 ins.	.03 ins.
Body 2	5.91 ins.	5.93 ins.	.02 ins.
Body 3	5.91 ins.	5.92 ins.	.01 ins.
Band	6.11 ins.	———	———
Rear	5.88 ins.	5.88 ins.	———



Maximum diameter and maximum increase in middle of bourellet. Shell symmetrical and uniformly set up.

The projectile having passed a very satisfactory test, the lot was recommended for acceptance.

Trials conducted since the date of the last report, both at Sandy Hook and Indian Head proving grounds, bear out the high quality of projectiles submitted for the tests. The following is a report of the test of big shells conducted in March, 1894, at Sandy Hook:

A large armor plate had been placed in position against a heavy wooden backing and a large sand butt. The plate weighing thirty-five tons, was 13½ inches thick. The 12-inch breech loading steel rifle was loaded with a Carpenter shell weighing 1,000 pounds and a charge of 333 pounds of brown prismatic powder. The charges gave a striking velocity of 1,625 feet per second. The first shot struck at the upper left hand corner of the plate and passed right through it, backing and sand butt. The shell was recovered back of the latter, having broken in two pieces in the middle. The plate was cracked somewhat.

The second shot, made at Midvale, was fired at a lower place. It passed through the plate and went into the butt. The third, a Carpenter shell, did likewise. The fourth, a Midvale, also passed through.

Two of the shells were recovered. One of them, a Carpenter shell, was in perfect condition; the other, a Midvale shell, was also nearly perfect.

The first shell fired, which was a Carpenter shell, was broken crossways in one small and two large pieces, about the middle of the shell. One Midvale shell still remains in the butt.

Up to this writing the latest use made of armor piercers was made at Indian Head, on May 19, 189; while testing the 18-inch Harveyized nickel steel plate. As is well remembered, although but two shots were fired at the plate, the same was practically demolished.

The following account shows the behavior of the two shots fired:

The first shot with the 12-inch gun at the central region of the plate was with an 850 pound Carpenter projectile, fired with a velocity of 1,465 feet a second, corresponding to the remaining velocity at a range of 2,200 yards when the full service charge is used.

The target had kept out the projectile, which lay cool and undeformed a few paces in front, but it had expended itself.

But as the plate was now already severely damaged it was decided to try the next shot at it with the second acceptance or perforating velocity of 1,926 feet a second, in order to test the Harvey surface away from the vicinity of the defects, this velocity corresponding to a range of 1,300 yards with full service charge. In this case the charge was 419.3 pounds, made up in four segments.

The shot was delivered on the axial line, about midway between impact number one and the bottom end of the plate. It penetrated about 24 inches, the shell breaking up, the forward two thirds remaining in the hole, and the bottom falling on the ground in front.

The projectile, although fractured, exhibited extraordinary toughness, the breaks showing a torsional effect, as if the base had been twisted off while the point was welded in the plate.

It may be well to mention that in case of necessity American manufacturers could quickly turn out a large supply of projectiles. Among the manufacturers the following companies are among the most important: The Carpenter Steel Co., the Midvale Steel Co., the Taylor Iron & Steel Co., the Sterling Steel Co., and the American Projectile Co.

The accompanying table shows the weights of service projectiles contemplated for use in the U. S. army and the penetration in steel that is expected of them.

Photographs numbered 1 and 2, accompanying this paper were furnished through the kindness of the Carpenter Steel Co. No. 1 showing 12″ projectiles after having been fired at the now demolished plate and No. 2 showing an 8″ projectile under similar circumstances. No. 3 shows the relative size of United States modern service projectiles.

	MOUNTAIN ARTILLERY.		FIELD ARTILLERY.				SIEGE ARTILLERY.			SEA-COAST ARTILLERY.						
	Hotchkiss. 1''.65 B.L.R. steel.	Hotchkiss. 3'' B.L.R. steel.	3''.2 B.L.R. steel. model 1885	3''.2 B.L.R. steel. model 1890	3''.6 B.L.R. steel. model 1891	3''.6 B. L. mortar steel. model 1890	5'' B.L.R. steel. model 1890	7'' B. L. howit'z steel. model 1890	7'' B. L. mortar steel. model 1892	8'' B.L.R. steel. model 1888M	10'' B.L.R. steel. model 1888M	12'' B.L.R. steel. model 1888M	12'' B.L.R. steel. model 1891	16'' B.L.R. steel. model 1892	12'' B. L. mortar cast-iron hooped with steel.	12'' B. L. mortar steel.
Weight in lbs. of projectile filled															800*	800
	1.95	12	13.5	13.5	20	20	45	105	125	300	575	1000	1000	2370	1000	1000
	ozs.	ozs.	ozs.	ozs.	ozs.	ozs.	lbs.	lbs.	lbs.						lbs.	lbs.
Weight of bursting charge															20.8	20.8
	1.8	6.3	7.25	7.25	14.5	14.5	2.58	9.8	12.5						37.5	37.5
Penetration in steel at — muzzle	1.3	1.4	3.8	3.8	3.9	1.1	6.2	3.8	2.2	16	20.4	24.9	27.1	33.8		
1000 yds.							4.6	3.2		14.2	18.5	23.0	25.1	31.9		
Inches — 2500 yds.							3.0	2.7		11.9	16.0	20.4	22.3	29.2		
3500 yds.							2.5	2.4		10.6	14.6	18.7	20.6	27.5		

* The 1000 lb. 12-inch mortar shell may be used for ranges up to 2½ miles with reduced charges; the 800 lb. shell will be used for greater ranges and the maximum charge.

COAST ARTILLERY FIRE INSTRUCTION.

First Lieutenant George A. Zinn, Corps of Engineers.

Little is gained by criticism of purely practical work, yet in taking up such a new idea as Lieutenant Weaver presents, it is well to examine it critically, in order that we may make haste slowly, and not be led astray by what seems on its face to be a distinct advance on anything previously proposed as a solution to that all important question of fire control.

It is an excellent thing to be able to set a gun mechanically upon any given point in a harbor, and to do it in as simple a manner as Lieutenant Weaver proposes, where the whole operation, after receiving a square number, is to read off from another chart a letter and number and to set traverse and dial pointers to the same letter and number on the gun carriage.

There are, however, a few points in Lieutenant Weaver's system which he should elucidate further before it can be admitted that it possesses all the advantages he claims for it over any other system for controlling the fire of a number of batteries and forts defending a sea-coast harbor.

Lieutenant Weaver proposes that the commanding officer (commander of the defenses) in controlling the fire of his works in an attack, shall be at the position finder with the ordinary harbor chart divided into 100 yard squares before him. He is in electrical communication with the group commanders, each of whom is provided with the same chart, upon which is also shown the outer range circle for his group of guns, divided into 100 yard lengths numbered in both directions from a fixed point.

Fastened to the chart and pivoted at the position of the guns is a transparent ruler of uniform width, having marked upon it, lettered spaces indicating range zones. If straight lines be drawn from the points of division on the range circle to its centre, and if the arcs of circles described by the range zones be also drawn, blocks would be formed which are readily described by letters and numbers. These lines are not drawn, but a "plot of experimental firing at Fort Monroe" shows how these blocks would appear. Some confusion might arise by drawing these lines, and besides they are not necessary.

The traverse circles of the guns are graduated and numbered to correspond with the divisions on the range circle. A dial plate on the gun carriage is graduated and lettered to correspond with the range zones, so that when the traverse and dial pointers on the gun carriage are brought to any particular letter and number the projectile will fall in the corresponding block in the harbor.

The system of fire control with which Lieutenant Weaver's may be compared is described in the *Journal* for April 1894.

In this system, the only map used is the harbor chart upon which are also lines marking the limiting arcs of fire for each group of guns in order to show the commanding officer which groups fire upon any particular square.

The traverse circles of the guns are divided into degrees and parts of degrees and numbered so as to read azimuths. The elevating apparatus is provided with a scale indicating elevations in yards of range (not in degrees of elevation).

Each group commander is supplied with a table giving the range and azimuth to the center of every square for his group of guns.

Lieutenant Weaver's system is to be used in the following way: The commanding officer telegraphs to the group commander the number of the square to be fired upon. The group commander moves his transparent ruler over the square indicated and reads off the letter and number of the corresponding zone block.

The gun (after being already loaded) is moved until the pointers indicate the same letter and number and is then ready for firing.

In the other system, the commanding officer telegraphs as before the number of the square, the group commander reads from his table the range in yards and azimuth in degrees to the center of the square. The gun is moved until the pointers indicate the same range and azimuth.

The object in detailing as above, the apparatus and successive steps required by each system is to enable the mind to compare them readily. Nothing essential to each has been omitted.

Both systems propose to use a harbor chart, with its systems of squares, a graduated traverse circle and a graduated arc for elevations.

The readings on the harbor chart are identical, the readings on the gun carriage are the same in number but different in kind. The difference between the two systems lies almost entirely, therefore, in the method of converting the commanding officer's reading on the harbor chart into the gunner's reading on the gun carriage.

In Lieutenant Weaver's system this is done by plotting the commanding officer's reading on a specially prepared chart and taking from it another reading: in the other, it is done by entering a table with the commanding officer's reading and taking out another reading. Will it be easier for the *average gunner* in the heat of battle to set a letter and a figure than yards and degrees, and which can he do the most accurately?

The gist of Lieutenant Weaver's system lies in his chart (fig. 4) so let us examine it closely.

It shows a set of squares similar to those of the harbor chart, and it might be said without further thought that the inaccuracies or defects of the square system are carried into his system.

This chart shows also an arc with sub-divisions 100 yards in length, numbered from a fixed point in both directions. A transparent ruler of uniform width is fastened to the chart as previously described.

The reading received from the commanding officer is the number of the square upon which is situated the object to be fired at. The reading taken from the chart is the corresponding zone.

The reading taken from the chart cannot be more accurate than the reading plotted upon it. The group commander would most likely, therefore, read off the zone corresponding to the center of the indicated square. I cannot see, therefore, where any gain of accuracy is obtained over a direct reading of the calculated range and azimuth to the center of the square from a previously prepared table. If the commanding officer plotted the position of a ship directly upon the group chart then the group commander could repeat it on his own chart, and obtain the advantage claimed by Lieutenant Weaver for his system, that of greater accuracy for the shorter ranges. The number of group charts which the commanding officer would have before him for this purpose or the number of lines on the harbor chart required to represent all the group zones would lead to considerable confusion, to say the least. Simplicity is not an attribute of such a system.

The advantage claimed, that the size of each block is adjusted to the danger space at all ranges and that the blocks are much deeper in range for the mid-ranges and short ranges must therefore fall to the ground.

That "fewer blocks are required by this system than by the square system" cannot well be admitted when one system is superimposed upon the other rather increasing than diminishing the number of blocks required. It seems to me a little more confusing to use these two systems than to use a system of squares alone.

Nor can it be admitted that "it has the advantage of simplicity and quickness of operation over other systems" since the number of steps required for its operation is just the same, although it may perhaps be easier for some minds to plot a reading upon a chart and take off another than to enter a table and take out a reading.

Let us also examine a little closer the range dial and traverse circle graduations which he proposes to substitute for arcs of elevation and azimuth circles.

Why is the range dial an "improvement on other means heretofore used to give elevations"? It appears rather to be a rough approximation than a thing giving accurate results. Suppose a ship is at anchor how would increased accuracy or a better shot be obtained by such an instrument? In fact the system seems mainly to have been devised for use against ships in motion, while modern writers believe very generally that ships must come to anchor to be effective against sea-coast defenses. That it gave good results does not prove that other untried systems would not give equally good or better results.

Has any one ever denied "that direction in azimuth can be best given by traverse circle graduations"?

A graduated arc can readily be attached to the breech of any gun and there are no cogs to wear out or be broken.

What advantage can there be in a system which requires each traverse circle to be graduated for its own particular gun after it is placed in position, over one in which the traverse circles are all traversed alike? Simplicity is in favor of the latter and errors are less liable to occur.

An 8″ gun carriage, for example, by the latter system may be set up anywhere and used immediately, while the former requires an elaborate series of observations and calculations to be made before it can be used.

The "plot of experimental firing at Fort Monroe" shows in detail the zone system proposed by Lieutenant Weaver, and when used with a small gun as a harbor chart without any squares whatever plotted upon it, would give undoubtedly greater "simplicity and rapidity of operation over that previously used": but when a system of defenses includes many groups of guns, it fails to do what is claimed, in fact it appears to have the disadvantages of complexity and greater cost.

The square system as outlined can be applied to the "apparatus and methods now employed in target practice at our coast forts" without the expense of range dials.

First Lieutenant *E. M. Weaver*, Second Artillery—I have read Lieutenant Zinn's comments on my system of directing the fire of coast guns with much interest. A carefully thought out and honest criticism like this is precisely what I hoped for, and I feel personally indebted to Lieutenant Zinn for the care and attention he has given to the study of my paper.

Perhaps I did not make clear in my paper some points. At any rate it seems to me the objections raised by Lieutenant Zinn are apparent rather than real. I shall endeavor herein to further elucidate the points he refers to.

As I understand it, his main criticism is to the effect that while "the zone system proposed by Lieutenant Weaver when used with a single gun and a harbor chart without any squares whatever plotted upon it would give undoubtedly greater simplicity and rapidity of operation over that previously used," "it appears to have disadvantages of complexity and greater cost" when used in connection with many groups of guns.

The "complexity" referred to appears to arise in Lieutenant Zinn's estimation from the use of the transparent rules and outer range circle on the ordinary harbor chart now in use, with its systems of squares, as represented in figure 4 of my paper. The "greater cost," from the use of the range dial.

In regard to the former objection I can assure Lieutenant Zinn there is no confusion whatever resulting from the use of the transparent rules on the system of harbor squares now employed. The two readings are brought into coincidence easily, each is distinct, and there are no lines whatever on the harbor chart belonging or essential to the system except the outer range circle for each group; the degree-minute azimuth system would require the same number precisely. *By the same act* the group commander establishes the coincidence and converts the commanding officer's harbor square signal into his own group reading. It is a mistake to speak of this as a "plotting of the commanding officer's reading." The transparent ruler is brought over the signaled harbor square, that is all, no mark is made and no time involved in anything like the act of plotting; the group-block reading appears *at once and is read off*; it is, in truth, a single simple step, not two, as Lieutenant Zinn has represented it.

But it should be pointed out clearly that the use of the system in connection with the existing system of harbor squares is not in any way an essential of the proposed system. In showing in my paper how my system could be adapted to the present square system I merely wished to illustrate a particular application of it to meet what I thought might be the preferences of some, but I did not mean to imply that it had no other application in the general control of the fire of several groups, and especially I did not mean to have it understood that the illustration was "the gist" of the system.

Putting the harbor chart and its squares entirely aside it is perfectly evident that the commander of all groups could have on his plotting chart a reproduction of the transparent rulers and outer range circles of all the groups as explained for the single gun, and that *no squares, blocks or lines whatever would appear on the paper except the single outer range circle for each group.* In this arrangement the chief commander would signal to each group *its own proper block signal.* This eliminates at once all intermediate steps between the chief commander and the groups, and places him in as full and intimate control of all the guns as the group commanders themselves of the respective groups.

Lieutenant Zinn is, therefore, entirely mistaken when he asserts that "the gist of Lieutenant Weaver's system lies in his chart (figure 4);" that is in the application of the system to the squares of our harbor charts. It follows that all criticism based on this assumption falls to the ground, even if it were well taken. This includes his remarks as to confusion of lines on charts, intermediate steps, number of blocks, etc.

The *gist* of the system is rather the principle established by the firings at Fort Adams in October in 1893, and at Fort Monroe in September, 1894, namely, that *it is possible through the science of ballistics and through the accuracy of modern angle measuring instruments to select a point on a chart properly oriented, and actually hit it, by simply setting the pointer of the traverse circle and that of the range dial to the readings taken from the chart.* On this principle the entire field of fire is divided into "danger blocks," such that if a block be occupied by a ship target it will be hit by a projectile laid for that block. The width of the blocks is uniform for each zone and on the outer range circle is 100 yards—the length of an average battleship—this is subdivided into 50-yard divisions, and these into 25-yard divisions. The longer divisions are for use with rapidly moving targets or when the ship stands broadside on, the smaller divisions for slower moving targets, ships coming more or less bow on, or when at anchor. It makes no difference where the chart is located after the orientation has been accomplished; it may be at the guns, or at a distance. There may be a general chart as already explained oriented in the same way with respect to several groups and their corresponding fields of fire, from which a central commander can direct the fire of each or all groups the same as for a single group, entirely independent of the square system, and without any lines except one range circle for each group.

Referring to the question of "cost," it is difficult to think that Lieutenant Zinn really meant to raise this as a point against the system. The range dial, as a matter of fact, is not an expensive piece of mechanism, would not cost any more than any other apparatus used in giving elevation to a gun of large caliber. But this objection has been entirely removed by the adoption by the Ordnance Department for our new guns of practically the same principle as used by me at Fort Adams and Fort Monroe. In this connection I would refer Lieutenant Zinn to the new elevation indicator for the new barbette carriage of the 12-inch B. L. R., see Chief of Ordnance Report for 1894.

Having replied in a general way to the general criticisms of Lieutenant Zinn, I will proceed to answer in detail some particular questions he raises.

He asks: "Will it be easier for the average gunner in the heat of battle to set [a pointer to] a letter and a figure than [to set in the usual way] to yards and degrees, and which can he do the most accurately?" We cannot, of course, answer this based on "the heat of battle," but I have no hesitation in saying that in firing with a four-minute time interval between shots with the 8-inch M. L. gun, and with less than one minute allowed the gunner in which to lay the piece, it is far simpler, less exciting and more accurate to bring the pointers to the letter and number given than to set the breech sight to the degrees and minutes necessary for the range, sight through the peep-hole of the sight and bring the gun to the proper azimuth angle first and then to the proper elevation. The difficulty in this method is in making the fine vernier adjustments for the minutes, the personal eye error of the gunner in sighting, and the fact that the elevation and direction cannot well be given at the same time. With the letter-number system there is a wide limit for the pointers to swing within each danger-block reading, there is little or no chance for eye error when the reading is taken from a pointer swinging over a dial, and both elevation and direction are given at the same time. It would be interesting and instructive to have the two methods tested side by side at ten separate targets scattered at random over the field of fire at Fort Monroe with a time limit of 3½ minutes between shots. This question of time limit between shots has been utterly neglected in our practice firing and I believe its importance is not fully appreciated. To apply Gen. Forrest's definition of strategy, it does not seem to be realized that coast artillery must not only "get there" with its shot, but it must "get there *first* and with *greatest number*" of shots. When the slowly changing evolutionary processes in operation about us shall bring us to this point in our target practice, we shall, I think, discover a number of "broken reeds" which have been serving to keep us upright.

Lieutenant Zinn asks, "Why is the range dial an improvement on other means heretofore used to give elevations?" and proceeds to add, "It appears rather to be a rough approximation than a thing given to accurate results." If it so appear its appearance certainly belies its actual performance. In replying to the question asked, one is almost prompted to think that the question is put merely to imply the opposite. The assertion following it confirms this view. But I am disposed to accept it as honestly asked, that he really wishes to be informed on a professional point outside the limits of his own field, especially since it is a point on which he can hardly have had any practical experience.

It has been found in using the ordinary breech sights that no two gunners are likely to give the gun the same elevation, within 3 to 5 minutes, for any given angle. This arises from differences in setting the vernier of the sight, from differences in taking fine and coarse sights in aiming, and from inherent eye and personal errors. The range dial, on the other hand, by multiplying the angle of elevation through the gearing, enables us to dispense with verniers altogether, and enables even an uninstructed man to set to any reading quickly and accurately, within the limit of one minute, that is to bring the point of a pointer to within the limits of one-sixteenth of an inch on the arc of the dial. This removes almost entirely the inaccuracies arising from fine and coarse sighting and from varying vision.

The arc of the range dial offers a convenient place for entering corrections for wind, drift, etc. It is also possible to change the graduations readily at any time to correspond with new muzzle velocities of new powders or changing velocities of old powder.

With the wind dial, both elevation and direction may be given at the same time with a corresponding economy of time, and with less exposure of the gunner.

It lends itself readily to indirect fire, when, for any cause, the target is not visible from the gun. In October, 1893, Battery "K," 2nd Artillery, in its regular firing with the 8-inch M. L. converted rifle at Fort Adams, found, after firing four of its ten rounds, that the target could no longer be seen from the gun because of a fog which had drifted in from the sea, but could be seen by the observers through their telescopes. The position of the target had been plotted on the chart. I had attached a range dial to the carriage and had my chart on the plotting board for purposes of comparison. A trial shot was fired according to the reading of my pointers. It plotted very close. The rest of the shots were then fired rapidly according to this same reading. The six shots so fired were the best six consecutive shots fired by the regiment that fall and served to give the battery first place in the record of firing with this gun. While the range dial is of special service in firing at moving targets because of the quickness with which the elevation may be accurately given, it gives even better results at an anchored target such as a ship would make. Lieutenant Zinn asks, "Suppose a ship is at anchor, how would increased accuracy or a better shot be obtained by such an instrument?" The foregoing example of Battery "K" is one way in which the instrument enabled good accurate shots to be fired when the ordinary breech sight failed, and generally speaking, in reply to the above, increased accuracy would be had in all cases *because the gun can be more accurately laid for range by the average gunner down to one minute of arc* than is possible with either gunner's quadrant or breech sight.

He says, "Modern writers believe very generally that ships must come to anchor to be effective against sea coast defenses," and intimates, therefore, that, because the system is chiefly of value in directing the fire at moving targets, it will have little application in time of war. I agree that battle-ships must anchor and anchor close to do any serious damage to coast defenses, but it does not follow by any means that we shall therefore have to fire only or chiefly at ships at anchor. It is also very generally believed by coast artillery-men and naval men the world over, that a ship at anchor is no match for shore guns at any range. And it may be stated quite positively that no ship will come to anchor in front of a fort that is armed with modern ordnance and manned by properly instructed troops, and no fleet of ships will come to anchor to fight a group of such forts. We shall have chiefly two distinct classes of targets, namely; first, ships rushing by forts to some position beyond; and, second, ships in motion, at a distance, bombarding cities or harbors at long range over the forts; both involve practice at moving targets.

Lieutenant Zinn asks the question, "Has any one ever denied that direction in azimuth can be best given by traverse circle graduations?'" I reply, "yes." He of course knows that such graduations have not heretofore been a part of our system. Even with the new carriages no provision is made for azimuth pointers and scale.

The reason I made the assertion in my paper that "Direction in azimuth can be given best by traverse circle graduations," was, that when I first submitted my method for the private criticism of a few friends it was claimed by some in high position that the system would fail because sufficient accuracy could not be obtained by the traverse circle graduations. The good record made in the firings on this point prompted me to call special attention to it.

Referring to the range-dial he says "a graduated arc can readily be attached to the breech of any gun and there are no cogs to wear out or be broken." He misses entirely the advantage due to the gearing. As before stated the object of the gearing is to so multiply the angular movement of the gun in elevation that *all vernier readings may be dispensed with*. In accurate firing it is very important to give precisely the elevation down to one minute of arc, especially at the ranges inside 3000 yards, and if the vernier be used it involves good eyesight and great care in reading and setting. Vernier setting is, in fact, the most confusing thing our gunners have to do in laying the gun; it absorbs much time and is a very fruitful source of error at a point where error —even a small error—affects most seriously the accuracy of fire. If it be attempted to use an arc without the use of gearing as suggested by Lieutenant Zinn the arc would have to be so large as to prohibit its use. The gearing accomplishes it in a limited space and with perfectly reliable results, giving a linear limit of one-sixteenth of an inch on the arc for a reading of one minute of elevation. There need be no fear about the cogs wearing out or breaking. The apparatus is in every way as substantially made and as durable as the breech sights used in our service or foreign services and not more costly, and will, with ordinary usage, last indefinitely.

It is asked: "What advantage can there be in a system which requires each traverse circle to be graduated for its own particular gun, *after it is placed in position*, over one in which the traverse circles are all graduated alike [beforehand]?" And, it is added, "simplicity is in favor of the latter and errors are less liable to occur." This is a bare question and a bare assertion, and, without support, has absolutely no weight in a discussion.

If the traverse circle be graduated after the gun has been mounted on its carriage by sighting along the gun itself, all causes affecting the graduation are included. For the purposes of artillerymen the gun, its carriage, and its emplacement are considered as a unit, and all adjustments and graduations should only be made *after all parts of this unit have been assembled.* This seems, in truth, axiomatic to us. It cannot be said either that these views have been changed in the slightest by the examples we have in the pre-graduated circles laid down for the 12-inch B. L. mortars. To graduate a traverse circle, put it down, place a carriage on the emplacement, and, finally, mount a gun on the carriage, seems somewhat like John Phœnix's celebrated method of taking transit observations, mounting the transit on a mule and then backing the animal up into the plane of the true meridian. There is a fundamental relation between points on the field of fire and the trajectories which does not always and necessarily adjust itself to variations introduced with job lots of graduated traverse circles manufactured and laid down by contract. It may be true that "simplicity is in favor of" circles so nicely fixed in advance for us, but I doubt if Lieutenant Zinn will get many practical artillerymen to agree with him that "errors are less liable to occur."

Furthermore, by orienting each traverse circle with respect to the particular field of fire in front of it all guns of the group *are set to one and the same block signal;* that is, *there is required but one signal from the commander for all the guns of a group.* In the ordinary degree-minute azimuth system the table of azimuths would have to be entered with the designations of the signaled square, then the appropriate azimuth in degrees and minutes taken out *for each gun*, and then transmitted separately to each gunner, or each gunner would have to enter the table and take out the proper azimuth for his gun. My system does away, absolutely, with all converting tables, and makes use at once and directly of the signal from the position finder.

Another objection made is, that the system involves "an elaborate series of observations and calculations to be made before it can be used."

It may be said in reply that there are no data required to install the system for any gun group or groups that would not be given by the range table of the gun. At Fort Monroe all ballistic data were taken directly from Whistler's graphic tables and required only a few minutes, perhaps an hour, to take out.

These data were required only for the range dial. The traverse circle requires no computations except the solution of one simple proportion. The chart (omitting the drawing of the lines showing blocks, which are unnecessary with a transparent ruler) occupied only the time required to plot Bug Light, draw the outer circle, and lay off the equal divisions from the datum line. I am confident that the system as a whole can be installed, at any time, for any number of guns, in, at most, one-half the time required to install the ordinary square-system including the chart of squares, the converting table*, and the degree-minute azimuth traverse circle. It is essentially incorrect to speak of the system as requiring "an elaborate series of observations and calculations to be made before it can be used."

I have endeavored to consider every material point raised by Lieutenant Zinn, to give due weight to each, and to make reply thereto. It seems to me that none of his criticisms hold. He has made a fundamental error in his conception of "the gist" of my system, and this being the groundwork of his criticism the superstructure falls with it. He is mistaken in thinking there would be confusion of lines when used with the square system. He is mistaken in speaking of *a plotting* on the group commander's chart. He has misstated the number of steps necessary between the chief commander and the gunner. His assertions as to the range dial are unsound, and also that in regard to pre-graduated traverse circles.

My own former assertions still hold in regard to number of blocks required for any group of guns compared with the square system, and also that "the size of each block is adjusted to the danger space at all ranges", and that "blocks are much deeper in range for mid-range and short range.

I had read last year with interest in No. 11 of this *Journal*, Lieutenant Zinn's contribution to the discussion of *Coast Artillery Fire Instruction*, and although he advocated strongly therein the square system, I had felt he would welcome a system which would accomplish all he therein desired, without the defects and delays attending the use of converting tables. I sincerely hope I have been able to explain away some of the difficulties he has found in my system.

First Lieutenant C. D. Parkhurst, Fourth Artillery.

OBSERVATIONS ON THE LIFT OF THE TRUNNIONS OF THE 8-INCH CONVERTED RIFLE FROM THEIR BEDS WHEN THE GUN IS FIRED.

As this lift has perhaps an important bearing in connection with the "jump" of the gun, the following experiments and observations were made to determine its amount.

For the first experiment light steel rods, suitably bent to give a tracing point, were firmly clamped to the cheeks of the carriage in such a manner

* Lieutenant Wilmot E. Ellis, writes on page 228, No. 11, of this *Journal* for April, 1894, "The average number of squares tabulated for each of the 15-inch guns at this post (the Presidio) is about 1500, and each tabulation covers some forty odd pages of a portfolio book." Imagine a poor gunner taking out his azimuth angle from such a table with one minute allowed for laying the gun. E. M. W.

that the tracing point coincided with the center of motion of the trunnions with its eccentric shoe, and so as to trace upon the trunnion the amount of lift.

On trial it was found that these rods were too light to give in a wholly reliable manner the data sought, for the reason that they sprung and vibrated too freely under the influence of the blow of the recoil acting against their own inertia. This vibration or spring was invariably towards the muzzle for the *first* motion, showing that the tracing point at the end of the rod did not partake of the motion of the carriage instantly as the latter started to the rear under recoil. From the character of the line traced it also became evident that an appreciable time elapsed *before* the lift began.

A second set of arms of bar iron 1⅛″×⅛″ in cross section were therefore made, with a hardened steel point set in near one end to act as a tracing point. An arm was put to bear against each trunnion, and they were bolted down as rigidly as possible by the heavy assembling bolts of the carriage cheek near and under the trunnion bed.

On trial it was found that these arms acted much better in tracing the amount of lift. But they also showed a line traced towards the muzzle from the initial point of rest; this line was approximately uniform in length and about one-tenth of an inch long, showing that these heavy arms still sprung under the blow of the recoil. Inasmuch as the tracing showed that the tracing point came back to its initial point of rest *before* the lift took place, it would appear that there was a considerable time interval *after* the blow of the recoil, and *before* the lift took place, this time being enough for the arm to vibrate through its limit towards the muzzle and back again and then to trace the vertical line due to the lift.

From nearly fifty observations it would appear that the lift is approximately uniform at all times, and also uniform for *both* trunnions. The amount of lift was found to be thirty-five one-hundredths of an inch.

The line traced by the tracing point was shaped very nearly like the figure 7 reversed, *i. e.* with the top of the figure turned to the right, for the right trunnion, and exactly like the figure 7 for the left trunnion. There was no indication of anything but a return of the tracing point over the same or approximately the same path in moving from the muzzle that it had traced in moving towards the muzzle. This line is represented by the top or horizontal part of the figure 7; the angle between this line and the vertical line which represented the lift was clear and sharp, and the tracing showed no indication of any approach to a triangular shape as would have been the case if the lift had begun while the point was vibrating towards the muzzle, or while on its return vibration towards the breech.

Though by no means conclusive, these observations perhaps indicate

1st That the lift does not take place until after the projectile has left the gun, and therefore does not affect the jump.

2nd That the amount of lift is uniform, and

3rd That the gun lifts evenly, and shows no sign of any rotation about its longer axis, the lift for the two trunnions having been found equal.

Captain Sedgwick Pratt, Third Artillery.

Lieutenant Whistler states in his pamphlet explaining the use of his graphic tables that the argument for entering the table of jump is the angle of departure, whereas the table shows that the argument is the angle of elevation.

While on a board of officers for examining candidates for gunners in my regiment I noticed this table was indiscriminately used for determining angles of departure and angles of elevation, knowing the jump. As Lieutenant Whistler, in his experiments by which he was enabled to construct this table, must have determined the jump for angles of elevation, it is well to point out that said table can not *directly* and *accurately* be used to determine the angle of elevation knowing the angle of departure only.

For example: the angle of departure for an angle of elevation 5° 25.′5 is by the table 5° 45.′0; whereas the angle of elevation for an angle of departure 5° 45.′0 is 5° 24.′2 by the table *when used as stated*, being erroneous by + 1.′3 (5° 25.′5 — 5° 24.′2). Similarly at the cusp point B of the jump curve an error of 2.′4 will result.

The elevation can, however, be very closely determined as follows: the jump for φ or angle of departure 5° 45.′0 is 20.′8; this from φ gives 5° 24.′2, the jump for which is 19.′4, differing from jump for φ by +1.′4. Adding this difference to 5° 24.′2 gives 5° 25.′6 the angle of elevation.

What is said above applies to Rodgers's tables, for in them also the jump is given for angles of elevation.

Another and simpler way to use Whistler's table is to find in the table that angle of elevation and corresponding jump whose *sum* equals the given angle of departure.

1st Lieutenant *G. N. Whistler*, 5th Artillery.—I have read Captain Pratt's paper, and he is undoubtedly mathematically correct in his view of the subject.

I am of the opinion however that for practical purposes the table of jump may be entered either with the angle of elevation or the angle of departure as the argument.

This subject was carefully considered at the time of constructing the tables, and I concluded to adopt the following plan: As the graphic table is intended to be used either for practical work at the gun, or for ballistic study, I was careful to use the words "angle of elevation" at the top of the table, so as to clearly indicate the curve was constructed for angles of elevation; but as the tentative process, necessary to determine the true jump when the angle of departure only is known, is too complicated for practical use, I in my explanation used the angle of departure in entering the table; believing it to be sufficiently accurate for all practical purpose to enter with either angle.

There is one great advantage that a graphic table has over an ordinary range table, which I think is not thoroughly appreciated. The ordinary range table cannot be worked backwards, and therefore cannot be used for ballistic study except by long and tedious tentative interpolations. Whereas in the graphic system, the record being continuous, it may with great advantage be used backwards, and hence is of great value for ballistic study. It is true that the table of jump cannot, except by a tentative process, be satisfactorily used in this manner, but there is no particular difficulty in this operation. Considering that the use of my tables for ballistic study would be of great value, I deemed it necessary to clearly indicate that the proper argument for the table of jump was angle of elevation, although I expected to use the angle of departure for ordinary use at the gun.

I very much fear that in the transition from the old system of "*rule of thumb*" to the more scientific modern artillery methods, there is a tendency towards a scientific refinement, that is hardly practical. The present idea of Captain Pratt's is I think a case in point. It is impracticable to use the jump table accurately in the time allowed at the gun, and the method suggested in my pamphlet appears to me to be sufficiently accurate for all practical purposes.

In this connection it may be interesting to know exactly how this table was computed. The powder to be used, after having been thoroughly mixed was tested for velocity at Sandy Hook, great care being taken in the measurement of density of loading, and all the other details of loading. A series of shots was fired at each of the following elevations: 3°, 5°, 7°, 9°, 11°, and 15°. The ranges were carefully plotted, and also computed from the base line angles. The deviation was taken by a transit; great care was taken in determining the exact velocity of the wind at the instant of firing each shot: and after each round was fired I noted in the column of remarks a figure which indicated from my personal judgment, what weight should be given to each class of data. After completion of the firing, the shots fired at each range were carefully plotted and reduced to zero wind and standard atmospheric conditions, and the center of impact plotted geometrically; the range to the center of impact being taken as the plotted range for that particular angle of elevation. After this the ranges were computed, and the center of impact determined by departures and latitudes. Finally the data as to range and deviation, each affected by its "*figure of weight*" was then considered by the method of "least squares", and the center of impact and range thus determined. As a rule the position of the three centers of impact did not vary materially. In determining my final data I was however in some cases obliged to use my judgment, and having thus determined the ranges for these various elevations, I constructed a range curve, and thus had a fourth check upon the previous computations.

These ranges having been determined, I computed by Ingalls' method, using the conventional muzzle velocity, the presumable angle of departure, and by deducting from this angle of departure the actual angle of elevation, I obtained the jump. I then constructed my table of jump using the actual angle of elevation as my argument.

Lieutenant H. C. Davis, 3rd Artillery.

THE DIAL OF THE WIND VANE.

The wind vane is used, primarily, to gain a knowledge of wind direction.

As used in artillery firing however, the ultimate information is not wind direction but the component of its velocity in each of two directions; the one along the directing line (12 o'clock) and the other at right angles to the first.

Let the length (R) of a pointer, pivoting on a center and traversing a circle about this center, represent the wind velocity as shown by an anemometer. Draw a right line through the center of this circle for the directing line, and another diameter perpendicular to the first.

Let the directing line be in, or parallel to, the plane of fire and let the pointer take the direction of the wind, making an angle (α) with the directing line. Then the projections of the pointer on these two diameters will furnish all the information desired and in its simplest form. The values of these projections are expressed by $R \cos \alpha$ and $R \sin \alpha$.

The angle α varies for a change in either direction of fire or wind, and wind velocity, expressed by R, may vary several times an hour. It is possible then that the calculations, indicated by the foregoing expressions, may have to be made quite frequently during practice, and, some times, at short notice, due to sudden changes in the direction of fire. This being the case, the simpler the factors entering these expressions, the greater the ease and quickness with which the computations can be made. If these factors may be expressed with sufficient accuracy, the one, R, in whole numbers and the other two, $\sin \alpha$ and $\cos \alpha$, in tenths or tenths and half tenths, the computation becomes quite simple and may with ease and celerity be performed mentally.

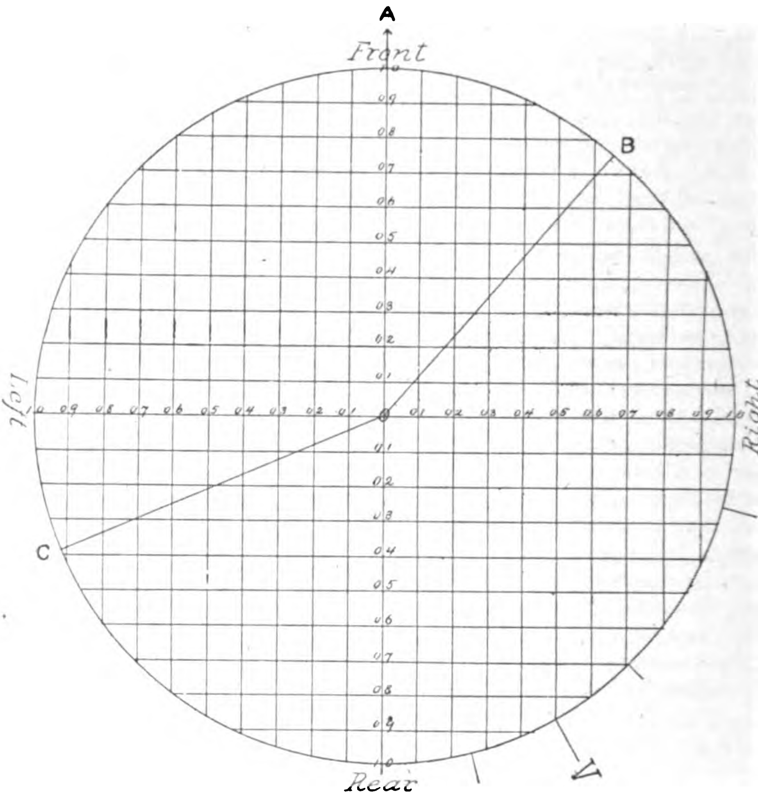
The method at present in vogue gives the value of R to the nearest whole number in miles per hour, while the values of $\sin \alpha$ and $\cos \alpha$ are taken from a table in which the quantities, expressed as common fractions, correspond to whole units of arc. This unit of arc is usually 15°, or half an hour by clock analogy: sometimes the unit may be $7\frac{1}{2}^\circ$ or quarter hours, although I can not now remember seeing such a table.

Since the values of the $\sin \alpha$ and $\cos \alpha$ are what we want and not the value of α itself, it seems natural, when these values are expressed graphically, that we apply our scale and determine the quantities themselves rather than apply the scale to some other quantity of which they are functions and then find the desired values through the medium of a table. Moreover, as shown further on, by direct measurement we get our values quite as easily, with equal or greater accuracy and in a simpler form for combination with the other factor (R) which enters the given expression.

Instead then of the old method of dividing the circle of the dial into arcs of 15° (half hours) and using a table therewith, I propose to divide each of the two diameters, referred to above, into twenty equal parts and to take therefrom the values of $\sin \alpha$ and $\cos \alpha$ to the nearest tenth, or half tenth if desirable.

Figure 1 shows the proposed method*. The division of the second quadrant into hours and half hours does not belong to the proposed plan, but it is made for a comparison of methods as noted further on.

Figure 1.

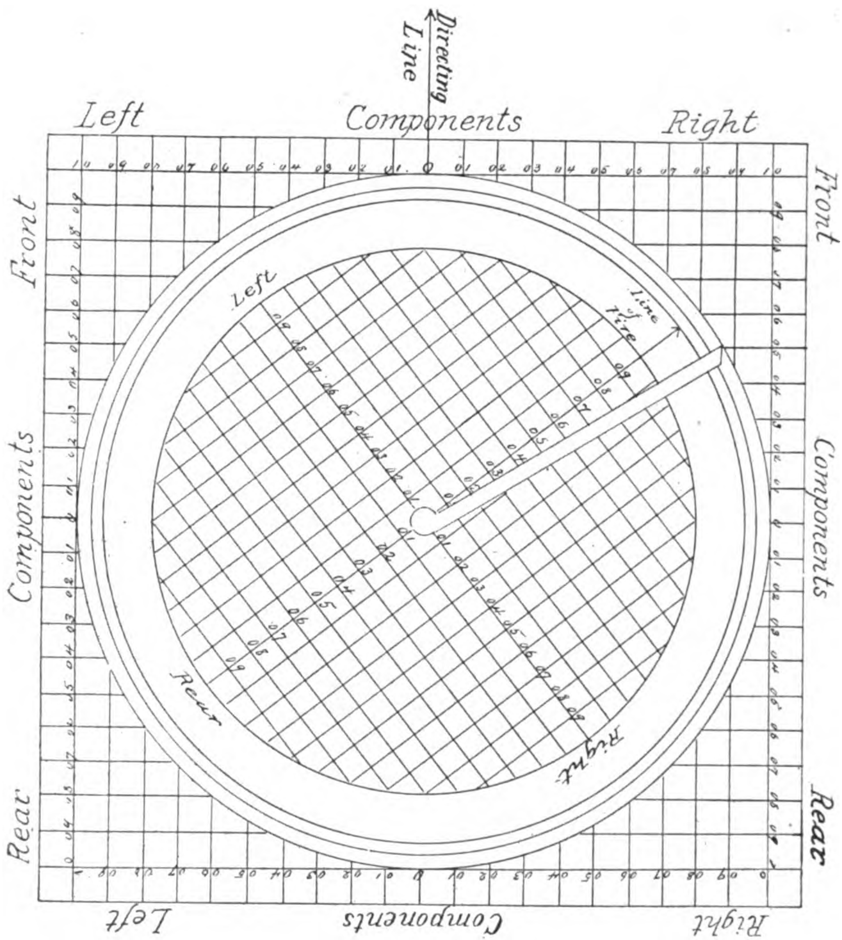


The directing line OA (fig. 1) being in, or parallel to, the plane of fire, and the pointer occupying successively the positions OB and OC, corresponding to two successive wind directions, we read the factors cos α and sin α directly as follows:

(OB)	cosine	0.7½	front,	sine	0.7½	right
(OC)	cosine	0.4	rear,	sine	0.9	left

If at this time the value of R be given, say 20 miles, we perform the multiplication mentally and get

*It would be more scientific to use the center as an origin of coordinates and give the value a positive or negative sign as required, but the method adopted is probably simpler when considered in connection with the transmission of their values by signal. This however is an open question not affecting the proposed method.


Directing Line
Left
Components
Right
Front
Components
Rear
Front
Components
Rear
Left
Components
Right
Left
Line of Fire
Rear
Right

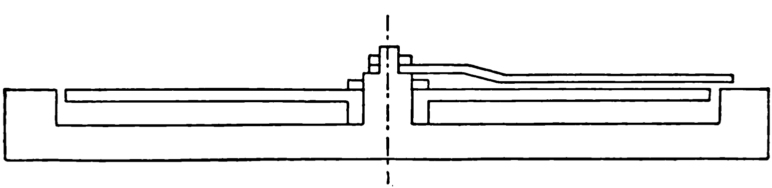


Figure 2.

(OB) 15 miles front, 15 miles right
(OC) 8 miles rear, 18 miles left

As already stated the old method requires a table of values, and these are expressed by common fractions*. For the convenience of those desiring to make a comparison of methods, I have divided the second quadrant (fig. 1) into half hours and give here a table corresponding to that quadrant.

HOUR.	COMPONENTS.	
	Right.	Rear.
3	1	0
$3\frac{1}{2}$	$\frac{29}{30}$	$\frac{1}{4}$
4	$\frac{7}{8}$	$\frac{1}{2}$
$4\frac{1}{2}$	$\frac{7}{10}$	$\frac{7}{10}$
5	$\frac{1}{2}$	$\frac{7}{8}$
$5\frac{1}{2}$	$\frac{1}{4}$	$\frac{29}{30}$
6	0	1

There is an error often committed in the use of this table in taking out values intermediate to those given. For instance, following the custom in the use of tables we would for the component, corresponding to $5\frac{3}{4}$, take a mean of the tabular values corresponding to $5\frac{1}{2}$ and 6. But the known relations of arc to circular functions indicate clearly that this is wrong and, moreover, that the error will vary according to the part of the arc considered.

This may be a refinement, but if the refinement costs nothing why not have it. In the proposed method interpolation is possible without fear of error.

If each gun or group of guns has its own vane, figure 1 shows all that is necessary for a dial.

The only additional requirements being that the mounting be such as to allow the dial plate to be clamped in any given position while the pointer, actuated by the vane, moves freely over it.

When a central vane or "wind clock"† is to be used, the dial takes the form given in figure 2. This was proposed by me in a previous article and described as follows:‡

"This converter consists of a stationary horizontal dial plate whose zero (directing) line is parallel with the line of direction of the vane on the clock when its index points to XII or zero.

*I have previously suggested that these tabular values be inscribed on the dial and be expressed decimally. This would be some improvement, but the present proposition involves a total change of base with a material advance towards simplicity. See last paragraph of foot note, page 52 of *Journal* No. 6.

†See paragraph 1, page 52, *Journal* No. 6.

‡See second foot note, page 52, *Journal* No. 6.

"Concentric with this circle and turning about its vertical axis, is a second smaller circular disk, graduated like the first, and provided with a movable pointer of a length greater than the radius of this disk.

"Operation: Read (or receive by signal) the indications of the 'wind clock' (central vane), turn the pointer of the converter to the corresponding graduations on the outer circle and hold or fasten it at this point. Turn the smaller disk till its zero (directing) line corresponds to that of the fire. The indications of the pointer on this (the inner) circle gives the direction (or rather the components) of the wind for that group of guns.

"This allows the central clock (vane) to be adjusted once for all."

The one claim remaining, for the retention of the clock system, is the ease of transmitting the indications. This advantage is more apparent than real. It may be easier to transmit "eight and a quarter" than "4 rear, 9 left," but when the latter is received it is complete, while the former but gives data for a calculation.

Clock analogy is well adapted to marking target and for wind indications, necessarily of a very general character, as used in small arms firing. Its success in these lines and the absence of some better method, probably, led artillerists to apply it when the conditions were not suitable.

Its application where components, and not directions, are desired is cumbersome, inaccurate and wholly unscientific. So with many thanks for past services let us consign clock analogy to an *innocuous desuetude.*

NOTE ON A PHOTOGRAPHIC METHOD OF DETERMINING THE COMPLETE MOTION OF A GUN DURING RECOIL.

BY

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It is often desirable to have a permanent record of the paths described by the points of a moving body, which is changing its position so rapidly that the eye is unable to observe them; and where it is not practicable to interfere with the motion of the body by causing it to trace its own path mechanically upon some surface. This may be done by causing the light from the moving body itself to record its own path upon a photographic plate. The method has many advantages to recommend it, for example, the motion of the body itself is not interfered with, and the path may be easily reduced to any desired scale. It is usual in investigating the motion of rapidly vibrating phenomena, such as tuning forks, stretched strings, variable electric currents, etc., to employ a *moving* photographic plate; but to determine the path alone, the sensitive plate need have no motion but may remain at rest and be used in the ordinary way.

The details of experiment vary according to circumstances. An example will illustrate a method of experimenting. Suppose that the moving body is a wheel rolling upon a level rail, a model in the laboratory, and it is desired to record the motion of one point in its circumference. Place an ordinary camera at any convenient distance from the wheel perpendicular to its plane, and focus sharply upon it. Attach to some point of the circumference of the wheel a luminous object such as a small incandescent lamp. This experiment requires that the room be dark, a condition easily obtained by working at night. First expose the camera, then roll the wheel carrying the small lamp across the field of view, then close the shutter. The exposure may be made in the dark room for any length of time without fogging the plate. Upon developing it will be found that the image of the lamp has described a minature cycloid upon the plate, an exact reproduction of the path described by the point of the wheel, and reduced in the ratio of the size of image to object.

Though the results obtained by experiments conducted upon the plan just indicated are perfectly satisfactory, giving good clear negatives with sharp curves distinctly traced upon them, as trials which we have made conclusively prove, yet in many cases the inconvenience of experimenting in a dark room is a great disadvantage.

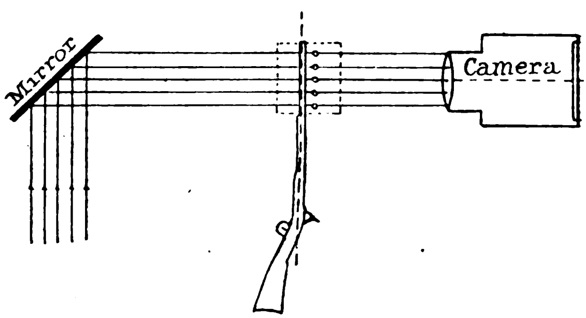
Another plan involving the same principles but enabling the experimenter to work in strong sunlight is the following: Prepare a dead black screen of considerable area, sufficient to more than cover the complete motion to be recorded; attach it to the moving object, and to the center of the black screen fasten a bright bead. The brilliant element of the bead in strong sunlight, in contrast to the black screen which forms the background, will be sufficiently bright to describe a curve upon the plate. In this work sensitive plates are required and care must be taken that the exposure, before and after the motion has taken place, is as short as possible to avoid unnecessary fogging.

If instead of a single luminous point two or more such points are placed upon the moving object, the negative will show two or more curves, and from them the motion of the body may be completely determined, that is to say, its path through space may be so determined. There is however no accurate indication of the velocity which the moving body has at various points of its path. It should be said that the negatives do indicate roughly when the velocity is fast or slow, and when it is increasing or decreasing, by the intensities of the trace due to the relative times of exposure of each point. If by any means the source of light upon the moving object could be made uniformly intermittent, such as the sparks from an electrical tuning fork for instance, then the record would not only give the path of the body but the velocity at each point of the path as well.

TO DETERMINE A RECOIL CURVE.

The above principles were applied to determine the behavior of a U. S. Army Springfield rifle during its recoil. The arrangement of apparatus is represented in figure 1.

Figure 1.



The rifle was fired from the shoulder as in ordinary practice. It is represented in the figure revolved through a right angle into the plane of the page to show the position of the luminous holes. Upon the muzzle of the gun is fastened a light piece of wood, which carries the black cardboard screen shown in outline in the figure. A piece of thin sheet copper fastened to the wood has a row of equidistant holes drilled through it, each being one millimeter in diameter with the distance between holes nineteen millimeters. The row of holes is approximately parallel to the axis of the gun. To obtain a brilliant illumination for the holes a mirror reflects sunlight through them to the camera. This method was adopted since more satisfactory results were obtained than with beads. The arrangement has its disadvantages since the size of the curve which can be recorded is practically limited by the size of the lens used in the camera: for should the gun move so far that the projection of a ray through a hole in the screen should fall outside of the lens, the illumination of the hole would not be sufficient to record itself. The

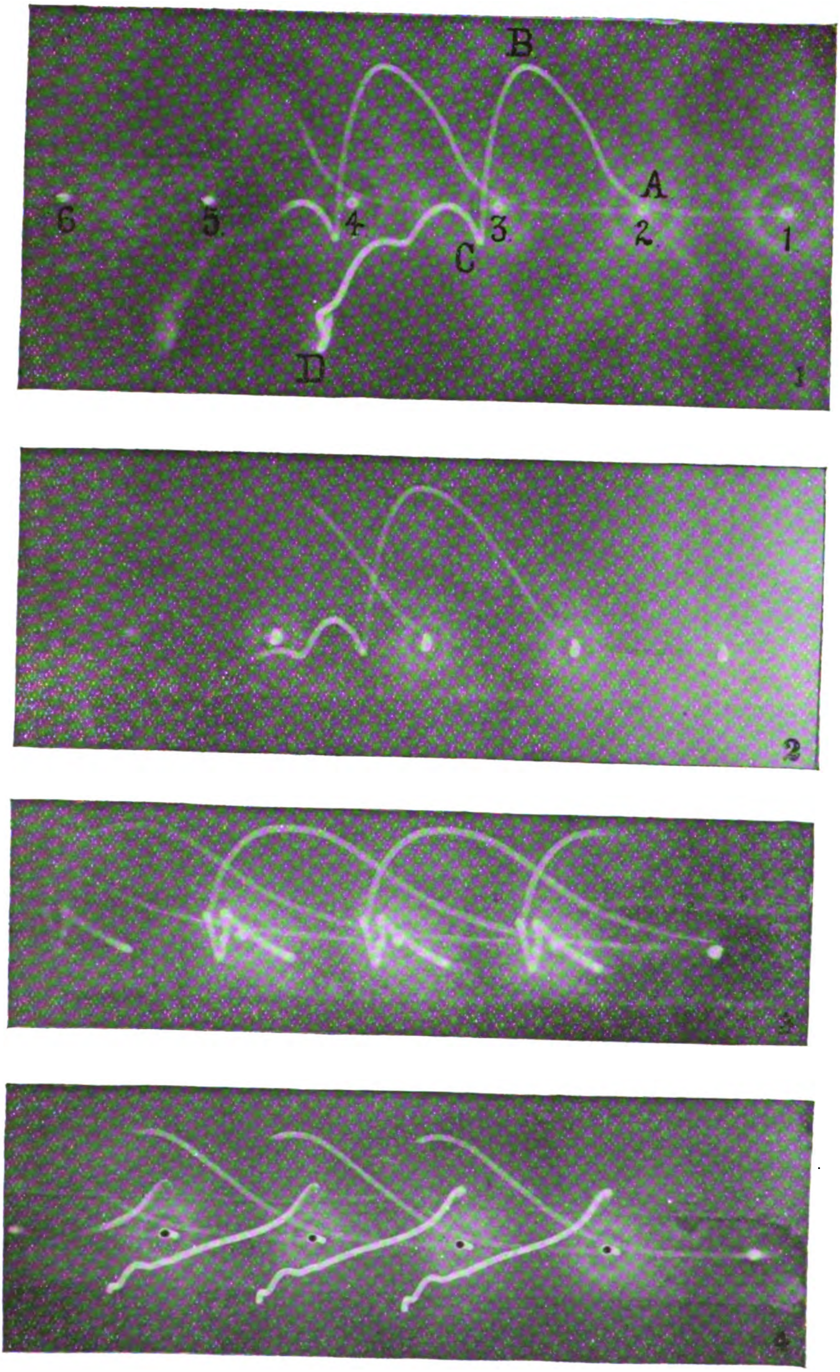


Plate I.

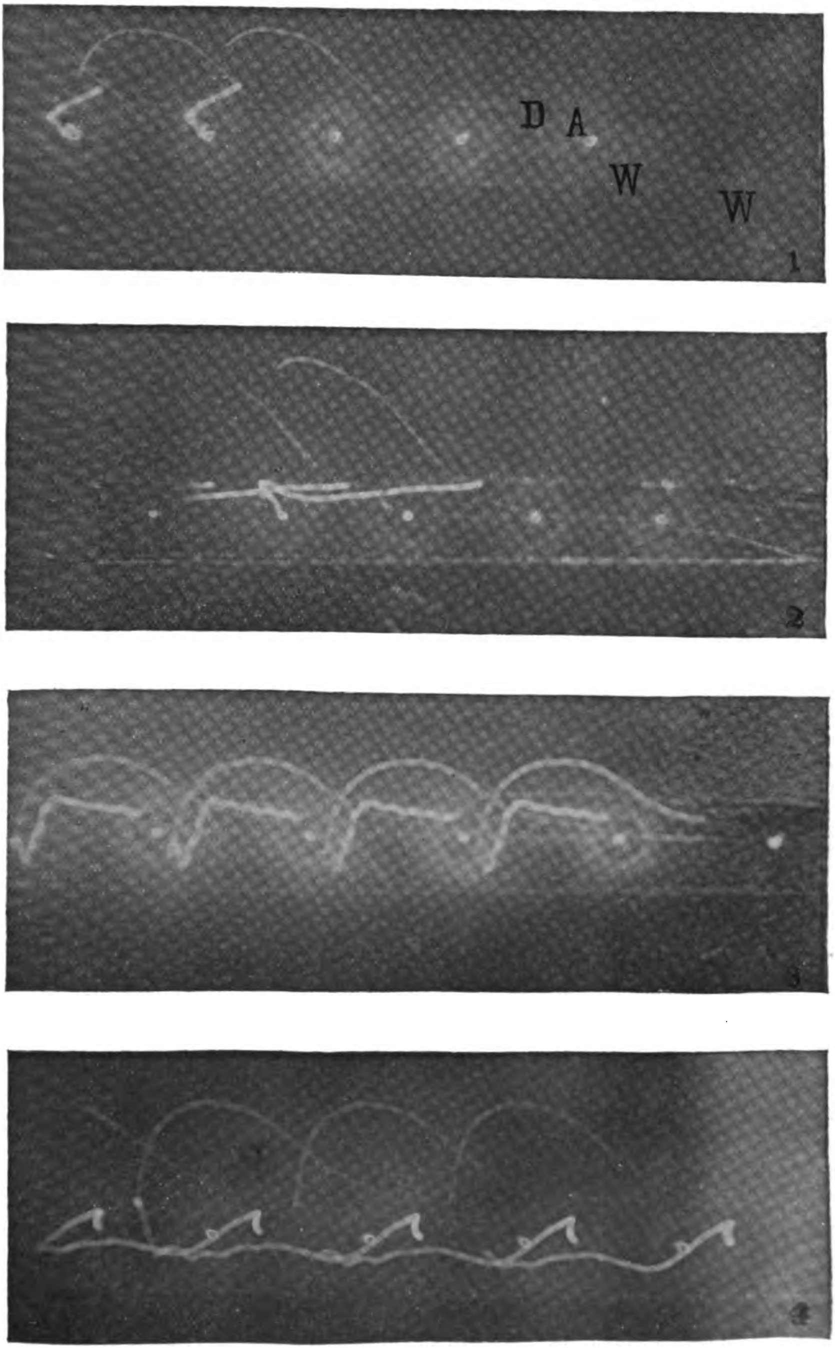


Plate II.

lens used in this experiment was over nine centimeters in diameter, being a Dallmeyer portrait lens 3*B* of their catalogue. This size was sufficient to cover the whole motion of this gun during recoil. A similar plan using a concave mirror instead of a plane one, would obviate the disadvantage mentioned above; namely, the necessity of having a large lens for the camera. In order to have the record of these curves the same size as the curves themselves, the lens was placed half way between the luminous holes and the camera plate. The distance of the lens from the holes was usually about two feet.

THE CURVES OBTAINED.

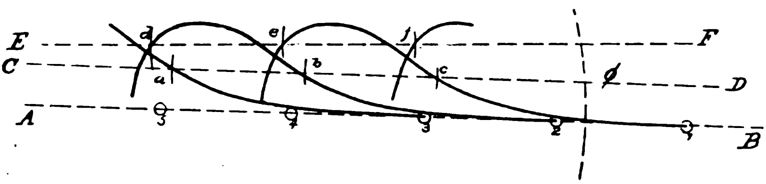
In plates I and II are shown some of the curves obtained by this arrangement. Referring to plate I, No. 1, the luminous points before firing were in the positions 1, 2, 3, 4, 5, and 6, and during the recoil these points each traced curves as shown. The complete motion of point 1 is the curve 1*ABCD*, the other points 2, 3, 4, etc., likewise traced similar curves. The part of the curve 1*ABC* from the origin to the point *C* is smooth and of the same type in all cases. The other part *CD* is unimportant and varies with the particular individual holding the gun. The exposure was made as short as possible after firing the gun to cut off this irregular part of the record. The point 1 is nearest the muzzle of the gun; the points 2, 3, 4, etc., are at equal intervals along a line parallel to the axis. It is seen from an examination of the curves that the first motion of the gun is very nearly straight to the rear for a distance of about 20 millimeters, shown by the parts of the curves corresponding to 1*A*. Here the point begins to rise rapidly, reaches its maximum at *B* and falls to *C*, where the recoil-proper ends.

The intensity of the light at different points indicates the relative velocity which the gun had at these points of its path. During the first period when the gun moves straight to the rear, the curves are faint in each case, showing that the velocity was great; beyond this as the gun begins to rise, its velocity diminishes and the curves grow brighter, until at the summit *B* there is a maximum brilliancy. The great intensity of the irregular parts after recoil shows the comparatively slow velocity which the gun has during this period. In plate I, No. 4, and plate II, Nos. 1 and 2, the light was accidently cut off before the latter part of the recoil path was completed but appeared again later as shown.

ANALYSIS OF THE CURVES.

Figure 2 represents actual curves taken with the Springfield rifle from which the instantaneous positions of the axis during

Figure 2.



its motion can be determined by a simple geometrical construction. The points 1, 2, 3, 4, etc., represent the initial positions of the luminous holes, and the right line *AB* the initial position of the axis of the gun. Since the distance between the holes remain invariable, the position of the axis corresponding to any point on any curve, as at *c*, is determined. With the assumed point *c* as a center, and a radius equal to the distance between consecutive holes on the diagram, describe the arc of a circle cutting the adjacent curve at the point *b*; and with *b* as a center using the same radius describe the arc cutting its adjacent curve at *a*, and so on for as many curves as are represented. These points of intersection must lie in a right line *CD* which represents the instantaneous position of the axis for the points considered. In like manner the points *d*, *e*, and *f* are determined by assuming one of them and constructing the other two, and the line *EF* represents another position of the gun's axis which shows an appreciable angular displacement, from the initial position *AB*, and indicates that the gun has at this instant a considerable angular velocity about an instantaneous axis at the intersection of *AB* and *EF*.

THE JUMP PROPER.

One of the problems of gunnery is the determination of what is technically called the angle of *jump*. The accuracy of modern high-power guns now requires that this angle should be known to at least one minute of arc. The angle of jump may be defined to be the difference between the angle of elevation at which the gun is laid, and the angle of departure at which the projectile leaves the bore, and theoretically varies with each particular gun and mount as well as the angle of elevation itself; and should be determined by experiment in each case. The complete motion of a gun during recoil is theoretically complicated in its character, and the true angle of jump should be carefully differentiated from the remaining motion if we are to obtain the true corrections for our tables of fire. During the short period while the projectile is in the bore, with which we are alone concerned in determining jump, a moment's consideration shows that the path of any point on the axis of the gun is theoretically the resultant of several distinct motions. The powder pressure acting along the axis tends to produce a motion of translation of the gun and its upper carriage with respect to the chassis rails; while at the same time the gun tends to rotate about its trunnions, the gun and upper carriage about its rear part, and the whole mount about its base.

From the above considerations it is evident that if we could trace the consecutive positions of the axis of the gun between its initial position when the gun is laid before firing, continuously until it comes to rest, this moving axis would envelope a curve, the tangent to which at the instant the projectile leaves the bore would be the true angle of departure, and when known would determine the true angle of jump.

EXPERIMENTAL DETERMINATION OF JUMP.

An experiment was tried to determine the portion of these curves belonging to the jump proper, or how much of the curves are traced before the bullet leaves the gun. The method adopted was to attach behind one of the luminous holes a small piece of cardboard so that its edge came just to the edge of the hole without covering it. To this minute cardboard screen was attached a small copper wire seen at *WW*, plate II, No. 1. This wire was carried forward directly across the muzzle of the gun and fastened to a nail in the light board. When the bullet reached the muzzle the wire was struck by it and cut in two, but at the same time the tension on the wire was sufficient to draw the cardboard forward and completely cover the hole. The curve should cease when this happens for this one hole only, while the curves of other holes are made complete. The cardboard passed completely by the hole and thus allowed the curve to begin again. The negative shows these points much better than the print can. The cardboard was originally at *A* attached to the wire *WW* leading across the muzzle. The curve appears again at *D* after the cardboard has passed completely by the hole. The portion of the curve described before the bullet arrives at the muzzle is so short that the only effect seems to be a slight elongation of the hole in the direction of the curve. It may be said therefore that a Springfield rifle does not move appreciably before the bullet leaves the muzzle. Even if the motion were appreciable its direction is such that it is parallel to the axis, and does not effect the aim of the gun. From this experiment the jump of a Springfield rifle is approximately zero, a result to be expected from practice with this gun.

In the case of large guns permanently mounted upon complicated carriages, the jump is often considerable, amounting to several minutes of arc and corresponding roughly to a muzzle motion of one or two inches, and its accurate determination is a matter of importance. On account of the comparatively large complete motions of recoil in such cases, a luminous object like an incandescent lamp upon the gun itself would seem a good method, and in order to remove the camera to such a distance as to be free from danger of the blast, it would only be necessary to employ a single plane mirror so placed as to reflect the rays into the camera placed at a safe distance in rear of the gun.

THE TRAINING TOGETHER IN PEACE TIME THE GARRISON ARTILLERY FORCES OF THE EMPIRE, INCLUDING REGULAR, MILITIA, VOLUNTEER AND COLONIAL ARTILLERY.

By E. G. NICOLLS, Captain, R. A.

"IN MEDIO TUTISSIMUS IBIS."

SILVER MEDAL PRIZE ESSAY, 1895.

In the last ten years great progress has been made throughout the army in the organization and training necessary for the proper conduct of war, and nowhere perhaps has this progress been more marked than in the Royal Regiment of Artillery. In both branches, definite methods, which though not altogether new had remained unrecognized and untried for many years, have gradually been evolved, for fighting, and training for fighting the different units, until a working and workable system has at length been elaborated. Most of us no doubt were in hopes that our present system of training was approaching finality, and possibly it is, but in the Garrison Artillery, at any rate, we have evidently not yet reached the end, or else we should not now be asked once more to consider this question. We have now however the great advantage of starting from a good forward position. The necessity for fire discipline, and a regular system of organization and training is no longer disputed. The question no longer is, "is a system of training necessary," but what system is most applicable to certain requirements? This is the question we have to answer, and to furnish a satisfactory reply we must carefully inquire into the conditions that give rise to these requirements, and the nature of the requirements themselves, before we can say what system of training is best suited to meet them.

As the particular subject of this essay deals with the training of artillery garrisons in coast fortresses, I propose to consider it under the following heads:

Chapter 1. The general forms that attacks on coast fortresses take.

Chapter 2. The particular forms of attack that our coast fortresses at home and abroad will most probably be called upon to meet.

Chapter 3. The kind of defense necessary, and the general duties of the artillery defenders in meeting these attacks.

Chapter 4. The system of training that will best fit the defenders to carry out these duties.

The remarks made hereafter apply only to the artillery portion of the garrison of a coast fortress, no attempt has been made to deal with the other portions, and where the word "garrison" occurs by itself it must be understood to refer only to the artillery defenders.

CHAPTER I. THE GENERAL FORMS THAT ATTACKS ON COAST FORTRESSES TAKE.

The subject of the prize essay in 1893 was "the attack of a coast fortress." In the July number of the "*Proceedings*" of that year are published the three essays adjudged the best. Each essay approaches the question from a somewhat different point of view, and treats mainly of some one particular form of attack. Written as they are with great ability, and combining as they do evidence past and present, and the contemporary opinion of the best writers who have studied the subjects bearing on this question with the well reasoned conclusions of their own authors, they present, taken together, a very valuable exposition of the whole subject, and one that may be considered in many ways authoritative. I propose therefore to extract from these essays much of the information required for this chapter and to put it forward without any attempt at argument, for which and for fuller information on the subject, the essays themselves should be consulted.*

* See "*Proceedings*," *R. A. I.*, Vol. XX., pp. 345 to 391.

A coast fortress is defined as consisting of "an area of land and sea provided at certain important points or along tactically selected lines with an artillery armament partly fixed, partly movable. The area is usually defined by the extent of land or water within range of its guns."* Whatever its area may be, the effective value of any coast fortress as such, is limited by the range of its guns over that area. Outside this limit, the fortress is incapable of affording any protection whatever, unless indeed its garrison is strong enough to, and provided with, the means of taking the field against an enemy, in which case the operations cease to be those within the *rôle* of a coast fortress.

The *rôle* of the coast fortress may be said to be to afford protection from molestation to everything within its defenses; it can best effect this by denying the use of the selected area of land and water it protects, to those whom at the time it may be expedient or necessary to exclude. The specially selected localities protected by coast fortresses may be:

1. Harbors and dockyards required for the use of the navy.
2. Harbors and ports which are required for the use of the mercantile marine, and which generally form the approach to important cities or towns.
3. Harbors and ports abroad which can act as temporary refuges, or at least furnish supplies, particularly coal, to the navy, and to the mercantile marine.
4. Harbors abroad which are required as bases of operation for the fleet, or for expeditions.
5. Positions guarding narrow water-ways, leading to more open waters which it is desired to deny to all comers.

An attack on a coast fortress may be made by:

1. Naval forces alone.
2. Military forces covered and supported by ships.

The object of the attack may be any of the following:

1. Conquest and occupation.
2. Passage to some objective beyond.
3. Destruction of the forts, or the ships, stores, and other material that they protect.

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* *G. A. D.*, Vol. I., p. 409.

4. To cover other operations, for moral effect, or without any very definite object but in hopes of obtaining some advantage.

The first two may be considered as attacks proper.

The last two, rather in the light of raids made with a more or less definite object.

The raids naval, or military, on territory adjacent to coast fortresses, but outside the range of their guns, which were so common during the wars of the 17th and 18th centuries, and which are undertaken purely for ravage and destruction need not be considered, as they do not properly come within the meaning of an attack on a coast fortress.

NAVAL ATTACKS.

1. With a view to conquest and occupation.

These may be undertaken:

a. By bombardment.
b. By regular attack.

a. Bombardment.—The ships employed would probably be at long range and under weigh: if after a bombardment landing parties are sent in, the ships would of course have to stand into closer ranges. There are but few historical instances of this method of attack, and it can only be successful against a weak or demoralized garrison.

b. Regular Attack.— By this term is meant engagements between individual ships and forts when the object is to silence the fire of the forts, by bringing a superior fire to bear against them previous to the landing of parties to capture them. The term cannonade would seem to be preferable to that of bombardment, to denote the ship's fire action under these circumstances. The engagement would be begun at long and medium ranges with the ships under weigh, but the final cannonade to be effective must take place at close ranges, and with the ships anchored in the most suitable positions close to the forts; landing parties would probably be employed at this stage. This form of attack is very rare in history, the most notable instance being the capture of Gibraltar by Sir G. Rooke's fleet in 1704. It is possible that the gallantry displayed in, and the success of this operation has tended to make us over-estimate the value of this method of attack.

2. *To force a passage.*—This is a very feasible operation for ships, provided that the water-way is clear, for it is an axiom that guns alone are powerless to stop ships running past. A fleet so employed would keep as far from the guns of the forts as possible, but the distance and formation of the attack must depend upon local conditions such as state and extent of the channel, etc. There are very few places in the world where opportunity is afforded for this kind of attack, which is not intended to include such an operation as steaming past the forts at the entrance to a harbor only to come under the fire of the inner chain of forts. This method of attack therefore can be attempted only very occasionally as a definite operation, though to some degree it may enter into the operations of a combined naval and military attack on a coast fortress.

3. *For the purpose of ravage and destruction.*—Attacks of this description would take the form of:

a. Bombardment.

b. Sudden inroads into harbors by small craft and torpedo boats.

a. *Bombardment.*—As the chief object is to inflict damage, not on the forts but on the property they defend, the fire must be at long range and accurate; it seems likely therefore that specially constructed vessels carrying mortars, or howitzers, or long range ordnance of some description, will be employed rather than war vessels, and that they will be anchored in positions as far as possible from the forts and clear of their fire also, when possible.

History gives frequent instances of this kind of attack. If ordinary war vessels are employed, the attack would be as already explained in 1*a*.

b. The essence of this attack is surprise and rapidity. Torpedo boats, two or three together, would appear suddenly before a coast fortress and proceed to run in, as rapidly as possible, past the defenses into the inner waters, when they would be able to destroy with their torpedoes any ships lying at anchor or in dock. Actual experience of this form of attack has necessarily not been extensive, but the little already known tends to show the ease with which such attacks can be carried out, and their extremely formidable nature.

4. *To cover other operations, for moral effect, etc.* We might call this kind of attack desultory bombardment. It may be undertaken as an operation in itself, for moral effect, or to draw off attention to a distant part of the theatre of war, or it may be part of a regular attack, the object being to divert the defender's attention from the main attack; but whatever the object, the action of the ships would be very similar and would consist of a long range bombardment under weigh.

MILITARY ATTACKS COVERED AND SUPPORTED BY SHIPS.

1. *With a view to conquest and occupation.*—These can only be conducted against the land defenses of a fortress; if these latter are weak or badly manned they may be captured by assault, otherwise they will have to be besieged in regular form. The covering naval force would generally assist by bombarding the sea fronts at long ranges. This form of attack is proved by history and generally acknowledged to be the best and most certain method of capturing a coast fortress. On this point Admiral Colomb says, "We have seen that the methods of attack by expeditions over sea had long been established, and that the idea of capturing ports or islands by naval force alone was almost entirely out of view. The experience of a century marked by only one or two successes and many failures of ships against works, and almost uniform success of troops covered and supplied by ships, when numerically sufficient and properly handled, had quite settled the plan of attack."*

2 and 3. *To force a passage and for ravage.*—"Troops have been used in the past in conjunction with ships for attacks with either of these objects, and may be so employed in the future, especially in the former case, for the development of submarine mines may make the clearing of a channel such a difficult operation that it may be advisable to land troops to take the batteries of the fortress in rear, and if possible silence them before the ships attempt to clear their way through."† The landing of troops

* "*Naval Warfare,*" p. 377, by Rear-Admiral P. H. Colomb

† *R. A. I.* "*Proceedings,*" Vol. XX, p. 394. Commended essay.

merely to ravage territory is not, as we have already agreed, an attack on a coast fortress, and therefore need not be considered.

Before concluding this part it would be advisable to briefly consider the general conditions under which the different forms of attack enumerated above would probably take place.

All operations into which the state of the sea enters as one of the conditions must depend upon the command of the sea, and in this respect it may be noted that "the command of the sea must be fought for if it is not admitted, and territorial attacks must cease while this process goes on. They cannot be undertaken at all whilst the command is in abeyance; but after it is settled, the side that holds it inevitably pushes on to the attack of territory"* and that on the "state" of the sea at any given time depends the probability and nature of any attack on hostile territory. The "states" of the sea have been classed by Admiral Colomb as that of "indifference" "when neither side attempts to hold command of particular waters and therefore which neither side threatens'† of "disputed command" and of "assured command," "and evidently these must be a continual passing from one state into a higher and back again, "‡ so that we get states of temporary command lasting for longer or shorter intervals. Further "if we take these three states of the sea into our contemplation as conditions under which expeditions across it succeed or fail, we may note, that over a commanded sea no such expedition can be put in force at all by the inferior naval power, except by evasion, else must we admit a sea which is of disputed command or one that is indifferent; on the other side, the power in command of the sea ought never to fail in any attack it undertakes, so long as it does not cut itself off from its sea communications."§

If therefore we have a navy powerful enough to assure the command of the sea, we need not fear attacks in force on our coast fortresses; but, as to command the whole seas requires an immense and vigilant fleet, and as it is in the power of an inferior fleet or of an expeditionary force to evade a superior hostile

* "*Naval Warfare*," by Rear-Admiral P. H. Colomb, p. 309.
† *Ibid* p. 207.
‡ *Ibid* p. 212.
§ *Ibid* p. 212.

fleet, we may have to be prepared even under the most favorable circumstances to meet some forms of attack, especially in distant waters where owing to their remoteness our command of the sea may not at the time exist in fact, or may have been temporarily lost. Here however such attacks can only be successful where there is sufficient time for their completion ; if the capture of the place can be delayed sufficiently long, relief must come and the failure of the expedition be certain, as witness the reliefs of Gibraltar in 1704–5. Now, more than ever, when the movement of ships and the duration of voyages are no longer dependent on fickle and variable winds, the power of relieving distant fortresses seems to be more firmly assured than heretofore to that side which has command of the sea. As Admiral Colomb says "The general result of improved marine architecture therefore must be to put a check on all territorial attacks which depend upon an indifferent sea; as the same cause must tend to make a doubtful command of the sea more doubtful, and a command of the sea more assured, the general result would appear to be rarer opportunities for territorial attack across a sea which is not commanded, but much more certainty in the results of expeditions carried on by the power which holds a command of the sea that cannot be challenged."*

The introduction of a time element into the conditions of successful defense under certain circumstances, would point to the conclusion that the value of a coast fortress may often lie rather in its capacity to delay capture, than in its ability to resist it altogether.

It may be presumed that as a general rule no attack on a coast fortress will be attempted unless there is some reasonable probability of success attending the attempt. It remains therefore for us to ascertain under what conditions success is likely to attend the different forms of attack already enumerated. We will take them in the order in which they have been considered above.

NAVAL ATTACKS.

1*a*. *Bombardment for capture*.—This implies the existence of a temporarily commanded, or at least an indifferent sea, for no

* "*Naval Warfare*," by Rear-Admiral P. H. Colomb, p. 216.

ships would waste their ammunition in bombarding a fortress with an enemy's fleet near enough to attack them before they can replenish their ammunition.

1*b*. Regular attack by ships is out of the question except command of the sea is assured for a sufficiently long time not only to permit of the ships making up the ammunition they had expended, but also to allow them to repair the damages they must receive even in a successful attack, before they may be called upon to meet a hostile fleet.

2. *Forcing a passage.*—There seems no reason why this should not be attempted in any "state" of the sea, provided that the ships undertaking this attack are not being actually watched by an enemy's fleet, which bring them to battle, and that when they enter the waters beyond they will be free from attack.

3*a*. *Bombardment for destructive purposes.*—To place a flotilla of specially designed vessels (probably in no sense sea-going) in a position to shell a fortress, and to keep them there long enough to effect their object, would seem to imply a fairly assured command of the sea; bombardment by war vessels for this purpose under any other conditions than this, could only be of a desultory nature.

3*b*. *Raids by torpedo boats.*—From the very nature of this attack it would not be unreasonable to assume that no "state" of the sea could prevent its being attempted

4. *Desultory Bombardment.*—When this is undertaken to support a military attack it is necessary that there should be at least a temporary command of the sea, assured for a sufficient time to afford reasonable prospect of success. If this is attempted for any other purposes, a temporary command of the sea at least is necessary, unless the ships so engaged are prepared to sacrifice themselves, if required, to attain their object, or unless the places attacked are near enough to their bases to allow the ships a reasonable chance of retreating, and refitting there; otherwise they render themselves liable to defeat and capture at the hands of an inferior naval force. In these exceptional cases, the attempt may be made in any "state" of the sea.

Military attacks.—It may be taken for granted that no form of military attack whatever will be undertaken unless there is a command of the sea sufficiently assured to afford reasonable prospect of success. The only possible exception to this is the case of a force which succeeds in effecting a landing on territory by evasion, but unless the territory invaded is likely to be friendly to the invaders they will find themselves cut off from their supplies and reinforcements, except they have the command of the sea.

CHAPTER II. THE PARTICULAR FORMS OF ATTACK THAT OUR COAST FORTRESSES AT HOME AND ABROAD WILL MOST PROBABLY BE CALLED UPON TO MEET.

It can hardly be expected that with coast fortresses situated all over the world, some close to a possible enemy's naval stations, some in mid ocean, some guarding important naval dockyards, others protecting coaling stations, etc., that all will be liable to the same form of attack. Mauritius might be captured by a force that would not attempt to attack Bombay, and Portsmouth might be the object of a form of attack, that would be impossible or thrown away against St. Helena. Each coast fortress will be liable to some forms of attack rather than others. It must be our endeavor to ascertain as far as possible the forms this liability will take in different cases. This can only be done very generally, for to attempt to classify all our coast fortresses with their differences of importance, locality, armament, types of fort, etc., would be, even if capable of satisfactory accomplishment, a task quite beyond the limits of this essay. There appears however to be one broad distinction which for the purpose of this essay would seem particularly suitable, because it is largely based upon the nature of the garrisons that will be employed to defend different fortresses. To all our home fortresses are allotted in addition to the R. A. Companies serving in the district, certain units of militia and volunteer artillery, to whom a share in the defense of the fortress is confided; while those abroad can only count on their existing garrisons, which as far as India and the Crown colonies are concerned are composed of the R. A., while the self-governing colonies find troops of their own to take up the work of the defense. This distribution of the garrison gives us a division of the subject into

1. The defense of coast fortresses at home.
2. The defense of coast fortresses abroad, *i.e.*, outside the United Kingdom.

It may be noted that this method of separating the subject practically puts into one class all the most important fortresses. viz: those at home; while it leaves those classified as "abroad" as descriptive with one or two exceptions, such as Malta. Bombay, etc., of the less important ones. These exceptions if they approximate closely in importance to the one class, approach from their geographical position still closer to the second in their liability to particular forms of attack, and it seems probable that the principles of their defense should be conducted with slight additional modifications on the same general lines.

But as we thus have a division of the subject in *space*, depending practically upon the geographical position of each fortress, so it will be convenient to formulate a division in *time*, depending upon the stage hostilities have reached at the time an attack is made. This division can most easily and appropriately be made into:

a. On the outbreak of hostilities, including the period when they are imminent.

b. During the progress of the war, when the command of the sea is held by ourselves.

c. During the progress of the war, when the command of the sea is doubtful, or only temporary, in certain seas.

d. During the progress of the war, when the enemy has obtained an assured command of the sea.

I think it will be apparent that some such division of the subject as this is needed, and will tend to a clearer understanding of what may be expected to happen under varying conditions. I propose therefore to examine the question of probability of attack from a combined view of the conditions due to difference in time and place.

a. At home.—Every effort will be made by each naval power when hostilities are imminent, to place every available ship that is fit for the line of battle at sea, in order to assure the supremacy of its own navy and to obtain as early as possible the command of the sea. At the outbreak of hostilities therefore, it may be expected that no attacks by ships on coast fortresses are likely to be attempted. As has been pointed out, however, by Major Elmslie, R.A.,* the individual value of a war vessel to the power to which it belongs is now so very much greater than it used to be, owing to the time and money required for its construction. and the impossibility of building new ships to replace those put out of action during the probable continuance of a modern war, that it is very decidedly to the interest and advantage of both sides (and of the probably weaker naval force in particular) to endeavor, while fitting out their own fleets, to harass the enemy engaged in a similar operation, and if possible destroy his battleships in their own ports. That this is quite feasible, and that the best way of effecting it now is by a torpedo boat attack, a perusal of the prize essay 1893 makes sufficiently plain. Torpedo boat attack then, is a form of attack extremely likely to be experienced by all our home fortresses, within whose defenses ships of war are to be found, but it does not appear that any other serious form of attack is to be apprehended at this stage of the war.

Abroad.—Those of our fortresses abroad which were situated within striking distance of an enemy's naval base, and within whose defenses ships of war are to be found, would also be liable to attacks by torpedo boats, and must be prepared to meet them ; but with our smaller fortresses and defended coaling stations in distant waters, such attacks need not be feared. At the most, bombardment either with the idea of capture, or of the nature I have termed desultory, is all that need be apprehended.

b. At home.—When during the progress of a war the assured command of the sea has been obtained by our own navy, the threat to our coast fortresses at home will cease almost entirely if not altogether. But unless the enemy has been very badly beaten, or is unusually wanting in daring and enterprise, it seems probable that he will still from time to time attempt raids by torpedo boats on our ports, and against these we must still be prepared. Any other threat to the home fortresses is out of the question, and therefore the garrisons that have been allotted to them can with safety be considerably reduced and will be available for employment elsewhere. In what manner they will

* *R. A. I.*, "*Proceedings*," Vol. XX., p. 346. Gold Medal Prize Essay.

then be employed is a question of war policy which is not for us to decide, and which has probably been already considered and settled by the proper authorities. But as in the words of the late General Hamley "it does not follow because an army is defending a territory, it must confine itself to the defensive; on the contrary it will best effect its purpose by actively threatening its adversary, and by taking the lead wherever the opportunity offers,"* so it is not unreasonable to anticipate that the forces thus freed from the coast fortresses will probably be employed in expeditions against the enemy's territory. Further, it would be quite legitimate to expect that, as any European power with which we might find ourselves at war, possesses an army to defend its own home territory, many times larger than our available force, and as it would be folly to place ourselves in a position where we could hardly help being beaten by a much superior force, any attacks we might contemplate on this power's territory would be directed against its outlying possessions and colonies, and would be of the nature of those military expeditions so common in the history of the naval wars of the seventeenth and eighteenth centuries.

Abroad.—With the command of the sea assured, our fortresses abroad would probably be exempt from any attack, for as Admiral Colomb says, speaking of the French raids in the West Indies during 1710 and 1711, "these attacks where the force employed is small, where the distance to be passed over the sea is short, and where if a successful landing is effected, capture of the whole territory may follow, constitute perhaps the limit within which there is any chance at all of a successful attack on territory by the inferior naval force."† When the command of the sea is lost to any power, its naval force in distant waters is likely to be very inferior, especially in the face of our own naval strength; and unless the above conditions are existing, even this form of attack cannot take place, much less any on a greater scale requiring serious defensive measures to resist it.

* "*The operations of war,*" p. 48.

† "*Naval warfare,*" p. 321.

c. At home.—As long as the command of the sea remains doubtful the fleets in the home waters on both sides will be too much occupied with each other's movements to pay any attention to the attack of coast fortresses, and no expedition against them that will be liable to interruption from the sea will be possible. As long as this state lasts therefore our home fortresses will not probably be liable to any other attack than that of torpedo boats and perhaps desultory bombardment by occasional cruisers. If the enemy obtain a temporary command, invasion may be possible, but this will not affect coast fortresses as such.

Abroad.—The case however with our fortresses abroad may under these circumstances be quite different. The greater part of our fleets will be employed in their legitimate work of trying to obtain the command of the sea. It is possible therefore that in distant waters the enemy may have a command which, though perhaps only temporary, will be his long enough to enable him to attempt the conquest of territory lying in those seas. In this case it seems probable that expeditions will be attempted against those places likely to be most easily captured and held, and which like our small coaling stations will be of value to him when taken, proportionate to the loss that their transfer will be to ourselves. These attacks may be made in any of the ways before mentioned, but the only form of attack that can be really successful against a properly armed and manned fortress, is that which is delivered by a sufficiently strong military expedition. The chances of the fortress attacked making a successful defense, depend therefore upon its power to meet an attack from the land side, and its ability to prolong its defense for a time sufficient to allow of relief arriving. Large fortresses requiring a very considerable force to capture them are not likely to be attacked, but may expect to have to meet desultory bombardment, or even one carried out by special vessels for destructive purposes, if their nearness to an enemy's naval base permits of this being attempted without interruption, and with a reasonable chance of success.

d. At home.—The day which sees the command of the sea held by our enemy will indeed be a distressful one for England. Then is made the first certain step to an invasion of these Isles. the consequences of which it is not pleasant to contemplate.

Assuming this condition of things to occur, it is not clear how our coast fortresses could play any sufficient part in helping to ward off an invasion. For the invading force would probably be landed on some convenient part of our open coast line, and would be under no necessity to approach any of our coast fortresses unless it was found that its presence threatened their base and communications, in which case a determined assault on the land front would probably give the place into their hands. For it seems highly improbable from political reasons arising out of the panic that would be created by an invasion, that the very large garrisons that would be required to defend the land fronts of our large fortresses, like Plymouth or Portsmouth, would be permitted to remain to do so, while London was threatened ; but rather that a considerable portion of them would be withdrawn to assist the field army in resisting the advance of the invading forces, if only to reassure the panic-stricken inhabitants of the capital. But assuming that this would not be done, and that the necessary garrisons were left in the coast fortresses to hold them, the chief part they would have to undertake in the event of attack would be the defense of their land fronts; for though no doubt whenever it was considered imperative to reduce such a fortress, the attack would be assisted by naval operations on the sea front, still these latter will have a less chance than ever of being successful by themselves, for it will be in the power of the defenders to completely obstruct their own waters with mines, torpedoes, etc., without fear of injuring their own shipping (which must anyhow fall an easy prey to the enemy), and thus to keep the enemy's ships at long ranges from their forts; so that if the speedy capture of the place is desired, as it will be, the real attack must be made against the land defenses.

It has not been thought necessary to consider the question of invasion under any other conditions than that of the assured command of the sea, to the enemy. The only other possible condition is invasion by evasion, that is by eluding our fleet, and throwing a force on to our shores, that must take its chance of making its own footing and being able to obtain supports and reinforcements as required, after it has landed. This is such a very risky operation that it can be only undertaken when the invading force is likely to receive assistance from the people of the country it invades, as in the instance of William III landing at Torbay, or Hoche's expedition to Bantry Bay. Where this assistance is not forthcoming, we have only to recall the inaction of the French after the battle of Beachy Head, and the failure of the enormous expeditions that from 1797 to 1805 Napoleon collected for the invasion of our shores, even to put out from their own ports, to show that while there is a fleet in being on the other side, the hazard is so great as to be prohibitive.

Abroad.—As regards the position of our coast fortresses abroad, when owing to the command of the sea being lost, they can no longer look for, or expect relief when attacked, all that can be said is, that their fall into the enemy's hands is certain, provided that he attacks them with sufficient force, and in the proper manner, that is by military expeditions. All that the garrisons can do (and probably will do) is to delay the day of capture in the hopes of something turning up, but to do this they must be prepared to meet the main attack on land which should be really the only formidable one.

CHAPTER III. THE KIND OF DEFENSE NECESSARY, AND THE GENERAL DUTIES OF THE DEFENDERS IN MEETING THESE ATTACKS.

The preceding chapter has served to show the forms of attack to which our coast fortresses will be most liable under different conditions. In Chapter I we sketched the general lines on which each attack is likely to be carried out. It is not difficult then by combining the two to arrive at the kind of defense that will be most suitable for each case, and the work that will therefore be required from the artillery garrison to meet them. Keeping to the same division of the subject as was made in the previous Chapter it will be seen that

a. At home.—For the purpose of repelling torpedo boat attacks and as far as the artillery defense only is concerned, quick-firing guns are likely to be the most useful;* other guns might be employed at times with advantage, but whatever nature of ordnance may be used it seems certain that it must be capable of being fired rapidly, and that smokeless powder, laying over the sights,

* *See R. A. I. "Proceedings,"* Vol. XX. Gold Medal Prize Essay.

and a system of rapid ranging must be employed; extraneous aids in the way of range-finders, etc., will generally be impossible. If desultory bombardment is attempted it would be carried out at long range by ships under weigh and could be effectively replied to by most of the heavy guns mounted in our coast fortresses.

The general duties of the defenders will be the manning of the quick-firing and other guns employed against torpedo boats (a system of fighting which has yet to be adopted) and possibly the manning of the heavy guns in the manner explained in the drill book.

Abroad.—Fortresses that are liable to torpedo boat attacks require the same means of defense, and the same duties from the defenders as those at home. But in addition they, with the other smaller fortresses, will be liable to bombardment either with a view to capture, or of a desultory nature; the former is only likely to be attempted against small fortresses, and differs from the latter only in that being undertaken with a definite object it may be expected that it will not be abandoned without an effort being made to land storming parties from boats.

Against bombardment the heavy guns will be required; for the boat attacks the light guns supplied for general defense will be chiefly used.

The duties of the defenders will then be:

1. To man the heavy guns, which will be fought by depression range-finder or position-finder according to the means available.
2. To man the light guns for general defense, which must usually be fought without the aid of these adjuncts.

b. At home.—The portion of the artillery garrison that would be left in our home fortresses must be sufficient to man the guns for defense against torpedo-boats, and perhaps a few of the heavy guns for general purposes. The remainder of the men who are to be employed in expeditions abroad will be required to make up the siege train which must accompany every such expedition if its success is to be insured. The duties of the larger part therefore will be to man the siege train.

Abroad.—The fortresses abroad must remain in a state of preparedness to meet any *possible* attack, but no serious attack need be anticipated.

c. At home.—The defense will be as indicated in (*a*) but the heavy guns required for engaging bombarding vessels may have to be more frequently employed, and consequently this form of defense may assume a greater importance.

Abroad.—Fortresses abroad according to their situation, strength, and the local conditions influencing the enemy at the time, may be subjected to any form of attack; all purely naval attacks on its sea faces alone, a properly armed and commanded fortress should be capable of repelling, and no really serious danger should threaten it until the enemy has landed troops to attack it from the land side. This is the point on which the defender's attention must be concentrated, and against such an attack the guns for general defense will not alone be sufficient, they must be supplemented by howitzers and siege guns of sufficient caliber to cope with the ordnance that the enemy would employ, for what virtually become siege operations.

The defenders therefore will be required to man the different guns they possess according to the nature of the attack, but principally to fight the ordnance employed to resist attacks from the land side.

d. At home or abroad.—When the command of the sea is lost, coast fortresses wherever situated must if attacked make the best defense possible. To meet attacks, which are not likely to be made except in sufficient force, the whole armament and all the energies of the defense will be required, but here again attention must be chiefly turned to the defense of the land fronts on which the main attack will be made, and for this purpose siege ordnance are required. If bombardment by specially prepared vessels is attempted, either by itself or in conjunction with a regular attack, it can best be met by high angle fire guns adapted for long range shooting in any direction, and some of these should be supplied at any rate to all our most important fortresses.

Before proceeding to consider the question of how the artillery garrisons can best be trained to carry out the general duties here indicated, something must be said regarding the manner in which the distribution of the garrisons to these duties should be carried out. Some such distribution, it will be admitted, is necessary, especially in our home fortresses where militia and volunteer artillery are called upon to take their share of work with the royal artillery. It may be laid down as an axiom from which no general dissent will be made, that when a variety of work has to be done, as in the manning and defending of our coast fortresses, it will be more efficiently performed, if the same men are always told off, and kept to the same work, and that when the nature of the work varies, the most important should be allotted to the most efficient men. A coast fortress therefore should be divided into a number of commands, and a portion of the garrison of it should be permanently allotted to each command, and kept entirely to its own command. In the home fortresses where the garrisons are composed partly of companies R. A. and partly of auxiliary artillery, the companies should be allotted to the most important works as far as they will go, and the auxiliary artillery to the remainder. Abroad where colonial troops are found, who have to work with the R. A., a similar distribution should be made. Where only royal artillery garrisons are found, it is immaterial how the distribution is made, as also in those fortresses manned entirely by the colonial artillery, but the distribution once made, should not be altered unless absolutely necessary. This distribution should be embodied in the defense scheme of each fortress, which as far as this question is concerned should be drawn up, on the following general lines.

1. *A distribution in time.*—It must be recognized that after the order for mobilization has been given, some appreciable time must elapse before the different units can assemble at their place of concentration, and that while they are assembling, the forces told off to each fortress, and that are on the spot, will alone be available; these will consist of the R. A. companies stationed in the fortress, and probably a considerable number of the local volunteers. As soon as the militia are mobilized, and reach their place of concentration they will relieve the volunteers. Thus two periods must be provided for, viz:

1st period, royal artillery and volunteers available.

2nd period, royal artillery and militia allocated to the fortress.

2. These forces should be told off into battery commands, a definite portion of the armament being allotted to each command. As many battery commands as may be convenient will constitute a fire command. Each battery command must consist of royal artillery only, or of militia or volunteer artillery only (according to the period of mobilization) each corps being under its own officers. Fire commands should be arranged in the same manner, if possible.

3. The apportionment of these commands should be on the principle already advocated of allotting the most important to the R. A.

4. In allotting the details required for any command allowance should be made for two reliefs at least.

5. Fire commanders and officers holding higher posts should be specially selected, and appointed by name, being commissioned as such if necessary.

6. All specialists required for range-finding, hydraulic mountings, etc., must be found by the R. A., and will be in addition to the battery details. These must be provided for the auxiliary artillery as well, and only to this extent is a mixture of corps permissible. Some of these provisions are applicable only to the home fortresses, or with slight modifications to those abroad which may be manned by mixed garrisons, but the principles on which they are based are of universal application.

A distribution of the artillery garrisons made on these lines would much simplify the question of training, for it would provide:

1. That battery commands should be kept separate, thus allowing the men of each corps to be trained and worked under their own officers.

2. That each battery command was told off to a specific portion of the armament, thus admitting of the duties of the different units being more clearly defined and separated.

3. In our home fortresses that, generally speaking, the dividing line of duties between the royal artillery and the auxiliary artillery can be more clearly marked.

This is important as it affects the question of the training of the different corps.

The actual distribution of duties between the R. A. and the rest of the artillery garrison in home fortresses can only be settled locally, with due consideration to the requirements of each fortress. But bearing in mind that the most important portions of the defense must be given to the R. A. companies, and also that these latter are liable to foreign service and with it varying duties in different localities, it should be the endeavor when distributing them at home to apportion them as far as possible to those means of defense which will be of most value under all circumstances. The distribution at home then should, generally speaking, be as follows:

The royal artillery to—

1. The quick-firing guns and other ordnance intended to repel torpedo boat attacks.

2. The movable armament or guns for general defense, which will be required against landing parties, and which must play an important part in the defense of fortresses abroad.

3. The most important heavy B. L. guns, and long range guns, etc., as far in each case as the available strength of the companies will permit.

The auxiliary artillery to—

The general fixed armament which will for the most part be composed of heavy R. M. L. guns, commencing where the R. A. have left off (at the most important), and working down to the less important as far as the available strength permits.

CHAPTER IV. THE SYSTEM OF TRAINING THAT WILL BEST FIT THE DEFENDERS TO CARRY OUT THESE DUTIES.

If the views put forward in the preceding pages with regard to the probable forms of attack on our coast fortresses, and the nature of the defense required to meet them be accepted it must be admitted that the duties of the artillery garrisons will not be confined to the fighting of the heavy guns mounted in fixed emplacements, but must include the service and ranging of many descriptions of light and medium ordnance, and that this class of ordnance will, if anything, be in more constant use, and of greater relative value to the defense than the heavy guns. It will not therefore be sufficient to train our gunners only in in the system of fire discipline and organization explained in the drill-book, as applicable to the working of heavy guns, they must also be taught the best method of working and fighting, the guns they will be required to man, under the varying conditions of actual warfare. It cannot be said with truth that the drill-book contains *no* information regarding the method of employment of the lighter guns, but I think it must be admitted that the chapters on coast defense deal so almost exclusively with the system of fighting heavy guns against ships, that it has come to be a matter of general acceptance that this kind of action will constitute if not the whole, at least the most important part of the garrison gunner's duties in war-time. The system of training, accordingly, has been largely based on this implied assumption, and drill and training with the lighter guns that make up the movable armament of a fortress, has been considered of only secondary importance.

It has been my endeavor in the preceding pages to show that the occasions on which the garrison gunner will be called upon to man his heavy guns will be few, compared to those when the movable guns will be wanted, and that when these latter are wanted they will always be required to repel an *important* attack, while the former may frequently only be employed, when they are required, in what will be little more than interesting practice.

If this view is correct, it is clear that a system of training to be complete and satisfactory must be based upon the requirements of the movable natures of guns, though it should admit of adaptation without difficulty to the special requirements of the heavy guns; our present system has been evolved on exactly the opposite principle and in some points is not well adapted to the working of lighter guns on traveling mountings, which have to be fought in different positions and under varying circumstances. Are we then to abandon the system of fire discipline, etc., under which our garrison artillery has been trained for the last several years? I trust not; for it is a system that has done much good service, and undoubtedly gave, when it first started, a much desired impetus to the training of the garrison artillery. But I think we ought to recognize *now* that we have taken a somewhat exclusive view with regard to the *rôle* of coast fortresses, and be prepared to modify our system as necessary, to bring it more in accordance with the probability of things. This we can do the more readily because the system being in itself a sound one, no very great changes are necessary: violent changes seldom lead to immediate beneficial results, and gradual modification to suit new circumstances is the law of healthy change. Let us see then what kind of system of training is required, and how far the present system as given in the garrison artillery drill-book needs modification.

In the first place it will be observed that as all garrison artillery companies are liable to foreign service and with it different duties in different stations, while the militia and volunteers are only required for home defense, it is probable that the former will require a wider and more general training than the latter; for while the training of the one must be such as to fit all companies to perform the different duties they may be called upon to undertake in different places, the training of the other need only be such as to best fit them for those particular duties to which they are allotted in the fortresses they garrison. It will, therefore, be advisable to consider the method of training each corps separately before we come to the question of how they can best be trained together.

This liability to foreign service will always be the great difficulty in the way of organizing and training the garrison artillery companies in the manner which otherwise might theoretically be the best. We cannot say that such and such companies shall be permanently trained to fight heavy guns against ships, such and such others as siege train companies, and others again to quick-firing guns, etc.; for to do so, means that some companies will not be liable to service abroad, or liable only to service in certain places abroad, some companies thus always getting the good stations while others have to be satisfied with the less desirable ones, some companies getting long periods of home service, whilst others cannot expect more than a brief spell at home between two long tours of foreign service. Desirable therefore as it doubtless would be, to have the different kinds of garrison artillery work permanently specialized, it does not seem that this is likely to be feasible with due regard to the exigencies of the service, and the training of companies therefore must be conducted on the principle of general foreign service, and consequent liability to different duties at different times and places. To meet then the various demands that may be made on garrison companies their training should be of two kinds.

1. A general training, embodying the simplest applications of the principles that underlie the successful fighting of all guns.

2. A special training, in the particular application of these principles to the fighting of those guns to which each company is for the time being allotted.

Before going further it will perhaps be of advantage to explain what is meant by the term "training," which must not be confused with the word instruction. Thus, training is the term applied to that special form of instruction which is employed to fit a soldier for the specific duties he will be called upon to perform in time of war; while instruction denotes the imparting to him of knowledge that may often be of great service to him, but is not absolutely necessary to the performance of his specific duties. An infantry soldier is trained to use his rifle, but he may be instructed also in gun drill. Training therefore includes instruction of a definite description, while instruction does not necessarily mean training.

The principles which underlie the successful fighting of all guns include, and may be divided into:

1. The correct service of the individual gun.

2. The method of laying.

3. The service of the combined pieces, *i. e.* the fire discipline of the battery.

4. The method of ranging, which includes observation of fire.

5. The chain of command, and means of communicating orders from the commanding officer to his subordinates.

The simplest and most general application of these principles is:

1. *Service of the piece.*—To be simple this must be as uniform

as possible for all types of guns, B. L. or M. L. An endeavor has been made of late years to obtain this, by keeping as far as possible the same numbers to the same duties with all guns. Nomenclature should also be uniform, and either the term "gun captain" or the term "No. 1" universally adopted, and not as at present, the N. C. O. in charge of a detachment called a gun captain when in charge of a 9-inch R. M. L. gun and a No. 1 when working an 8-inch Howitzer. These little differences tend to confusion, and to the idea that the drill of different guns must necessarily be wholly different.

2. *Laying.*—The most universally useful method of laying is over the sights by aligning them on the target. Great importance has rightly been attached to this method, as it is the foundation of all laying, and every encouragement has been given to men to make themselves good layers.

3. *Fire discipline.*—This must be of the most simple and general description; the groups should consist of two guns each, the working of them should be carried out quietly and rapidly, orders should be by word of command or signal, and the rates, and orders of fire should be as simple as possible. Here again uniformity in nomenclature would tend to simplicity, and either the term group commander or group officer should be universally adopted; similarly the group command for all guns should be either "commence firing" or "fire No. —— gun."

The method of fighting guns up to this point concerns chiefly the N. C. O.'s and gunners, and comprises the essential part of their general training. The remaining portions, viz: the ranging and communication of orders, as far as the rank and file are concerned, constitute merely an amplification of fire discipline, but their methods should be equally simple and capable of comprehension by all.

4. *Ranging and observation of fire.*—All ranging rests on the bracket system, and every method of observation of fire is merely an extension of the method of visual observation aided by field glasses or telescopes. These are the fundamental and necessary methods.

5. *The chain of command, etc.*—This must always be the same, viz: from the commanding officer through his subordinate

officers to the gun captains and detachments, and the simplest means of communication is by word of command, or signal between each link in the chain, all being in positions where this can easily be applied.

These are the principles on which the general training of all ranks, officers and men, should be conducted, and the simplest practical application of them is to the working of 4 or 6 light guns on traveling carriages, divided into groups of two guns each, and placed in open battery and close enough together to be all under the eye of the commanding officer, and within reach of his voice, so that the means of communication may also be simple; the method of ranging can be made equally simple by employing standing targets at medium ranges where visual observation of fire is possible and easy. These are in fact the conditions of field artillery fire-action in their simplest form, and they are equally applicable and necessary to the general training of the garrison gunner. Instead however of using field guns, the guns composing the movable armaments of fortresses should be employed for this purpose. This would have the great additional advantage of basing the general training of the garrison artillery on the service and method of working that class of gun which they will most frequently be called upon to man in time of war. These guns are already supplied in sufficient numbers as "movable armaments" to be available for purposes of general training; but where they are not conveniently parked for the use of companies, there seems no reason why other guns should not be issued for this purpose, especially as there must be numbers of them in store, and as it is not a matter of importance that they should be all of the same caliber or type. On the contrary seeing the different types of guns we have in the service, and the necessity for training the men in the use of them all, the ideal instructional battery for general training should consist of six guns made up, say of two 40-pounder R. M. L., two 40-pounder R. B. L., and two 4-inch B. L. guns; the actual caliber supplied is not of importance, provided that the guns used belong to that class which are now issued as the movable armaments of coast fortresses. The general training carried out on these lines having being completed, each company will pass on to its special training, but should annually, as a preliminary to the drill season, be regularly put through the course of general training.

The special training will consist in the particular application of the principles learnt in the general training, to the working of those guns to which each company is specially allotted, and generally speaking will include:

1. *Service of the gun.*—This will be modified according as the guns are B. L., M. L., quick-firing, or siege ordnance, and will include instruction in the special mountings belonging to them.

2. *Laying.*—The methods best adapted to the particular guns will form the subject of training.

3. *Fire discipline.*—What modifications of the general system are necessary for most effectively fighting these guns must be taught. The number of guns in a group may be varied to suit local requirements.

4. *The method of ranging* may be modified by the means of range-finding, or observation of fire, that is most suitable.

5. *Communications, etc.*—The means employed depend upon the relative positions of the various units in the chain of command and the appliances to hand, and must form the subject of training.

By following this plan each company will receive a general training on the same lines, and on such lines as will enable it without much difficulty to pass on to its special training, which will be solely according to its special requirements. Thus a company told off to fight a battery of heavy guns against ship attacks would be specially trained in the method of so doing, while another detailed for duty with the howitzers of the general defense must be specially trained in siege work, and neither need for the time being have any particular knowledge of other branches of coast defense; as soon however as they move on to other fortresses and have new duties assigned to them, their special training in these must recommence. Beyond this point, training ceases and instruction commences, and how far this should be carried on cannot here be decided.

To the complete performance of the fighting duties of the garrison artillery a further training which we may call "specialist" is necessary. By this term is meant instruction in the use of the many adjuncts that are now employed in both coast and siege artillery practice, and which includes such items as depression range-finder, and position-finder specialists, observers for siege artillery fire, specialists for electrical communications, artificers for complicated mountings, etc. For these special duties which require special instruction, and which will not, according to the views I have put forward in the preceding pages, be of general use, specially selected and trained men are required, and should alone be employed. This has been recognized by the appointment of such men as specialists, but in addition to the district specialists others have been allowed to companies both for range-finding and as gun layers. As regards the latter they should not be considered as specialists in this meaning of the term; laying must be considered as an important part of the general training, and though it is right that men who show a particular aptitude for laying should be selected as gun layers, and paid as such, they belong essentially to the company and the company only, and therefore should not be given a designation which is apt to be misleading. Outside the companies there should be no gun layers recognized. The district establishment of range-finders should be sufficient to supply all wants, and do away with the need for any company specialists. So that all specialists should belong to the district establishments, which are distinct from the companies, and all gun layers to the companies only.

A reference to Chapter II will show that the garrison artillery may in time of war be not infrequently called upon either to form a siege train, or to man siege ordnance in defense of their fortresses from land attacks; it seems clear therefore, that a portion of each company's special training should at times be devoted to this work. At present only three or four companies are trained in siege work; their number might well be increased, and if it is not possible, as is most certainly desirable, that the siege train should be permanent as such, it is at any rate possible to put more companies through this training annually. Each company should in turn go through a three years' course, and there should be at any one time, three companies at least from each garrison artillery division going through this course, each company being in a different stage of instruction. By shortening the course at Lydd to 6 weeks, and by arranging the companies so that one from each division attended each course, three siege divisions of three companies each could annually be trained at Lydd, without interfering to any great extent with the armament work of districts. There would thus be each year a fresh company learning siege work. All such companies when not at Lydd should be told off as far as possible to the movable armaments in their districts, the other companies in the division which are at home being trained for the time either in the working of quick-firing guns, or of the heavy guns for the attack of ships as required. But special attention must be paid to the means of repelling torpedo boat attacks, and for this purpose some practical system of ranging and working quick-firing guns is specially needed.

In fortresses abroad the same system of general and special training will be necessary, while in the colonies again the training should be carried out on the same lines, but as siege work is not likely to form an important part of their duties, the general training should be sufficient to meet and repel possible landings, while those portions of the force told off for the coast defense proper should be specially trained to the duties pertaining thereto.

When we come to consider the duties of the auxiliary artillery at home we are met with a different state of requirements. Brigades are permanently told off to certain fortresses, the men are not liable for service abroad, and therefore the whole duty of each unit consists in the proper landing and fighting of those guns to which they are allotted in the scheme of defense. Their training therefore requires to be only to this end, and the general and special training are merged into one particular system of fighting special guns. But to ensure sound and efficient training, this should be conducted as with the companies R. A. on the basis of the battery command being the unit for training. On the views put forward in Chapter III the auxiliary artillery will be restricted to the manning of the heavy guns in fixed emplacements, and to them therefore only does the system explained in the drill-book apply in its entirety. They must be prepared to work these guns when wanted, and will not be required to man any others. Each company then need be trained only in the method of fighting those guns to which it is allotted, and the system of training will follow that already described for the special training of garrison companies. As the time and opportunity of training these forces is considerably less than that available for the regular forces, this restriction of necessary duties is a distinct advantage, and the limits of the training required should admit of efficiency in the comparatively little that is asked for.

In the militia the officers have as a rule to go through a regular course of instruction, and each unit is regularly called out annually for its month's training, so that with systematic training, and proper insistance that officers attain the required standard, the militia artillery should, with the assistance of their Adjutants and gunnery instructors, be qualified to perform the duties that are demanded of them; especially if, as has been done lately, they are sent for their annual training to the fortresses which in time of war they are called upon to man.

But the volunteers do not enjoy the same advantages. Though it may be possible in the limited time at disposal for instruction, to train the gun detachments to the useful handling of the guns to which they may be allotted, the present instruction of volunteer officers is not altogether satisfactory. They are as a rule eager and willing to learn, but the opportunities for satisfactory instruction are not as frequent as could be desired. On the distribution advocated in Chapter III, volunteer officers may be required to act as fire commanders, or in any of the grades subordinate to this appointment, they should therefore be thoroughly trained in the duties of all commands from that of fire commander down to gun group commander. As a rule many of these officers cannot find time to attend regular courses of instruction, they are not below the average standard of intelligence, and would soon pick up their duties if opportunities were given for learning them. To each volunteer brigade is allotted an Adjutant, who is an officer Royal Artillery, and it should be part of his duties to hold, at least at head quarters of the brigade, evening or afternoon classes as most convenient, for the instruction of officers in the duties relating to coast defense. He should, moreover, pay visits to outlying companies from time to time with a view to giving similar instruction to the officers of the company, and where such outlying companies are found, a gunnery-instructor, who should be a volunteer officer who has been through a special course, and obtained a certificate, should be appointed to assist in the proper training of all ranks.

The general sketch given above of the kind of training required for the separate units of an artillery garrison leads us to the question of how the combined training together of these units can best be carried out. One of the points already advocated is that the training should be on the basis of making the Battery Command the unit. If this is done, so far as the men are concerned, when they are trained to their duties in this command, they are trained to all that is required of them. Such commands work much more independently of one another in garrison artillery work than in other military operations, and their combined action consists merely in the direction by one mind of their independent actions to one definite object. The grouping of battery commands under a fire commander, so far as it adds to, or alters the duties of such commands, affects only the officers. If the men know their duties connected with the battery command, and can work their guns efficiently they will do so equally well, whether their guns form a separate command, or are being fought under the direction of a superior officer as parts of a larger command; therefore to train the garrison to work the "chain of command" smoothly and efficiently, all that is required is to train the various officers to take up rapidly and intelligently their positions and duties, when the chain extends from the section commander down to the gun group commander. It is only to this extent then that the training together of the various units of the artillery garrison is necessary or desirable.

As far as the R. A. are concerned opportunities can generally be found in the ordinary course of training for instruction in these duties.

Militia officers too have an opportunity of being exercised in the duties and workings of a fire command when called out for their training, particularly if this takes place as it should, whenever possible, at the forts which they will be called upon to man in time of war.

Volunteer officers are generally placed at a great disadvantage in this respect for, as has been pointed out, their instruction is not as complete as it should be, and often they have but few opportunities of becoming practically acquainted with their duties. It might however surely be arranged that once or twice a year such portions of the artillery garrison of a home fortress as is represented by the R. A. companies therein stationed, and the volunteers available at short notice should be brought together to work the different forts to which they are allotted under the conditions most resembling service conditions: but for this to be of practical benefit such an assembling should include practice from all the guns manned wherever possible, even if only two or three rounds are fired from each gun. This means an expenditure of ammunition and consequent expense for which it is always difficult to obtain sanction. But such a combined fire-action might be arranged, if the present allotment of ammunition to station practice were utilized for this purpose. At present it can hardly be claimed that this ammunition is used to the best purposes, indeed it seems often to be fired away simply because it is to be expended, and it would therefore surely be much better to utilize it to test to some extent the value of the chain of command in each fortress, and to discover where the weak links lie. Moreover, on the distribution of the garrison advocated here, this ammunition, or at any rate as much of it as belongs to the guns that are to be manned by the volunteers, should be expended by them. Such combined practice where feasible would be of great benefit to the volunteers, and invaluable to the commanders of the higher units as giving them an opportunity of practically testing their commands.

It may perhaps appear somewhat strange, that when asked what is the most suitable system of training together the garrison artillery forces, we reply that the best system seems to be not to train these forces together, but to train each unit separately;

and yet the considerations given above point to this. If we emphasize the intention already expressed that the company drill and training should be wherever possible with the very guns that they will be called upon to man in time of war, and that this is intended to apply as much to the militia and volunteers as to the royal artillery, I think it will be seen that the work of the battery commands should be satisfactorily and efficiently carried out, and that this is really all that is required from the ordinary rank and file. The kind of co-operative action required to work the units of a fire command together does not necessitate more than individual action of the units guided by one master mind. To work a gun all the men in the detachment must work in unison; to work a group of guns, the gun detachments must work in combination; while to fight a battery command, the guns must be worked not only in combination but in harmony. But where several battery commands are fought under a fire commander, each battery command works independently though it may be in support of the others: each has its particular portion of the work to be done allotted to it, and the actual doing of this depends on its own training and efficiency, not on previous training with the other commands, it is less concerted than combined action. Where then is the necessity for training these forces together, beyond that already mentioned of affording the officers an opportunity of learning their duties and positions? but this can be done without elaborating a system of training which is not required and which would be difficult to arrange so as to be of practical value. Under the system here advocated no difficulty should be experienced in training each unit at the times and places most convenient to it; no unit will have to wait in order to complete or perfect its training till a time or place suitable or convenient to other units can be arranged. This is certainly a practical advantage gained.

The adoption of some such system of training as here advocated would entail but little alteration in the existing methods of drill and organization. In fact the only alteration required is the recognition of the use and importance of the lighter guns of coast fortress armament in carrying out the work of defense that will most usually be necessary, and the consequent desirability of having the elementary system of training based on their requirements: the need for a further special training is due to the multiform character of garrison artillery duties. And here it is curious to note how easily the proper signification of a term may be lost, and how much there really is in a name if the meaning it connotes is not allowed to drop out of sight. We call that portion of the royal regiment of artillery which has no mounted duties to perform "garrison artillery," and we do so presumably to denote in a general way what its duties are. If we enquire what is meant by the term garrison artillery we must perhaps admit that it necessarily has a somewhat indefinite meaning; but if it is difficult to attach an exact meaning to this term, it is not less easy to predicate of it, that it cannot and does not mean merely "coast artillery," that is artillery employed on sea fronts, whose sole business is the attack of war vessels; and yet with the exception of a few companies which are detailed as siege train or heavy batteries, the whole of the so-called garrison artillery is at present trained only to fight guns on sea fronts, and thus becomes a coast artillery and ceases to be a garrison artillery. The word garrison certainly connotes a fortress and with it the idea of general duties varying with the locality and importance of the fortress. But the duties of any fortress including coast fortresses are not confined to defeating an attack by ships' guns and yet *Garrison Artillery Drill*, Vol. I., is devoted almost entirely to this one object. This is either a confusion of terms or a misapprehension of their meaning if the former, let us call our companies *coast* artillery companies, if the latter, let us train our companies so that they may be able to perform garrison duties. Garrison is the term we use, and ought to keep to, but we must understand that it is synonymous with fortress, and connotes certain general duties that are necessarily indefinite, and therefore by implication denies the existence of only special duties.

It has been my endeavor in this essay by enumerating the different forms of attacks on coast fortresses, and examining the probability of their occurrence under various circumstances, to ascertain what the duties of artillery garrisons in war time are likely to be, and hence to formulate a system of training that will be suitable to the requirements of all cases. This examination has led to the following conclusions.

1. That the attack by war ships on coast fortresses is by no means the most general or the most important form of attack to be expected.

2. That therefore our present system of training which deals almost exclusively with this aspect of war, is a too particular one, and requires generalization and simplification to meet the other more frequent and important needs of coast defense.

3. That in modifying this system of training care should be had to the requirements of the different units composing the artillery garrison, their training being in accordance with the duties that are expected from them, and that therefore R. A. companies whose duties at different times cannot be particularly defined, must receive a different training from that sufficient for the auxiliary artillery whose duties being always the same are clearly marked and quite definite.

4. That the training for the R.A. should be (*a*) *general* in the application of the broad principles that underlie the fighting of all guns. (*b*) *Special* in the particular adaptation of these principles to the working of those guns which each company may at the time being be called upon to fight.

5. That the training for the auxiliary artillery need only be with reference to those guns to which each company is allotted in the scheme of defense.

6. That the training of all should be carried out on the basis of the battery command being the tactical unit.

7. This leads us to the final conclusion that it is not necessary to train the N.C.O's and men of different units together in order to obtain efficient work, but that it is very desirable that all officers should have frequent opportunities of practically carrying out the duties connected with the tactical working as a whole, of the command to which they belong.

I have endeavored as far as possible to avoid any suggestions of a radical or revolutionary nature; these seldom meet with much consideration, are generally of theoretical rather than practical value, and indeed as regards this question are in no way necessary. As in my opinion our system of coast defense has hitherto inclined altogether too much in one direction, so I am anxious now that the swing of the pendulum should not carry us too far in the opposite direction, but that our progress in the future should follow the sounder and more even course which is indicated by the motto of this essay

"in medio tutissimus ibis."

PROFESSIONAL NOTES.

A. ORGANIZATION.

(a). Field Telegraphy—Germany.

The work of the general staff on the war of 1870–71 asserts with great emphasis that the war strength and endurance of the fighting parts of an army are in a high degree dependent on the manner and method by which its intercommunications are regulated, the mode of furnishing the various requirements in food and ammunition, the measures taken for the care of the sick and wounded, and the system under which the necessary supply of men, horses and material is effected.

It is evident that an extensive use of the field telegraph will not only greatly assist the execution of these important duties, as well as the establishment and maintenance of communication between different parts of the army, but will also have a decided effect on the tactical and strategical decisive actions. A glance at the present organization of military telegraphy appears, therefore, at this time, of sufficient general interest not to be out of place here. Military telegraphy may be divided, at present, into field telegraphy and permanent or étappe telegraphy (on the successive bases of operation). Field telegraphy is that required in the service with troops operating in the field, and uses light material, while étappe telegraphy establishes communication with the permanent telegraph line of the country and employs heavy material. The general control and direction of the branch of military telegraphy is in the hands of the chief of military telegraphy at the headquarters of the army, but it is placed directly under the quartermaster general, who regulates the inter-relations of field, étappe and state telegraphy. The more efficient and mobile a field telegraph is, the farther it can be pushed forward into the most advanced lines; and the more rapidly and surely it establishes the communications between the marching columns, the more effective it will be as an important accessory in war. The value of telegraphic communication diminishes, in general, as the distance between stations decreases. Up to from seven to ten kilometers (4.5 to 6 miles) orderly officers and mounted orderlies are preferred to telegraphic communication. The distances that actually come into consideration, however, are often much greater, and therefore field telegraphy can in such cases be applied with great advantage. In the advance of an army the army corps are placed in communication with army headquarters, by means of the field telegraph, a few hours after their arrival in quarters. The lines are taken down to be again erected for the same purpose on the next marching day. In case of a temporary halt in the movements the telegraphic communications may, under certain circumstances, extend even to brigades, detachments, outposts, cavalry or artillery reserves, important points of observation and the different parks.

For the performance of the field telegraph duty in the army eight field and six reserve field telegraph sections were until recently intended. But, as each army corps is soon to have a field telegraph section, an increase in this organization has been proposed. In telegraphy well instructed engineer officers and pioneers familiar with all the important work connected with it, have charge of the duty with the field telegraph sections. The material consists either of plain copper wire, about 2 mm. in diameter, fastened to wooden poles some 4 m. high, furnished each with an insulator, or of insulated wire, 6 mm. thick, coated with caoutchouc and a hempen covering, which is to be simply placed on the earth or buried. Each section carries in addition a light sub-aqueous cable about 300 m. long. A mile* of field line can be laid in two and a half hours, and when two sections work together, in about one and a half hours. The maximum efficiency of a telegraph section is four miles.* It can lay and take down daily from one and a half to two miles* of line. The corps commanders attend to the construction of the lines of communication with one another, the commander-in-chief to the erection of the lines to the rear of the army. Lines found already established are repaired, if necessary, and utilized. For locating and repairing breaks in the line a number of efficient messengers are attached to each station.

The étappe telegraph sections have charge of the construction of the field line to connect with the base of operations, and they use galvanized iron wire, 2.5 mm. thick, and insulators somewhat heavier than those of the lighter line. The poles are taken from lines which have been destroyed. The Morse writer is the apparatus used in field telegraphy. Telegraphy is of special importance in the attack and defense of positions in the field, and in and about permanent fortifications. In sieges the entire line of investment, the higher commands, and points of special tactical importance are connected telegraphically one with another by the reserve field telegraph sections, or by sections newly formed for the purpose. The principal and secondary depôts are connected with the first and second artillery positions and with the first parallel, and this network, by laying transverse lines, is expanded to the third parallel. The cables are buried 1.25 m. to make them shot proof, and they are placed for better protection on the rear side of apparatus and stations. Portable telegraphs and telephones, in the form of the Siemens' outpost telegraph, are used by the advanced observation parties in their duty of correcting the artillery fire. These pieces of apparatus contain in suitable cases cables 4 mm. thick for a line with return wire (ordinarily the return is effected by the earth, a metallic plate or a wire rope being buried in the earth as deep as the underground moist layer, if possible). Four men, comprising two telephonists, are sufficient for the service of the apparatus. In the fortifications, as at Metz

* The *mile* here referred to is probably the German mile, equal to about four(?) English miles. It is stated in a late volume of Von Löbell's Jahresberichte that the line can be laid as fast each day as the infantry marches. J. P. W.

and Strasburg, for example, the telegraph, secured in protective constructions, finds application on an extensive scale. These instruments are provided with telephone arrangements and are kept in use there and in all the large garrisons even in time of peace. For war purposes the telephone is to be used only at short distances; at distances over 60 km. (38 miles), in its application in time of war, it is considered unreliable. Continued noise and clatter, wagons rattling, strong wind and rain, and more particularly musketry fire, render the telephone useless. A system of correspondence in time of war cannot therefore be based on the telephone. "Sounders," in which the messages are transmitted and received by the sound alone, serve as apparatus for the light field telegraph material. Telephone and sounder can be used to take off messages from the enemy's telegraph lines, by simply inserting them in the line by means of short wires. The use of a cipher in sending the despatches would secure against this danger.

The experiences of the late wars warrant the following conclusions relative to field telegraphy: Close connection of the field telegraphs with the larger lines already established in the country, all under one general direction, as well as the organization of the whole strategically according to the principal zone of the theater of war, tactically according to the strength of the separate subdivisions as determined by the work required; furthermore, the establishment of peace cadres for field telegraph troops, the officials for them being supplied from specially instructed non-commissioned officers and lance corporals; finnlly, a sufficiently extensive practice of these troops in field constructions with wagons properly horsed and equipped, the continued testing and improvement of the material, and the regular detail of field telegraph troops to the great maneuvers, in order to make the general staff officers and the troops more familiar with all the arrangements. The tendency of the art of troop leading of the present day to press on to deliver a series of rapid and decisive blows, and the immense size of the armies themselves, open a wide field for the application of field telegraphy, and the latter will undoubtedly be of great importance in future wars.

—*Allgemeine Schweizerische Militärzeitung.* No. 32, 1895.

(b) Organization—Russia.

In 1892 according to the *Recueil Militaire Russe** the French legislative power has received from some deputies a bill having for its object the fusion of the engineer and artillery troops. Parliament has not proceeded to the examination of this bill.

But a law promulgated the 29th of June, 1894, has modified the organization of the above-mentioned arms.† The principle dispositions of this law are summed up as follows:

1. Two regiments of pontonniers (which were attached to the artillery) are abolished.

* *Voiennii Sbornik*—Important changes in 1892.

†*Romania Militara* of Bucharest according to the *Revue Militaire Italienen.*

2. The service of the pontonniers passes to the engineers.

3. General staffs for two new regiments of engineers are created, and the number of companies of sappers is augmented by two.

4. The artillery receives general staffs for two regiments which will bear the numbers 39 and 40; twenty-eight mounted batteries are formed, composed as the existing batteries.

5. The new formations will be constituted by utilizing the resources in officers, non-commissioned officers and men of the troops which will become available by the suppression of two regiments of artillery pontonniers, and making necessary the employment of Lieutenants.

The officers belonging to those regiments shall be able to obtain their passage into the engineer regiments. Like power shall be accorded to officers of the same grade and equal number who shall ask to pass into the artillery.

No new employment of superior officers and captains will be made.

A decree of the President, dated July 4th, 1894, based on the power accorded by law to modify the number of batteries for special purposes fixes this number as follows:

Foot batteries	108
Mounted batteries	421
Batteries	23
Horse batteries	52

Batteries in service out of France.	foot	4	16
	mounted . . .	4	
	horse	8	

An addition of eleven batteries is made, and a diminution of 5 horse batteries. The diminution provides that the divisions of independent cavalry should only have two batteries, instead of three as at present, in view of procuring horses for the new mounted batteries.*

The two new regiments of artillery are to be originized on the first of October, 1894, but the Minister was authorized to fix the date of the creation of the twenty-eight new batteries, and to distribute between the forty regiments, the mounted batteries, mountain and horse, stationed in France and out of France.

The plan of distribution shows that to the northeast frontier has been given two mountain batteries, which did not exist before this, or at least were transformable mounted batteries; to the southeast frontier, an addition of nine mounted batteries is established.

Another decree has distributed the battalions of sappers-miners among the six regiments of engineers.

—*Revue de l'Armée belge.*

*Compare this with a proposition of the Russian Colonel Huysmans de Huysman (*Revue de l'Armée Belge*, January-February, 1895, p. 119).

B. PERSONNEL.

(a) Army in 1894—England.

The preliminary return of the British army for the year 1894, lately issued, is in many respects one of the most satisfactory which has yet appeared. The numbers of the regular army, the army reserve, and the volunteers are higher than they have ever been before in the history of the nation—at least in peace time—and, although the numbers of the militia are lower than they were in the year 1893, the total is much better than it has frequently been of late years. It is in the Yeomanry only that there is a continuous falling off. The first table of the return shows that whereas on January 1, 1894, the effective strength of the regular army, including all ranks, was 219,400, the total had increased by December 1, 1894, to 222,015, and that the average total for the year was 219,121 officers, warrant officers, non-commissioned officers, and men, this total being made up of 1,315 household cavalry, 18,265 cavalry of the line, 3,818 royal horse artillery, 14,417 field artillery, 1,433 mountain artillery, 17,440 garrison artillery, 7,480 royal engineers, 5,994 foot guards, 136,665 infantry of the line (including army pay corps), 5,073 colonial corps, 3,527 army service corps, 858 ordnance store corps, 315 corps of armourers, and 2,521 medical staff corps. On January 1 of the present year the numbers had increased to 222,151, or no fewer than 4,213 above the authorized establishment of 217,938. The reason of this large excess over the establishment of the army is that January 1 comes right in the middle of the trooping season, and although the British establishment is never allowed to exceed the numbers voted by Parliament, it is different with regard to the Indian establishment during the trooping months. The army in India is at its lowest ebb in September, and is then gradually increased in strength by drafts from home till the following April, when the draft supply ceases. It then begins to decrease in numbers till the trooping season recommences in the following September. The total of 222,151 above referred to is made up of 7,694 officers, 902 warrant officers, 13,975 sergeants, 3,395 trumpeters, drummers and buglers, and 196,185 rank and file.

Part II of the return deals with "Recruiting and Casualties," and from the tables in this portion we find that there was a total increase of 35,871, of which 33,698 were recruits enlisted during the year. The total decrease was 33,179, showing a net increase of 2,692 men. The 33,179 decrease is made up of 1,792 deaths, 10,480 discharged men, 3,958 deserters, 16,229 men transferred from the colors to the army reserve, 644 transferred to the militia, yeomanry, and volunteers, and 76 given up as deserters. These numbers include non-commissioned officers and men only, and although the number of recruits raised last year was the lowest for several years past, the net increase was the highest of any year since 1886, with the sole exception of the year 1892, when 41,659 recruits were raised (the highest number ever attained in a single year), and the net increase was 6,120. There is in this part of the return a particularly welcome piece of information with regard to desertion from the army. It is indeed a record year in this respect, for not only is the total number of deserters smaller than at any time during the last twenty years, with the single exception of the year 1883, but it has also the lowest percentage of deserters to recruits raised, which is only 11.7, as compared with 13.8 in 1893, with 14.5 in 1889, and with 17.2 in 1887. And similarly it has the lowest percentage of net loss to recruits, viz., 6.3, as compared with 7.1 in 1893, with 8.6 in 1889, and 9.2 in 1888.

The tables relating to "Courts-Martial, Crimes and Punishments" refer to the troops serving at home only, and it will therefore be well to await the publication of the general annual return before proceeding to comment on these particular points. The same remark applies to "Rewards and Services." But, although the tables relating to ages, height and chest measurements similarly refer only to the troops serving at home in 1894, it is just amongst those troops that the question becomes most interesting, and we may therefore devote a few lines to their consideration in this place. There were serving at home on January 1 last 103,276 non-commissioned officers and men, and of this number 2,586 were under eighteen years of age, and, including these, 12,636 under the age of nineteen, and an additional 16,411 under the age of twenty. This means that of the total force at home nearly one-third are, under existing rules, unfit to be sent abroad. Of the same force 3,196 were below the height of 5ft. 4in., and another 27,313 below the height of 5ft. 6in. As regards chest measurement, 2,922 were under 33in., and another 26,616 under 35in. It is curious that there should be just about 30,000 men inferior in each of these categories, and it is quite fair therefore to conclude that this proportion of the force at home are of very poor physique.

On January 1 last the army reserve numbered 82,497 men; the militia, at the dates of inspections in 1894, numbered 121,667; the yeomanry, at dates of inspections, 10,014; and the volunteers on November 1, 1894, numbered 231,-328. The 82,947 of the army reserve is the highest number ever yet attained by that force, the number on January 1, 1894, having been 80,530, the total being now nearly double what it was ten years ago. The militia is 3,025 less than in 1893, but is still at a higher figure than in 1892 and many previous years. The yeomanry continues to gradually decrease. It was 386 fewer in 1894 than in 1893, and has steadily declined, almost without intermission from 12,463 in 1875, to 10,014 in 1894. The volunteers have once more reached a record, the 231,328 of 1894 being an increase of 3,587 on 1893, and the highest number ever attained. The percentage of efficients has also increased from 96.21 to 97.06, a very considerable and satisfactory advance.

—*Army and Navy Gazette.*

(b) German and English Officers.

When examinations for direct commissions in our army were abolished, a competitive examination before the Civil Service Commissioners was introduced. Successful candidates were posted to regiments direct, and then after a year's service were sent to a reformed Sandhurst. To a certain extent this was a fair copy of the German system, but there were just these points of difference: In Germany the candidate's name has first to be approved by the colonel of the regiment; then he must pass a qualifying (not competitive) examination; and, finally, after passing through the "*Kriegschule*," which corresponds to our Sandhurst, he must finally be approved by the officers of his regiment. Of course, where a regiment is stationary for years in the same garrison the colonel will be well able to decide on any names submitted to him, but in our army this would be difficult if not impossible, and might—perhaps would—lead to a good deal of nepotism. If the German officers are able to work such a system without friction, it is absurd to suppose that Englishmen could not be trusted to do so in similar circumstances. Harmony in a regiment is more essential to its efficiency than anything else, and there are certain social qualifications whose presence or absence in an individual cannot be discovered by any amount of competitive examinations.

Moltke gave it as his opinion that there were only two things worth copying in the English army, those were our purchase system and our regimental messes. Though no steps have been taken in Germany to imitate the first, efforts have been made to secure the second. Almost every regiment in the German army has now, or will before long have, a mess; but though the form can be easily copied, the spirit is hard to create, as the Germans find. The rules of these messes are much the same as ours, but, as German officers themselves admit, the seniors have not quite the knack of dropping their authority off parade, and the etiquette, still very burdensome, ruins all social enjoyment. Hence, perhaps, the young officers do not make as much of the institution as ours do. They are obliged to dine at mess just as ours are, but their dinner is our lunch, and they prefer, as a rule, to pass the evenings in clubs or selected restaurants, frequented also by judges, barristers, civil servants, &c., who are reserve officers.

Let us look for a moment at an ordinary day in a German garrison. Parade in summer about six a.m., sometimes earlier, steady hard work till about half-past ten or eleven a. m.. It is thus too late to breakfast, as dinner comes at one p. m.; officers therefore disperse to their "*Bier Kneipe*," and drink a couple of glasses of beer, accompanied by anchovies on toast or some other light refection of the kind. Then come company work and orderly room. At one or two all sit down to dinner. With luck, they are free till about three, then begin afternoon schools and gymnastics. They seldom get away till half-past five or six. About eight they generally rendezvous for beer and supper, and in winter often sit in a close atmosphere of tobacco smoke till about eleven p. m. In small stations the *ennui* would be fearful if the officers were ever given time to think, but they are mercifully spared that trouble. Everyone will remember the description of an ordinary night at mess at a native infantry mess during the hot weather before the mutiny in the "Delemina;" but there, at any rate, the major had his old tiger stories to tell or some pigs to stick. The German has nothing of this kind to help him. It is not surprising in such circumstances that the conversation should turn on shop and garrison "gup;" in fact, become what to most Englishmen would be tedious. How the Germans who have visited England envy our army the constant change of scene and employment, at which so many British officers grumble. Many of them are very keen sportsmen, and never miss a chance of going after big game in the forests of central Germany and towards the Russian frontier. It is true they do not play games. Cricket, rackets and tennis are practically unknown to them, but, on the other hand, they are usually fair—often very good—swordsmen, and have exercise all the year round.

Plain clothes have always been allowed for sporting purposes, but the strict rules about constantly appearing in uniform in garrison are not relaxing in the Fatherland. Along the Rhine one frequently meets, however, officers in plain clothes, but these are officers on leave and on a travelling tour. The majority of German officers are poor men, and cannot afford to keep two sets of clothes, namely, plain clothes and uniform. However threadbare the uniform may be, it is always more respected than the most fashionable civilian garb, because in Germany the aristocratic dress is the uniform. Every country has its traditions and should stick to them, and one of the main pillars of the *esprit de corps* of the German officer is the constant wearing of uniform. He has to live up to it, which is advantageous in a moral sense, and helps to keep the corps of officers what it is and should be; it is disadvantageous in some respects, but life and habits in Germany are simpler than in England.

The practice of duelling also deserves a few words. It is well known that it is still permitted in certain circumstances in Germany. The Emperor, with reference to a case which occurred some time ago said, "I will not tolerate a bully or fire-eater in my service, but I also do not care to keep a man who is not ready to defend his honor if it is called in question." If a serious quarrel occurs in a German regiment, a council of honor, consisting generally of one officer of each rank in the regiment—either the seniors of each rank or selected by each rank—is assembled, and they, after hearing the evidence, decide whether it is possible to accept an apology under the circumstances: if so, the matter is settled there and then before the council, and no further steps are taken. If, however, the council is of opinion that an apology does not meet the case, the parties must fight before the next morning or be brought before the court of honor, consisting of the whole of the officers of their regiment. The powers of this court are to give a "warning" or "simple dismissal" or to "cashier." After a duel everyone having taken part in it is tried by court-martial. Quarrels about trifles are not likely to occur under these conditions, and, at any rate, the class of scandal which from time to time casts a dreadful shade on our own cloth is entirely avoided. It would be utterly impossible, for instance, for such a case to happen in Germany as that in which, a short time ago, an officer ran away with his brother officer's wife, and then returned and did duty in the same regiment with the man he had injured. Nor could the disgraceful system of baiting a young fellow out of a regiment, which from time to time occurs over here, be possible under the German system.

If German officers were taken to be professionally superior to our own, the reason would be not that they possess individually greater natural military talent, but that they are trained under a system which teaches them to act on their own responsibility and initiative, and not to be ever looking to others for orders. That the German has not greater natural aptitude for war is, we think, evident from the lives of those Englishmen who are serving or have served in the German army. There is no reason to suppose that these are, or were, in any way superior to their more fortunate brethren who are able to serve their own country; but they hold, and have held, a very marked position in every regiment in which they have been placed. And the career of our countrymen in the old Austrian army will tell the same tale.

—*Army and Navy Gazette*, July 20, 1895.

(c), Strength of European Armies.

An interesting synopsis of the present position of the European Powers in the matter of armaments has just been published. At the head of all stands Russia with an army of 858,000 men in peace times, or a percentage of 9 soldiers to every 1,000 inhabitants. Germany comes next with an effective strength of 580,000 men, which works out at 13 per 1,000. France follows Germany with an army of 512,000 men, or 14 per 1,000. In Austria-Hungary the effective is only 380,000, and the percentage 10 per 1000. Italy comes next with an effective of 300,000, and only 1 per 1,000; while the English army is said to have total effective of 230,000, and a percentage of 6 per 1,000. The Republic of Switzerland has a force of 131,000, with a levy of 45 per 1,000 of the inhabitants; the Spanish army has 100,000 effectives, or a percentage of 6 soldiers per 1,000 inhabitants; and the Belgian 31,000 soldiers, or 8 to every 1.000 of the population. The combined force of the Franco-Russian Alliance, it is interesting to know, in times of peace is 1,400,000 men, and in time of war 9,700,000. On the other hand, the Triple Alliance has available on a peace footing 1,192,000 soldiers, and on a war footing 7,700,000 men.

—*Army and Navy Gazette*, September 7, 1895.

C. INSTRUCTION.

(a) Artillery Drill Regulations.

The Drill Regulations of 1888 relating to horsed batteries, not having altogether satisfied the artillery, a new drill on the subject is now being tried in several artillery brigades.

Although we have a vague knowledge of the principal points which will doubtless be touched in the revision of the present regulations, it seems worth while to call the attention of such of our comrades, as may be charged with the experiments, to the following points which perhaps it may not be intended to modify or which it is proposed to modify on other lines than those we are going to indicate.

Wording.—It is important to start with this, the new regulations should be drawn up in clear simple and concise terms: take as example the German drill regulations, which in 70 pages only, express what in ours it takes three volumes each of double that number.

In this respect there is much to be done.

Gaits.—In deciding upon the rates of speed at the different gaits, it is expedient to make a distinction between mounted batteries and horse batteries. The mounted batteries being intended for service with the infantry, the rate of the quick step of that arm will answer for them. As to the trot, a trot of 200 yards a minute will be sufficient; and in all reason no more should be asked of heavy batteries, whose chests are loaded down with the weight of the cannoneers. One cannot go fast through fields when the ground is ploughed, especially if soaked with water. A more rapid trot should be an exception, and so with the gallop. Besides, we should remember that when mobilization takes place, the horses of the peace establishment will be lost among those obtained by requisition, while the latter will be heavy and awkward, have few gaits, and consequently incapable of much speed, without danger of being ruined quickly. When it comes to the horse batteries the case is different; called upon to follow cavalry, they must necessarily take the gaits of that arm; which can be done all the more readily because of the quality of horses especially selected for them.

To assign by order uniform gaits to batteries differently equipped and designed for entirely different purposes is sheer nonsense.

Reversing the carriages.—The reverse can be simplified. It must be reduced to two successive changes of direction to the left, and the oblique march which terminates it omitted: the only object of the latter being to try to bring the carriage exactly back in the original tracks; this is all very well, but unfortunately complicates a movement which it is desirable to make simple, which gets the teams tangled up and causes not a few poles to be broken.

Upon a road where the space is restricted, but two turns to the left are used, why then ask more on the drill ground, where there is plenty of room literally.

As it stands, we have two methods of reversing, which is one too many. Let us be content with the simpler one.

Doubling carriages.—Just as in the previous example, doubling up carriages is done in two ways according as they are on a roadway or moving about a drill ground; upon a road we double up to the left; on the drill ground to the right. Do away with the latter as useless.

Firing batteries.—Give a firing battery the following composition: 6 guns, 2 caissons. The two caissons forming an independent section, maneuvering on its own account.

Consequently, in mounted batteries modify the way of carrying the gunners; place 4 on the limber of the guns (2 facing to the front and 2 to the rear). In column by piece or section, the caissons will follow in rear. In line and in battery they will be placed behind the 2nd and 5th pieces.

Assign the center section to the senior lieutenant, this is more logical; the guide being at the center.

Breaking.—Admit as a principle that breaking to the front shall be from the center, whether breaking into column by piece, section or battery.

Formations in line.—Admit equally that most formations on the head of the column shall be fan-like, that is by moving to the right and left of the unit in front. Go back to the movements which used to allow direct formations in battery from column without passing through intermediate ones.

Do away with the "mass" which is used in two ways with the "line of columns," because the whole thing is only a question of intervals, which the troop leader can always change at will.

Admit that the formation into "line of columns" can be done by batteries in column of pieces also.

Retain echelon formation only in battery, when required by the ground, suppress all others.

Prohibit the "close column with extended intervals" which is hardly manageable; on the contrary, recommend frequent use of the "close column with closed intervals," giving 25 meters as the distance between batteries. This formation offers great facilities for maneuvring; two examples follow below:

"Deploy on the head of the column into line or battery." The 2nd battery obliques sharply to the left of the leading one and the 3rd to the right. The intervals are taken in marching to the line if there is room.

"Deploy on the flank into line or battery." The three batteries wheel simultaneously to the right or left, as the case may be; then this being done, they extend intervals on the center if necessary. To handle a group with this formation is a pleasure, each captain has his command thoroughly in hand, little room is needed and accidents are avoided.

Formations into battery.—At fast gaits, rein in to a walk at the command "In battery", so that the combat (battle) formation may be taken calmly in an orderly manner.

Replenishing ammunition.—When fire is opened, the adjutant moves two full caissons to positions behind the first and sixth pieces. The agent who has them in charge waits until the caissons 2 and 5 are empty to conduct them back to the echelon; he takes back at the same time such men and horses as the captain sends to the rear. As soon as this agent has rejoined him, the adjutant sends back to the battery two fresh caissons, as well as the spare men and horses called for by the captain and so on. In this way, the captain has less anxiety on the score of ammunition, which will always reach him in sufficient quantities to feed his fire.

We limit our observations at this point; it is certain that an application of the principles we have just opened up will be of a nature to facilitate the execution of drill movements and to give them a flexibility and quickness which are too frequently wanting.

—*L'Avenir Militaire.*

(b) Marching—England.

Can the British army march? Some seem to think it can not. We believe ourselves it is all a matter of training. It is to be regretted that our rank and file are so youthful, but even if they were otherwise there would still be difficulties in producing marching capacity if the men were not properly schooled to the work, for schooling in such matters is everything. Cricketers, football players, rowing men, etc., would all find themselves very much out of condition if suddenly called upon to submit to a severe strain. They are all careful to keep themselves in practice. And so it should be with soldiers. We have lately read rather distressing accounts of the march of the Aldershot Division to the New Forest. It has to be remembered, however, that the troops in this particular instance were exceptionally unfortunate, for the heat on the first three days of their march was simply tropical, and the men were severely tried, not by the heat alone, but by reason of the weight and uncomfortable nature of their field kit. References have been made to the march of Colonel Howard's brigade from Dublin to the Curragh on its way to the Irish manœuvers. Here again the men had a rough time of it, for the rain came down in torrents during the whole period of their march. Yet we have it on the authority of staff and regimental officers alike that they behaved splendidly under the ordeal, and arrived at their destination in good spirits and excellent fighting form. Colonel Howard, who commanded the column, has borne testimony to the admirable behavior of all ranks; and, as those who know him are well aware, he is not the man to coddle soldiers. He is too keen himself, where the duties of his profession are concerned, to overlook faults in others, if there were reason for fault-finding. Both he and Lord Ralph Kerr, commanding the Curragh District, have expressed themselves in terms of admiration of the soldierly spirit displayed by the men under conditions of extreme difficulty. We feel bound to accept their verdict, and we do it the more readily because statistics endorse their judgment conclusively. As it was in Ireland so it has been in the case of the Aldershot division, the men have shown a most praiseworthy desire to do their duty cheerfully. More could not be expected of them, and those are wrong, we think, who seek to make out that the fault for shortcomings rests with the men.

We have no wish to disguise facts. On the contrary we open our columns freely to both sides, holding as we do that in the long run it is the best, and certainly in the interests of the army, that criticism should be free and independent. Even in matters of religion and of politics there are differences, and it is not to be expected that in military affairs all will agree, for things would drift into a very bad state if they did. There must be controversy, and those are no friends of the army who would seek to check it. We admit readily that the spirit of our young soldiers is excellent. This is clearly demonstrated by the reports which reach us from officers of all ranks who have had experience lately in Ireland, and with the Aldershot-New Forest maneuvering force. The conditions in both cases have been trying to a degree, but youthful as our soldiers unfortunately are, they have conducted themselves in a manner which is beyond praise. Again, we have evidence of the wisdom of those who decided in 1881 to increase the number of highland battalions. Scotland may not be all that we might wish it to be as a recruiting field, but that the kilt is a good and serviceable "kit" is shown by the experiences of the 1st Battalion Argyll and Sutherland Highlanders in the march to the New Forest. When other regiments were losing men by the score daily, the old 91st arrived at their destination almost intact. They had no better time of it than the rest. They were not all Scotchmen, but they bore the fatigue of the march as no other regiment could. The London Scottish Volunteers, in the disastrous competition at Bisley some weeks ago for the *Daily Telegraph* Cup, were equally fortunate. When other teams reached the firing point, footsore and exhausted, the London Scottish were fresh and fit.

There is only one deduction to be drawn from this, viz,. that kit has a good deal to do with the marching powers of soldiers. But system plays its part too, and we fear our system, or rather want of system, has a great deal to answer for. A sergeant of the postoffice rifle volunteers, writing to the *Morning Post*, tells us that: "On the 6th instant 850 men of the 24th Middlesex (postoffice) volunteers marched from their camps at Jubilee Hill to Bisley, did their ball-firing practice from the 1,000 yards range to the 200 yards twice over, and then marched back to camp, a total distance of nearly twenty-five miles, without one of them suffering from sore feet." These men were volunteers, called up for a week's training, yet their record is a most creditable one. Why? only because they were in physical training. They were letter carriers, constantly on their feet and consequently in good condition. Is it not an argument in favor of training, and an argument also in support of controversy? Had this discussion not have been raised this fact would not have been brought to light to assist our military authorities in putting things right where they are unquestionably wrong. The first requirement of our army is a loose equipment, which would enable the soldier to undertake a long march with an open belt. The gain to the soldier would be enormous if he could be given this advantage. Then again, he wants good and properly fitted boots. Some maintain that trousers could give place to pantaloons and gaiters with advantage, whilst others would provide a turn-down collar to the tunic for marching purposes. But these latter suggestions are details. The questions of boots and accoutrements are pressing ones, and ought to be fully considered at once.

But we must train the soldier systematically, and cause him to feel that he has a fair chance. We can best do this by taking the practical view and submitting him to the same ordeal as the cricketer, the rowing man and the football player undergoes to keep himself bodily strong. Such a system is enforced in France and Germany. In both these countries a soldier having been put through his course of squad drill, is taught before anything else to march. In Germany, instead of going out with a company or battalion occasionally, as is done in England for about nine or ten miles at most, the young soldiers are sent out in small squads of ten or twelve men under a non-commissioned officer every day, beginning with a light load and for a short distance. Distances and loads are gradually increased until the recruit is able not only to march an ordinary stage, but to undergo the fatigue of a forced march with full equipment. At the same time the recruit's intelligence is developed. Under the non-commissioned officer's guidance, he is told to take note of all the features of ground passed over, hedges, bridges, farms, etc., and on return to quarters the squads are questioned by an officer to see that due attention has been paid to developing the men's intelligence. Have we any such system in England? Is there any system at all? There is absolutely none. And yet we wonder why it is that our youthful defenders have collapsed in such large numbers recently during the march of the Aldershot division to the New Forest. What we want in our army is more common-sense and less red tape. It is the same in every department, civil and military; sealing wax and red tape are the prevailing features, intelligence is allowed no scope. Thus the efficiency of the army suffers in every way.

—*Army and Navy Gazette*, August 31, 1895.

(c) Experiments with Lee-Metford Rifle.

The following brief notes on experiments carried out in Waziristan by Brigadier-General Symons are published in the *Pioneer*. It may be well to state that the animals had to be killed in any case, and they were put out of pain immediately:

At a small bullock, 50 yards. Bullet, hollow at point, filled with beeswax. About one-third of the lentgh of the bullet from the point pure lead, the remainder lead with nickel casing. Bullet hit stomach between the ribs, and lodged under the skin on the opposite side. The point of the bullet was well mushroomed. No bone were broken. It was most remarkable that the animal scarcely flinched when hit.

2. Same bullock, same bullet, same distance. Hit in thick part of neck and passed through, piercing the jugular. Bullock fell to the shot, all crumpled up, and died at once.

3. Same bullet, same distance, at a small sheep. Bullet hit bottom of breast-bone. The nickel casing passed through heart and body, and hit a rock beyond. The leaden tip and body of the bullet broke up into many small fragments, and passed out of the skin in five or six places. A portion of the breast-bone and surrounding tissue were smashed into pulp. Death instantaneous.

4. At a small bullock, 50 yards. Bullet, nose and center lead, no hollow at point; two-thirds of the length and base nickel cased. The bullet hit stomach, and passed through the body between the ribs. No visible effect on animal.

5. As in 4. The bullet passed into body, 8 inches behind shoulder, just missing the lungs, and then breaking a rib, went out on other side. Small portions of lead and nickel casing were found about broken rib under the skin near exit. The bullock dropped to the shot.

6. As in 4 and 5, at a small bullock. The bullet hit a shoulder bone, and reduced it and surrounding tissue to a pulp. Three or four pieces of bullet then passed through the lungs. The nickel casing, much jagged, was found against the opposite shoulder-bone. The lead of the point and body of the bullet spread in minute pieces all over the chest cavity. Death instantaneous.

7. Ditto, ditto, as in 6, at a small sheep. Hit immediately behind shoulder, broke foremost ribs on each side, and passed through lungs and body. Death instantaneous.

8. Service bullet, 30 yards, at a mule. Bullet hit close behind elbow, passed through one side of front rib, which was slightly splintered, then through lungs, fracturing half a rib on opposite side and out. The exit hole in skin was half an inch in diameter. A portion of lung was driven, most likely by a piece of fractured bone, through the exit hole. The mule staggered about after the shot, and would have quickly died. A second shot with government ammunition was, however, fired at close quarters to put it out of pain. The bullet hit in center of skull, making a hole the size of its diameter. It broke up the bones and tissue inside, and then passed out at back of jaw, making only a small hole.

—*United Service Gazette*, August 24, 1895.

(d) Use of Pigeons.

The successful employment of pigeons for transmitting military despatches and orders has suggested that they might possibly be employed successfully for communicating between ships and the shore. Divers trials of birds for this purpose have been made from time to time, but until recently upon no considerable scale. Not long ago, however, the French steamship *Manoubia* carried several hundreds of birds to sea in the Mediterranean and set them at liberty at distances of one hundred and 500 kilometers, or sixty-two and 310 miles from the shore. With few exceptions they regained their homes in the north of France, Luxemburg, Belgium, and even Holland. This evidence as to the use of pigeons as bearers of messages from the sea appears most valuable. M. Delêtre, an expert in such matters, has indeed concluded that pigeons may be depended upon to bring to Paris in a single day messages despatched from a distance of 300 miles at sea, or to the ports from a distance of 500 miles. French steamship companies are taking the matter up, and more will soon be heard of it. Apart from the naval use of despatch-bearing pigeons, it will often relieve the minds of many to hear tidings of over-due vessels.

—*Army and Navy Gazette*, August 24, 1895.

(e) The Force of the Blast From an 8-inch Gun.

Recently, with a view to the practical determination of the effect of a blast from heavy gun firing over a protective plate, Commodore Sampson had a series of experiments made at the Indian Head Proving Ground. The Indian Head experiments were interesting, and are the first of the kind ever held in this country or abroad. Lieutenant Mason, the officer in charge of the proving ground, conducted them. An 8-inch gun was employed. Under its muzzle was placed a 7-inch armor-plate, which was 8 ft. square, and weighed about 8 tons. The center of the plate was 20 inches in front of the muzzle and about 4 ft. below it. Over the plate, and nearly parallel with it, was secured a 1-inch wrought-iron plate, 74 inches long × 68.5 inches wide. It weighed about two-thirds of a ton, and was supported at each corner by a 2-inch armor bolt, screwed into the corner holes in the back of a 7-inch plate below. The corner holes in the bottom of the plate were not directly below the holes in the corners of the wrought-iron plate. Consequently they were bent to bring their upper ends into proper position. The center line down the length of the 1-inch plate was parallel with the axis of the bore of the gun, prolonged .25 of an inch to the right and 24 inches below, the surface of the plate being inclined 1° with the horizontal, the same as the gun. The muzzle of the gun projected from the rear of the 1-inch blast plate 17.5 inches. Two rounds were fired.

In the first round the charge of powder was 100 lbs., the muzzle velocity 2,018 foot-seconds, and the pressure 16 tons. The elevation of the gun was 1°. The wrought-iron 1-inch plate was bent downward at right angles to the line of fire, along its central transverse line, the center of the plate being forced down by the blast 3.93 inches. A slight rotary movement to the left was also given to the plate. The 7-inch armor was not moved at all. In the second round the charge of powder was 107 lbs., the muzzle velocity 2,000 foot-seconds, and the pressure and elevation the same as in the preceding. The blast plate was in the position produced by the first round. The effect of the second blast was merely an augmentation of that of the first fire. The lower plate was not moved in the least. After the second round the support of the right-hand rear corner retained nearly its original position. The other three bolts had twisted to the right nearly 45°. The second round crushed the plate downward about 7 inches, making the extreme deflection about 10 inches.

—*American Engineer and Railroad Journal*, August, 1895.

(f) Musketry in the French Army.

The following table, based on experiments at the Chalons School of Musketry, is intended to show the percentage of hits to be expected from a well-trained body of men:

Range.	Rifle of 1874.	Rifle of 1886.	Target.	Position.
100 m.	58.7	70.4	50 c. m. diameter	**Kneeling, no rest**
200 "	55.4	67.9	1 m. diameter	**Kneeling, no rest**
200 "	40.7	53.8	1 m. diameter	**Standing**
300 "	37.6	50.1	1.50 m. diameter	**Standing**
400 "	47.5	60	2 m. diameter	**Kneeling**
400 "	43	58.8	2 m. diameter	**Lying down**
600 "	20.7	46.2	3 m. × 2 m.	**Lying down**
200 "	38	50	1 m. diameter	**Standing, fixed bayonet**
200 "	15	67	1 m. diameter	**Kneeling, fixed bayonet**
250 "	10.3	16	Kneeling figure	**Standing, fixed bayonet**
400 "	18.5	24.5	2 kneeling figures	**Kneeling**
350 "	. .	40	2 m. × 2 m.	**Magazine fire, 30 seconds**
200 "	. .	11	Head and shoulder disappearing (3 seconds exposure)	**Magazine fire, time not given**

COLLECTIVE FIRING.

Range.	Rifle of 1874.	Rifle of 1886.	Target.	Position.
600 m.	7.8	12.9	7 standing figures.	Squad volleys
800 "	5.3	10.1	14 " "	Half-section volleys
1000 "	3.7	7.6	28 " "	Section volleys
800 "	5.8	11.4	28 " "	Section volleys
600 " } 500 " }	8.9	16.9	28 " "	Independent firing
350 "	8.6	11.8	28 " "	Rapid fire

—*Journal of the Royal U. S. Institution.*

(g) Target Practice—India.

"Lord Roberts' forecast regarding the improvement that would take place in the shooting of the field-artillery in India, when officers and men had become accustomed to the 12-pounder breech-loading gun, has been fully verified. The 12-pounder is, indeed, a splendid weapon, and when it comes to be used in action its killing power should demoralize any enemy. The recent annual practice of the horse and field batteries in India has been most instructive. We will take first the average struck on all the batteries at various ranges and targets, the range being in every case unknown to officers commanding. As regards the 'ranging' the general rule has been that at the longer distances (usually at targets representing a 6-gun battery in action) the battery range-takers were employed; at the medium distances it was optional with the officers commanding to use the range-takers or not; at short distances, generally against 2 feet square targets representing infantry kneeling, range-takers were not allowed at all. Thus no unfair advantage was allowed, the conditions approximating as closely as possible to those which would obtain in the field. The averages were as follows: (1) Range about 2,450 yards; targets thirty-nine standing dummies (6 feet × 2 feet) to represent the *personnel* of a battery in action with normal intervals between detachments; effect 6.6 per cent of the targets destroyed per minute in action. In other words, in less than sixteen minutes from the command 'Halt; action' every dummy would be hit with an average of five hits on each. (2) Range about 2,100 yards; target fifty standing dummies in the open, with one yard clear interval between them; effect 11.43 per cent per minute. Thus in about nine minutes every dummy would have received five hits. (3) Range about 1,500 yards; target fifty kneeling dummies at yard intervals; effect 10.35 per cent per minute, or every dummy hit from three to four times in less than 10 minutes. We quote these figures in detail as showing what our guns can do, and it should be remembered that these are averages and not the figures of picked batteries. What may be expected from good shooting batteries, armed with the 12-pounder, under fairly favorable conditions of light and ground, is shown in the results obtained by five batteries practicing together last January in the Bombay Presidency. Two targets—one representing infantry, fifty standing dummies painted khaki-color, in line at yard intervals, range about 1,300 yards; and the other an artillery target represented by thirty-nine standing dummies, also khaki-colored, arranged as the detachments of a 6-gun battery in action, distance about 2,000 yards—were placed on ground quite unfamiliar to the batteries practicing. This means that not only was the distance unknown, but also that, the ground being strange, officers commanding could not from previous experience in that particular place form any estimate of what the range might be. No range-takers were allowed. Fire was first opened on the infantry target; then, at the expiry of four minutes from the usual command 'Halt: action,' the stream of shell was turned on to the artillery target. Each battery practiced independently, but from the results obtained it appeared that had the five been firing together against 250 infantry dummies and the detachments of five batteries, 1,549 hits would have been scored on 231 of the infantry in the first four minutes, and 663 hits on 152 out of the 195 artillery dummies in six minutes from fire being switched off the infantry target. We can find no previous record of such an effect as this either in England or in India, for in ten minutes there would have been only sixty-two dummies untouched out of the whole 445, and this at 1,300 and 2,000 yards range respectively."

—*Journal of the Royal U. S. Institution.*

(h) A Military Application of Photography.

According to the *Armeeblatt*, experiments were made in France in telephotography with a very ingenious apparatus.

It appears that the results were very satisfactory, and it is recognized that the apparatus may have great usefulness in service of exploration as well as in siege warfare. In the first case they were able to recognize with accuracy the hostile positions from considerable distance; in the second they were able to obtain a clear photographic print of the fortress and its vicinity.

When a fortress is commanded, as at Grenoble, by a high mountain from which the picture can be taken, a bird's-eye view is obtained in which it is not difficult to determine the positions of the pieces within the work and recognize clearly the works under construction, and the effects of bombardment, and it was possible to obtain from the summit of the Moncherotte, distance eight kilometers, a complete view of Grenoble.

Then coming nearer the fortress up to a distance of two kilometers they were able to obtain with the same apparatus partial views which showed the effect of projectiles. If commanding heights do not exist in the neighborhood of the fort recourse to captive balloons will be necessary in order to obtain a complete photographic view of the place.

French aeronauts have succeeded in obtaining good photographs with a 13″×18″ apparatus at a distance of from 5 to 6 kilometers; but with a small instantaneous apparatus it was not possible to obtain a complete picture. Still better photographic results were reached with a captive balloon at 2000 meters. With the camera placed below the car they photographed even the most concealed details of the fortress. When captive balloons or commanding heights are not available good views can be taken from high towers. They also made experiments at Grenoble in this line. They formed with long timbers fastened together a small tower, from 30 to 35 metres high. To the top of the highest timber they attached a photographic machine whose shutter operated automatically by means of electricity. At 1200 meters they secured in this manner good views. Telephotography has also been employed in certain kinds of topographical work with fair success.

—*Revista Cientifico Militar.*

(i) The Mountain Artilleries of France and Italy.

ITALIAN MOUNTAIN ARTILLERY.

On August 10 and 11, I was permitted to attend the practice of the 7, 8 and 9 batteries of mountain artillery, on the mountains between Bousson and the Franco-Italian frontier. These three batteries formed a brigade-division under the command of a major, and at the time of my first visit were being inspected by the Lieutenant-Colonel in command of the regiment of mountain artillery, headquarters Turin. The batteries, which had no Reservists present, varied slightly in strength but averaged about 100 rank and file and 50 mules. All the 9 regular mountain batteries have 6 guns on the peace establishment. The two transformable batteries have only 4.

The physique of the men was extremely fine; their average height was at least five feet 9 inches, and they were, almost without exception, powerfully built. They wore loose cloth tunics, khaki trousers, and Alpine boots, and were invariably in complete marching order (knapsack, haverrack, water-bottle, etc.), throughout the operations. The only weapon carried by the men was the short artillery sword resembling that of a drummer. Twenty-four men per battery carry a carbine. Under-officers carry a long artillery sword and revolver. The most distinctive feature in their equipment was the aforesaid "Alpine boot," which resembles a short, heavily-nailed "field" boot (very similar in pattern to that worn by officers of some of our mountain batteries in the Afghan war), and laces in front up to about 8 inches above the ankle. Similar boots were very generally worn by the inhabitants of the district, and officers and men alike declared that, if well made and fitting tightly round the ankle, it was the best form of foot-gear for mountain work.

The practice took place among the highest ridges between Mont Chaberton and Pointe Rascia, and involved each day a climb of over 3,000 feet from Bousson. Both men and mules, however, stood the work admirably, and there were absolutely no signs of distress. As an instance of the physical power of the gunners I may mention that, on the second day's practice, a battery having taken up its preparatory position at the foot of a knifelike ridge, on the top of which it was coming into action, it was found that the slope was in places too steep and narrow to allow of the guns and carriages being carried into position by three men to each load, as is usually done. Wherever this was the case the gun was promptly shouldered by one man and the trail by another and so carried into action 20 or 30 feet up a steep slope. Each of these loads weighed over 200 pounds, and was carried by a man in full marching order who had just climbed over 3,000 feet in two hours.

The mules were of an extremely fine stamp, many *over* 15 hands high and in excellent condition. The saddlery was in serviceable order, though with no attempt at polish of any sort. Four mules go to make up a gun-team, and march in the following order and with the following loads: 1, gun-carriage; 2, gun; 3, two wheels, a pair of shafts (very awkward and unnecessary load projecting over the mule's back), and a box containing gun implements and small stores; 4, two wooden boxes of ammunition, ten rounds in each. The remaining ammunition mules march in rear of the six gun-teams, each mule carrying 20 pounds. (This constitutes the "ammunition line" as in our batteries; there was no "relief line" of mules, nor did it appear necessary).

Two sorts of saddles are used, one with an iron cradle on the top, carried by the first three mules of the gun-team as above described, and the other, without the cradle, adapted for slinging the ammunition boxes. (The principle of having only one saddle adapted for the carriage of either gun, carriages, and wheels appears an advantage over our system of a different pattern cradle for each nature of load.) The panels are stuffed with straw, with a layer of horse-hair next the mule's back; split leather girths are used and are generally, to English eyes, too far back under the stomach. The gun is a 7 cm. (2¾ inches) bronze breech-loader by Krupp—weight, 214 lb.; length 39 inches; muzzle velocity, 840 foot seconds; weight of shrapnel, 9¼ lb.; charge, 10½ oz. The fuze is a combined time and percussion, and is always carried in the shell, the detonator being carried separately and fixed in the fuze when the gun is loaded. The average weight carried per mule throughout the battery is 340 lb. Shrapnel is almost exclusively used, with percussion fuze for ranging and time fuze for subsequent effect. The number of rounds carried in the "fighting line" of the battery is 14 common, 56 shrapnel, and 4 case shot per sub-division. Owing to the low muzzle velocity of the gun, it is necessary to burst the shell close up to the target, otherwise the effect is lost. The bronze guns are considered to be fairly good weapons when new, but are said to wear out rapidly. The fuzes also are said to deteriorate considerably after being some time in store. In the batteries now described both guns and fuzes were old, which may to some extent account for the inferior practice made by them. I was told that experiments were being made with a new gun (Nordenfeldt), and that its adoption was shortly expected.

Each battery had a range-finder, somewhat similar in principle to, but rather more elaborate than, the Weldon instrument. They were, however, seldom used, as the ground on which the batteries came into action rarely allowed of a sufficiently long or level base being obtained. There were no men specially classed as range-finders, and on the only occasion on which I saw the instrument used the battery commander himself took the range with an error of 600 yards.

An Italian mountain battery on service is divided into three units—the "battery of maneuver" (referred to above as "fighting line") of six guns, and

74 rounds of ammunition per gun, etc., carried on 4 ammunition mules odd sub-divisions, 3 ammunition mules even sub-divisions; the "ammunition column," of 33 mules, carrying amongst other stores 60 rounds of ammunition per gun; and the "section of park," of 52 mules, carrying 150 rounds per gun, 126,400 rounds of small gun ammunition and 1,080 rounds of revolver ammunition. In action the latter is always left on a carriage road, and a mile or two in rear of the battery. The "battery of maneuver" in action has 6 ammunition mules close to the guns, and the remainder 50 to 100 yards in rear. The "ammunition column," if with the "battery of maneuver," forms a second echelon 500 yards in rear of the guns.

When on the march and changing camp every day, the mules are picketed in a circle, by simply fastening each animal's collar chain to the head-collar of the animal on its right, so as to leave about 18 inches between their heads. By this method they are of course prevented from lying down at night, but this is not considered much of a disadvantage; at least, not so much so as to counterbalance the saving of weight in picketing-gear, etc. When, however, a battery was stationary for some days the commanding officer made arrangements to picket the animals separately by passing head chains along a long picketing rope, somewhat similar to our method for horses. Officers and men slept in tents, those of the men being carried on their backs and those of the officers on two mules allowed to each battery for officer's baggage. The poles of the men's tents, both in the mountain artillery and Alpini, are not jointed, but are in one piece and are used as alpenstocks.

The practice was conducted under service conditions, and the nature and position of the targets (which were placed by the major commanding the brigade division) were unknown to the battery commanders. On arriving near the place where it was to come into action, the battery was halted and the commander called up by the major, who pointed out the target and indicated the position for the battery. The battery commander then took up his preparatory position, as near as possible and under cover, and pointed out the target to the officers of Nos. 1 (who are invariably the gun-layers), during which the battery came into action and loaded. The guns were then run up by hand or by the shafts to the firing position; the whole position in fact closely resembling our own. After each practice, the officers and non-commissioned officers were called up by the lieutenant-colonel. The battery commander then described his performance in detail, giving his reasons for each step. The non-commissioned officers then withdrew and the major criticized or commended, as the case might be, and finally the colonel criticized both the major's remarks and the battery commander's action. In addition to the above, range reports (of which I was unable to obtain a copy) were made out, both by the battery and the range party, but these, I was informed, were intended chiefly for the information of higher authority. An observer was always employed to assist the battery commander. He was placed about 20 to 50 yards to a flank, and considerable reliance (which was not always justified) seemed to be placed on his reports.

The first practice witnessed was that of the 7th battery on August 10. The target, about twenty full-length wooden dummies, represented a section of infantry in line at about 1 yard interval. The range was rather over 1,000 yards, light good, and observation easy. On coming into action (with percussion shrapnel), the right, center, and left sections laid with elevations of 1,000, 1,200, and 1,400 meters respectively, and fired rapidly from the right. One shot from the center section gave a direct hit, and time shrapnel was at once proceeded with, without any further verification. About 18 rounds were fired with considerable rapidity, which were all too long and burst much too high, but no attempt to alter the fuze was made.

The 8th battery practiced next, at a similar target but at rather a longer range. The procedure in this case was different, and elevation given for each gun separately, as with us. A good bracket, of 200 meters, was obtained with the first two shots, but the third shot (laid on the mean of the bracket), which was palpably long, was reported by the observer as a hit. Time shrapnel was at once commenced at that range, without verification, and twelve were fired, which were all long though the fuze was reduced twice.

The 7th battery then fired again, the target representing two guns in action. Petards, intended to represent the enemy's fire, were let off at intervals by the range party, but being placed too much to leeward of the line of fire, they did not obstruct view or observation. In this case the range-finder could be used, and the range, as found therewith, was 2,600 meters. Fire was opened with this elevation, but the first two shots could not be seen. The range party was then communicated with by signalling and reported that both shots had fallen in a valley, far beyond the target. A bracket was finally obtained after several shots at about 1,800 meters. The time shrapnel was, however, ineffective.

On the second day the practice at a moving target was good. Generally speaking, there seemed to be a knowledge of the rules of fire discipline in each battery, but there seemed to be an invincible repugnance to putting them into practice. This was the more curious as the allowance of practice ammunition (400 rounds per battery per annum) was quite sufficient to have allowed of a high standard of efficiency being attained. The tactical ideas throughout were sound.

Comparing the batteries generally with our mountain batteries, I think they cannot be classed in any way as equalling our own equipment, smartness of turnout, rapidity of drill, or artillery knowledge generally, but from being born and bred mountaineers, they excel in hill climbing and capability for lifting heavy weights over our men. The weights carried by the mules exceed those carried in India by our batteries with the smaller mules. The ground in the Alps was quite as difficult as those portions of the Himalayas in which our batteries are accustomed to work. The drivers are all the older soldiers who have gone through the gunners' training in a previous year. "Gun" and "ammunition" lines attend all parades. There are no separate mules for the carriage of pioneer tools as with the French and our mountain artillery, the necessary entrenching tools being divided amongst the mules generally, excluding gun mules. The detachment consisted of seven men, who brought the gun into action in 45 seconds. Only the officers are mounted; and they rarely use their chargers on the hillside. The saddlery and turn-out generally resemble much in detail that of the French, and one must have copied much from the other it would appear. The October number of the *Journal* of the United Service Institution gives a very interesting description of the action of the two Italian mountain batteries (native) in the engagement at Agordat. The guns were too weak to be of much use, and were kept in action too long, whereby they were temporarily taken by the enemy after all the mules had been shot.

—*United Service Gazette*, July 6 and 13, 1895.

D. MATERIAL.

(A) ARMAMENT AND EQUIPMENT.

(a) The Terrible.

The new first class cruiser *Terrible* was launched on the 27th May, from the yard of Messrs. J. and G. Thomson, at Clydebank, near Glasgow, and the subjoined description is taken from the *Times*. "The new ship is notable from more than one point of view; in the first place, she far exceeds in size any vessel of her class that has gone before. When the dimensions of the *Blake* and the *Blenheim* were announced a few years ago it was considered that a remarkable advance had been made in regard to size, and there were some critics who exclaimed against the extreme dimensions which it was considered had been adopted. These ships are 375 feet long, and 65 feet beam, the mean draught being 25 feet 9 inches, and the displacement 9,000 tons. The *Terrible* and her sister-ship the *Powerful*, now under construction at Barrow, are each 500 feet long between perpendiculars, or 538 feet over all, and with a beam of 71 feet, are designed to have a draught of 27 feet, and are to be 14,200 tons each in displacement. In the machinery department the advance is hardly less marked. On trial the engines of the *Blenheim*, which alone of the two vessels was tried with forced draught, gave off 21,411-I.H.P; the *Powerful* and *Terrible* are to be driven by engines exerting 25,000-H.P. On the natural draught trials, however, the *Blake's* propelling machinery gave out 14,525-H.P., with an air pressure equal to a head of 0.4 inch of water, that of the *Blenheim* 14,924-H.P., with an air pressure equal to 0.2 inch of water only. As it is intended to run the *Powerful* and *Terrible* with natural draught only, the powers just quoted should be compared with the 25,000-H.P. hoped to be obtained with the latter vessels. It may be stated here, for the information of those who are not acquainted with Admiralty trial trip practice, that the term 'natural draught' is not always used in its primitive sense of being the draught due to the chimney alone, but that a slight plenum is generally maintained in the stokehold, anything under half-an-inch being considered natural draught. On her forced draught trial the *Blenheim* had 2 inches air pressure, which is the maximum allowed for large vessels.

"The chief feature of interest in the two new cruisers is not, however, in their size, or even the enormous power that is to be obtained from their engines, but the manner in which the steam is to be generated to supply that power. In fitting water-tube boilers to these important ships the Admiralty authorities have made one of the boldest and most important steps ever taken in the history of naval engineering.

"The *Terrible* is a first class twin-screw protected cruiser, but, like all her modern sisters, she has no side armor, the protective element being entirely confined to the armored deck, which extends over the whole length of the ship. In its thickest part it is 4 inches thick, and it tapers to 3 inches at the ends. It is composed of three layers of steel plating, the practice of fitting the deck in layers, instead of solid plates, much facilitating construction and reducing cost, as the price of curved plates rises enormously as their thickness increases. The edges of the deck join the skin of the vessel 7 feet below the load water line, and the deck rises amidships to 3 feet 6 inches above that level, so that in cross section the deck forms a flattened arch 10 feet 6 inches from the springing to the crown. This, we understand, is in excess of anything hitherto planned, and it enables the cylinder tops of the engines to be kept below the deck without the use of armored coamings. The spandrels at the sides are arranged in the usual manner for excluding water by means of subdivisions and stowage of coal or stores, the provision for coal armor being very complete. In regard to hull construction, the universal double bottomed system has been followed, the virtues of which were so notably made manifest in the grounding of the *Apollo* and the *Howe*. The usual flat keel with internal vertical keel is used, together with the ordinary longitudinals. The hull is wood sheathed for coppering, but only a very small part of the metal sheathing at the extreme bottom is now in place, the remainder will be attached when the vessel goes round to the dockyard to be completed by the government. The rudder is of large area, and is partially balanced. The stem and stern frame are of phosphor-bronze, and there are long bilge keels which are covered with metal sheathing. The ship is extensively subdivided into water-tight compartments. The armament of the *Terrible* will consist of two 9.2-inch guns, twelve 6-inch Q.F. guns, sixteen 12-pounder Q.F. guns, twelve 3-pounder Q.F. guns, nine machine guns, and two light guns. There will also be four torpedo discharges.

"The twin screws are each three-bladed, the diameter being 19 feet 6 inches. The blades are of manganese bronze and the boss is of gun-metal. Both screws rotate inwards, which is the reverse of the ordinary practice, but recent experiments made by the Admiralty warrant the change.

"The engines are of the vertical three-stage compound type, with four cranks, there being two low-pressure cylinders. The diameters are as follows: High-pressure cylinder, 45 inches; intermediate, 70 inches; the two low-pressure cylinders being each 76 inches. The stroke is 4 feet. An excellent arrangement of standards has been adopted, the engines possessing the advantage of being very open and accessible, with efficient and ample rubbing surface for the guides. There are four cast-steel standards to each cylinder, two back and two front. The cross head is of considerable length, the guides being at each end, both back and front. In this way the cranks are quite exposed, and the cross girders in the engine bed for taking main bearings are conveniently placed between the standards. The low-pressure and intermediate-pressure valves are of the ordinary flat type, with an arrangement for relieving the pressure at the back. The high-pressure valve is of the piston type. The link motion and the reversing gear are of the usual description. There are two air-pumps to each set of engines, both worked by side levers, one from the high-pressure cylinder and the other from the forward low-pressure cylinder. The receiver pipes are of steel with gun-metal expansion joints. The thrust-block has eight adjustable collars, with white metal. The shafting is hollow and is of Vickers' steel, being 20 inches diameter. The stern shafts are covered entirely with brass. There are two main condensers of the cylindrical type, having a combined cooling surface of 25,000 square feet. There are also two auxiliary condensers, the combined surface of these being 3,000 square feet. There are four 24-inch centrifugal pumps for the main condensers, and the two 9-inch auxiliary centrifugals, with air-pumps, for the auxiliary condensers. There are three Weir's feed-pumps in each engine room, or six in all. There are also six pumps of the same type in the stokeholds.

"The ship has no fewer than forty-eight boilers, these being all of the Belleville water-tube type. They are situated in eight compartments, four of which contain eight boilers each, and the four others four boilers each. There are, in addition to the stokehold pumps already mentioned, eight sets of air-compressers. These form an essential feature in the Belleville system of steam generation, as they are used for forcing air, through suitable nozzles placed above the fire doors, into the interior space of the boiler. The object is to promote combustion, not only by the admission of fresh air, but by securing a thorough mixture of the gases; whilst, at the same time, the flame is spread over the heating surface so as to reach all parts. Baffle plates of sheet steel are also placed amongst the tubes to secure the same end.

"The *Terrible's* boilers are equally divided in number between the eight element and seven element arrangement. The collective grate surface is 2,200 square feet, and the total heating surface is 67,800 square feet. The tubes are of lap-welded steel, 4½ inches external diameter and about 6 feet 8 inches long. The total length of pipe in an element is 120 feet. The boxes into which they are screwed are of cast-iron, carefully annealed, or what is generally known as 'malleable cast.' The thickness is $\frac{5}{16}$ inch. A great deal of care has been taken to make sure that these malleable castings are trustworthy, though the long-continued use of them abroad should give confidence in their adoption. A test piece is cast on each part, and any one box is liable to be tested. The tubes are screwed into the boxes by threads of differential pitch, jam nuts being provided as additional security. The boiler casings are of sheet steel with 3 inches of asbestos between. The boiler pressure will be 260 lbs. to the square inch, but this will be brought down to 210 lbs. by means of reducing valves.

"The steam piping is of steel with gun-metal expansion glands. There is a center line longitudinal bulkhead running right through the machinery space, and on each side of this there are three lines of steel piping between the boilers and engines, or six lines in all. The arrangement is such that the boilers on either side can be made to serve either set of engines at will. The steam separator, the lime tanks, the automatic feed regulators, and other parts essential to the Belleville system are, naturally, all to be fitted.

"There will be four funnels having a total height of 80 feet above the grate bars, and with these it is hoped to get the 25,000-H.P. without forced draught.

"It would be interesting to compare these two new cruisers the *Powerful* and *Terrible*, with the United States cruisers, *Columbia* and *Minneapolis*, the triple-screw vessels which attained such remarkable speed on their trials; but this may be better done when we have seen what our own ships can do. In the meantime, it is to be hoped that the Admiralty authorities will adopt some more trustworthy means of ascertaining the speed than by the ordinary log, the records of which are notoriously fallacious."

—*Journal of the Royal U. S. Institution.*

(b) The Powerful.

The first-class protected cruiser *Powerful* was launched on the 25th ult. at Barrow, from the yard of the Naval Armaments and Shipbuilding Company. She is a sister-ship to the *Terrible*, launched on the 28th of May at Clydebank, and of which we gave the principal details in last month's notes. The *Times*, however, gives some further details which are of interest:

"Both vessels have been built to the same drawings so far as constructional work is concerned, and putting aside the design of the engines and general arrangement of machinery. As we stated in our description of the *Terrible*, these vessels are the largest cruisers ever constructed. They have been designed by Sir William White, the Director of Naval Construction. They are each 500 feet long between perpendiculars, or 538 feet over all. The beam is 71 feet, and the designed draught 27 feet. The displacement at that draught will be 14,200 tons. This is only 700 tons less than our largest battle-ships of the *Magnificent* class, and about 200 tons less than the Italian vessels of the *Italia* class, for so long the largest war vessels in the world, which are described as 'armoured' ships, though they have no armor in the shape of belt or for side protection. The *Powerful* and *Terrible* have a considerable proportion of their displacement devoted to armor, there being the armored deck, with a *maximum* thickness of 4 inches, the conning-tower, the barbettes, and the casemates of 6-inch thickness, besides ammunition trunks and additional protective plating at the backs of the casemates and elsewhere. If the tendency towards suppression of side armor in battle-ships, which was so apparent a few years ago, and of which the *Italia* may be taken as an extreme example, had continued, it would soon have been difficult to draw the line between battle-ships and cruisers in view of the reduction in caliber of principal armaments. The *Italia* has four 100-ton guns. This alone is sufficient to differentiate her from the *Powerful*, which has no larger weapon than the two 9.2-inch guns mounted fore and aft. The *Italia* is credited with 18 knots on her trial, whilst the *Lepanto*, a more recent vessel of the same navy, steamed about a third of a knot faster.

"The armament of the *Powerful* will consist of two 9.2-inch guns, twelve 6-inch Q.F. guns, sixteen 12-pounder Q.F. guns, and twelve 3-pounder Q.F. guns, with nine machine and two lighter guns. The barbette armor for the protection of the bases of the mountings of the two 9.2-inch guns is in place. These weapons are mounted on the upper deck forward and aft, and have, therefore, an extended arc of fire. The armor for the barbettes and conning-tower has been supplied by Messrs. John Brown and Co. of Sheffield. It is of Harveyized steel. The rings of armor are composed of four segments, which together form a dwarf roll or cylinder 15 feet 6 inches diameter, and 2 feet 6 inches deep. The shield for the protection of the gun will, of course, be raised above this fixed armor. The armor plates, which form the outside part of the casemates for 6-inch Q.F. guns, are very fine pieces of work by Messrs. Cammell, of Sheffield. The twelve 6-inch guns form the chief fighting element of the ship. Eight of these guns are placed on the main deck, four on each side. The two pairs forward and aft are arranged to have a wide range ahead and astern respectively. In order to provide for this, the sides of the ship have been recessed so that the forward guns may be pointed well ahead, and the aft guns well astern. The armor for these casemates is in two parts, the division being vertical in plane with the axis of the gun. Each of the two plates is about 13 feet long, and 7 feet to 8 feet high, the height varying with the position in the ship. As this is 6-inch steel armor, and as the plates have to follow the contour of the ship, which forms a considerable curve at the ends, it will be seen that powerful machinery is required to form these plates; and here it may be said that the modern disposition of steel armor has only been made possible by the improvements of late made in hydraulic presses and special machine tools. The plates are, however, not only bent to a considerable curve, but the part which would formerly have been cut out to form the gun port has not been entirely removed, but has been bent inwards, thus forming very efficient protection to the guns' crews. The design is not altogether new, it having been adopted in some previous cruisers designed by Sir William White; but it is worthy of notice, as an example of the difficult work which the steel-worker of to-day can perform by means of powerful modern machinery. The broadside casemates, of which there are four in all, form shallow sponsons standing out from the ship's side, thus increasing the range of fire, which amounts to 60 degrees. The four remaining 6-inch guns are mounted in casemates placed immediately above the fore and aft casemates on the main deck. All these casemates have 2-inch armor at the back to protect the crews from splinters of shell or *débris*. The ammunition is brought up through armored trunks, the trunk for the upper deck guns being brought up through the back of the main deck casemate. Dismounting rails are fixed to the deck, and by the aid of these the guns can be slung and traversed back, so that they be housed well inboard outside the casemates.

"Turning to the more general features of hull structure, we find that great pains have been taken by skillful disposition of material to get extreme lightness combined with the great strength and rigidity required in a vessel of this nature. The armored deck is, of course, a great feature of strength, and affords an excellent foundation to work from. Under the machinery space there is the usual double bottom, which extends from edge to edge of the armored deck. Above this the ordinary frames are spaced 2 feet, but every sixth frame is a deep web frame stiffened by a reverse angle. These frames are 2 feet 6 inches deep and are 12 feet apart. This form of structure extends from the armored deck to the upper deck.

"The armored deck itself is composed principally of three thicknesses of steel plating, but at the edges where it joins the side of the ship, two of the skins of plating are discontinued, so that the extreme edges of the deck, for a width of a foot or two, are only one skin of plating. This feature, which, presumably, is chiefly to facilitate and cheapen construction and save weight, has been very severely criticised in some quarters; but the objections raised are more apparent than real. With the ship at rest the edges of the deck are a long way below water level, and it is only when the vessel is rolling that the supposed defects would be manifested. To bring the lower edge of the deck to the surface, however, would require a considerable roll. If the ship were rolling from the enemy the tendency would be to bring the edge of the deck more nearly parallel with the line of fire, when penetration would be far more difficult. If the ship were rolling towards the enemy the high crown of the very much arched deck would have to be surmounted. In these considerations the trajectory of the shot is supposed to be flat; with a plunging fire the danger would be increased, but that applies to deck protection generally. A cruiser, not being designed for the line of battle, must take its chance. There is, however, another argument to be advanced in favor of the thin edges—namely, that a shot penetrating them would not pass into any of the large compartments of the ship, but into the double bottom space, unless, of course, it pierced both the inner and outer skin. Whether the thinner edges for the armored deck are or are not a desirable arrangement may be a matter of opinion, but the points now advanced are worthy of attention in view of the fact that only adverse criticisms have been hitherto heard.

"The machinery space occupies about half the length of the ship—240 feet—and this, of course, in the middle part of the vessel. Such is the price paid for high speed. The coal capacity of these vessels is very large, the *maximum* amount carried being 3,000 tons. A good deal of this coal is utilized as protection against the destructive effects of shell fire. At the time of launching, the ship was far nearer completion than is often the case with vessels of this kind. All the armor proper is in place, pedestals for gun-mountings, skylight and companion ways, etc.; even a great part of the joinery work is fitted. In regard to the latter great pains have been taken to reduce the quantity of wood used as much as possible. The necessity for this has been amply proved during the recent war in the East between China and Japan. To the credit of the Admiralty it may be said, however, that this was previously recognized, and Sir William White had made provisions for reducing the risk of fire during action before the late war began. In the *Powerful* steel panels are largely used in place of wood for cabin partitions, etc , and sheet-steel is largely used in all places possible.

"The engines of the *Powerful*, which consist of two pairs of three-stage compound engines, designed by Mr. A. Blechynden, have cylinders, 45 inches high-pressure, 70 inches intermediate, and two low-pressure cylinders each of 76 inches, the stroke being 48 inches. These incorporate the modern features of steel in place of iron and large bearing surfaces. The boilers are, as in the *Terrible*, of the Belleville type. As in the *Terrible*, there are forty-eight in all, in eight watertight compartments. A more extended description of the machinery may be left until its performance is proved by the trial trip of the vessel. It may be stated, however, that there are 144 steam cylinders in the main and auxiliary engines, the former, however, contributing but eight of these. The boiler pressure will be 260 lbs. to the square inch, with reducing valves to bring it down to 210 lbs. in the cylinders. The total I.H.P. will be 25,000 at 110 revolutions. The legend speed is 22 knots."

—*Journal of the Royal U. S. Institution.*

(c) H. M. S. Terrible.

The description of the *Terrible* in *Engineering*, is pleasing as far as it goes, but it does not go far enough, for a mere account of the structural work in a ship. however full, is no compensation for the complete absence of any reference to certain broad fundamental characteristics embodied in her design for the first time in a British warship, and which have aroused unusual interest both in professional and general circles.

The *Terrible's* dimensions are unprecedented in naval annals. Her length is the same as that of several fast Atlantic steamers, and her displacement is enormously in excess of that of any other cruiser, British or foreign. Her boiler installation is largely experimental in its nature, entirely so in its extent, but of a type alleged to save considerably in weight of propelling machinery, to add to the combative qualities of the ship. It is only reasonable to expect, in view of such novelties, which may have a marked effect upon the maintenance of our naval supremacy and national position, that a description of this ship should include some attempt to answer the questions: Are her extreme dimensions and enormous cost attended by any commensurate augmentation of the qualities suitable for the purpose for which she exists? And to what extent, if at all, has the use of Belleville boilers contributed to the result? Not only are neither of these questions touched upon in your description, but care has been taken to render their examination from outside as difficult as possible: still, a negative reply can be given to both of them.

At the launch of the *Powerful*, the Duke of Devonshire stated what the object of these ships is. He said, in effect, that other maritime powers, with little commerce of their own, build ships of this class, and we could only conclude that they do so in order to cripple our commerce in the event of war. We would have to clear the seas of such craft, and it was to do this that the *Powerful* and *Terrible* were primarily intended. As the *Terrible* is 125 ft. longer, 6 ft. broader, and 5000 tons or 55 per cent more displacement than the *Blenheim*, our hitherto largest cruiser and about double the displacement of the first-class cruisers built under the Naval Defense Act, it would appear as if these foreign cruisers were extremely formidable vessels to require such a big ship to dispose of them. That is, the *Blenheim* either could not catch them; or, if that were possible, could not engage them without serious risk to herself. The *Edgar* and smaller classes can catch nothing; that is well understood. On the other hand, your table of comparative dimensions shows that these foreign cruisers are not, in the main, any larger than our own existing ones; so it would appear that on a given displacement, most of our rivals can produce vessels far more effective than those designed by Sir William White. If this is denied, then, for the large margin of displacement of the *Terrible* over the others, a large increase in her efficiency should be apparent. But what are the facts? She has the same heavy armament as the *Blenheim*, and only two more 6-in. quick-firing guns. The increased armament is chiefly in 12-pounder quick-firing guns, of which there are sixteen. Obviously, with so much more deck area, more guns would be expected; the constructive department have provided an increased armament, certainly, but they have made it as innocuous as possible. The result is, that if any one of the foreign cruisers, which have called the *Terrible* into existence, would not hesitate to engage the *Blenheim*, neither will she be deterred by these sixteen 12-pounders from engaging the *Terrible*. Then as to protection, the protective deck is no thicker, if as thick, as the *Blenheim's*, but differently disposed; and it has a blemish which has been pointed out; then there are barbettes on a small scale for the 9.2-in. guns, and casemates for the 6-in. guns. This protection for the guns is an advantage, of course; if it has the enormous importance which is being attributed to it just now in order to justify the *Terrible*, it is only another proof of the absolute uselessness of the cruisers built under the Naval Defense Act. The fact that none of those latter designs are to be reproduced, even approximately, seems to show that at Whitehall their uselessness is accepted as a matter of course. All the more reason, then, for an earnest attempt to make the new cruisers as invincible as possible. But, by spreading out the 6-in. guns, and putting four of them on top of four others, the actual protected area is made very limited, and in view of the enormous unprotected target presented to him, the commander of a ship armed like the *Rurik*, *Brooklyn*, or *Emperador Carlos V.*, would not be deterred by the fact of the casemates from having a little practice at the *Terrible*.

If our commerce is so seriously threatened as to render it necessary or advisable to build such large ships for its protection, and as their number is so small compared with the work they have to do, and the character of the ships they have to deal with, it would appear wise to take advantage of their large dimensions to give them such offensive and defensive qualities as would have a pronounced moral effect. The mere presence, on a trade route, of a ship that could certainly catch any marauder, and just as certainly destroy her, would have a marked effect on the marauder's range of action, and so long as it kept our commerce unmolested, that is all we require. The moral effect would do the work in ordinary cases; in the exceptional case in which resistance was offered, the physical power to overcome that resistance would be there in preponderance. With modern weapons the damage done in a contest with, generally speaking, an inferior force, might be so serious as to entail the necessity for a return to port for repairs, leaving the trade route unprotected; and in a ship of the length and freeboard of the *Terrible*, this risk is strongly accentuated. Yet, knowing this, her protection is paucity itself; and the very contingency that should have been provided against has been actually courted by the constructive department. The ship has no moral qualities whatever, and her physical ones are of so limited a character that there will always be the inducement to try and get rid of her presence on a trade route, by knocking her long hull to pieces, and sending her home for repairs. If the more powerful foreign cruisers are so much more than a match for the *Blenheim*, that such large ships as the *Terrible* are necessary, so much the more reason for insuring them the maximum of efficiency, by utilizing their large size to its fullest extent. This has not been done, and if it is contended that the *Blenheim* is a fair match for the foreign cruisers, and that the increased armament and protection of the *Terrible* are quite sufficient a margin to make her more than a match for them, then some other reason must exist for her size, besides the primary one mentioned by the Duke of Devonshire.

—From letters to *Engineering*, August 16, 1895.

During the past few months four Russian armored ships have been launched. This has not stopped the activity of Russian state naval departments. The launched ships are now supplied wlth engines and armament, and on the slips upon which these were built four new ships have been begun. The first-class armored ship *Sisöi the Great* received the boilers and engines made by the Baltic works, and a portion of side armor of the lower citadel, in the summer of 1894. The engines will be tested during the coming summer.

The armored cruiser *Dupuy-de-Lome*, 6,300 tons, has, after repeated alterations, again failed to answer satisfactorily the demands made on her. She is a long narrow vessel with three screws, and the three sets of engines constantly hamper one another. This vessel was launched in 1890, and is still in the experimental and alteration stage. The *Times* says: "The Americans have had greater success with three screws in the *Minneapolis* and *Columbia* class, but those vessels, in addition to greater lengths, have nearly 7 ft. more beam than the *Dupuy-de-Lome*."

(d) New Battleships.

The main features of the plans for the two battleships authorized by the last Congress have been decided upon. Two of the main points were settled by Secretary Herbert himself, and the others were referred by him to the Board of Bureau Chiefs for settlement. The Secretary's decision was contained in a letter which he sent to the Board of Bureau Chiefs. It stated that he had come to the conclusion that double-deck turrets and 13-in. guns were best fitted for the new ships, and referred the question of raising the armor belt 1 foot, as proposed by the Ordnance Bureau, to the board for settlement. The board immediately took up the Secretary's letter, and after considerable discussion it was decided to design the ships with the bottom of the belt 5 feet 6 inches below the water when the draft of the vessel was 25 feet, the extreme draft set by the Secretary. The dimensions of the new battleships are as follows: Length, 368 feet; beam, extreme, 77 feet 2 inches; mean draft, 23.50 feet; extreme draft, 25 feet; normal displacement, 11,500 tons; speed, 16 knots, with 1 inch air pressure. The armament for each consists of four 13 inch, four 8-inch, and sixteen 5-inch rapid fire guns. Regarding the weight to be allowed to the Bureau of Steam Engineering, it was limited by Secretary Herbert in his letter to from 1,000 to 1,200 tons. It was claimed by Chief Naval Constructor Hichborn that 1,000 tons would be all that was necessary to produce 9,500 H.P., the amount required to drive the vessel 16 knots under 1 inch air pressure, the speed wanted by the Secretary.

—*American Engineer and Railroad Journal*, September, 1895.

(e) The New Naval Artillery.

The following are the outlines of this part of the armament matériel supplied by the statement forwarded by the Minister of Marine to the Chambers:

LARGE CALIBERS.

For vessels under construction 420 mm. guns are cast aside and a lesser caliber is preferred, so as to obtain easier handling and more rapid fire. On board the *Requin*, with a view to decreasing the load of the vessel, the 420 mm. guns are to be replaced by others of 340 mm. caliber, model of 1893. It has been found practicable to increase the initial velocity from 40 to 50 meters by this decrease in caliber. Ammunition for 370 mm. guns will hereafter contain smokeless powder only, the initial velocity being thereby sensibly increased. The 340 mm. guns, model of 1887, ordered for the *Jemmapes*, the *Brennus* and the *Valmy* have been completed. Certain modifications were introduced in their construction while the work was going on. The advantages over the previous model are marked. The guns tried so far have behaved well. The 305 mm. caliber, introduced a few years ago into the fleet artillery, after the reaction against monster guns and the machinery used in handling them, appears to be the maximum caliber to be placed upon the new boats. Armor piercing shell of this caliber may suffice against all armor or fenders afloat or projected, if the improvements made in the manufacture of the projectiles include those which the Harvey and similar processes may introduce into that of armor plates.

The guns of the *Jauréguiberry*, *Bouvines* and *Tréhouart* have been subjected to the regulation tests.

A change from the length of 30 calibers to one of 45 calibers was at first thought necessary. With a modified outline and the qualities of steel at our service, the length of the 305 mm., 240 mm. and 194 mm. guns may be fixed at 40 calibers. It has seemed wise not to allow ourselves to lengthen guns beyond measure to gain a few yards more of initial velocity, which we can obtain equally well by reinforcing them and lengthening the powder chamber.

The tendency is to do away with machinery wherever the work can be done by hand, and, for aiming, to have some way of replacing by manual labor in case of accident, the hydraulic or electric devices, usually employed to accelerate the fire.

The artillery will, in the near future, lay out at Ruelle and Gavre the necessary equipment for trying both the guns and the carriages which are to carry them when on the vessels, with all the apparatus for placing them in position and for serving them. Thus every defect may be ascertained and remedied before the appliances are placed on board.

MEDIUM CALIBERS.

The 164.7 mm. guns, model of 1891, will be completed in time to be ready for being placed on the vessels destined to carry them. Their initial velocity will be 800 meters. The new model of 1893 will allow a decided increase of initial velocity to be reached. All the work of converting guns of the mcdels of 1881 to 1884 into rapid fire ones is completed. With about two exceptions these remodeled guns have been placed in position already. The results obtained at the trials and in service, especially in the very numerous tests at the school of gunnery, have been very satisfactory. The continuous experiments of the years 1892, 1893, 1894 have given us a continuation of proofs of the military value of this remodeled matériel which was the best that vessels afloat in 1890 could receive, besides being superior to what was possessed by foreign nations.

The 138.6 mm. guns, model of 1887, already in use, have given very satisfactory results, as well as those of the 1891 model on the cradle carriage of the French naval model. The guns of the latter model will be ready as soon as the vessels upon which they are to be mounted. A new model has been devised which will allow, owing to its resistance, a new gain in initial velocity by a better quality of powder.

Guns of the naval model, with the Canet breech system, are but 45 calibers long and weigh 1500 kilogrammes; the initial velocity of the 14 kilogrammes shell is 740 meters. The guns, Canet system, of 55 calibers, weigh 2200 kilogrammes and give 760 meters initial velocity to the 14 kilogrammes shell. The gain in initial velocity due to the great excess in weight and length of the Canet gun is therefore but 20 meters. We point out this very instructive fact because the idea of returning to small caliber high power guns is still frequently urged and lauded. People forget to consider the weight and length of the gun, the necessity of having a very long powder chamber, a very long cartridge, broad spaces available in the magazines on the decks, the corbelling of the vessels, all matters which cannot be overlooked in the armament of the fleet.

SMALL CALIBERS.

63 mm., 47 mm. and 37 mm. rapid-fire guns. The modifications which were worked out to facilitate the fire of these guns, by making the laying of them more and more independent of the loading process, by allowing the gunner to follow the target without interruption, and by firing whenever he wished, without loss of time, have been brought into practical use on nearly all the fleet and have given good results. The *Direction de l'Artillerie* is now busy devising new types of rapid-fire guns, calibers 47 mm. and 65 mm., having a flatter trajectory than the guns in use and a breech system better adapted than the present one to rapid and continuous fire.

SEA COAST ARMAMENT.

Regarding the sea coast armament the statement goes on to say: "The navy feels itself prepared to have when needed all the matériel provided for according to the joint opinions and reports of the inspectors general of the sea coast, approved by the Ministers of War and of the Navy." We see, on the whole, that the 305 mm. gun seems likely to be the preferred type of the "large calibers" of the navy; in the same way that the 138.6 mm. gun seems likely to become the normal type of "medium calibers;" as for the "small calibers," it appears that the 47 mm. gun is the most convenient model. It is more especially on board ship that simplicity in artillery supplies seems necessary.

—*L'Avenir Militaire*, July 30, 1895.

(B) ARMOR AND PROJECTILES.

(a) Armor Plates in Europe.

English makers of armor plates and other war material have been complaining for a long while past that they are not given enough encouragement to go to any expense in improving their methods of manufacture. If the government requires any special material it has always appealed to the cheapest market, irrespective of any other consideration than that of price, and as the English maker has to carry out experiments on his own responsibility, he is obliged to ask for higher prices than his foreign competitors. Consequently, in many cases he has been passed over, and valuable orders for steel shells have gone to France. Of course the natural question arises, how is it that the English maker has not been able to keep pace with his foreign rival? The answer is simple.

The French government when it requires any special war material invites specimens from the home manufacturers who are relieved of any expense incidental to trials. The war authorities make an exhaustive series of experiments, and select the most suitable material, for which important orders are given out quite irrespective of any question of cost. The maker is thus able to lay down a plant for the execution of the contract, and when this is completed he is at liberty to quote very low prices for supplies of material to foreign countries.

From an economical point of view this buying in a cheap market may be all very well, but it is now being urged that in depending upon the French makers for war material the country is placed in a somewhat precarious position. It is a fact at the present moment that there are no adequate means for the manufacture of shells for some of the largest marine guns, and in the event of war breaking out they would be practically useless. This difficulty will no doubt soon be remedied.

The War Department has been attacked so unmercifully for its selfish policy that it is hardly likely to give out any more orders abroad. English makers are determined to do their best to equip themselves with enough efficient plant to meet the home requirements, and at the present moment Messrs. Beardmore, of the Parkhead Forge, Glasgow, are laying down some powerful machinery for this purpose. They have lately succeeded in rolling armor plates under license from the Harvey Armor Plate Co., weighing 24 tons, and they will soon be in position to compete with the three Sheffield firms who have hitherto enjoyed a monopoly of this manufacture. At the same time there is little hope of English makers doing much beyond what may be required by the government. Now that every European country is beginning to produce its own armor plates and shells, and is becoming more and more independent of foreign aid, the scope for further activity in this branch of trade is very restricted. The latest enterprise in armor plate rolling is about to be carried out in Russia, where a Belgian company with a capital of $600,000, of which one-half has already been subscribed, purposes to lay down an extensive plant in the neighborhood of the Black Forest. As all the Russian armor plates have hitherto been supplied in England and Germany this threatens a serious falling off in the number of foreign contracts. The only opening for an important business is the probability of an increase of the floating armaments of the East, but even here Japan is establishing iron works for the supply of its own necessities, and should any contracts be given out abroad the American firms are in as good, if not better, position to secure them.

—*American Machinist*, August 29, 1895.

(b) Test of Armor Plate.

An important test of armor plate took place on September 4, at the Government Proving Grounds, Indian Head, Md., the object being to ascertain the effect of heavy projectiles fired from the new 10 and 12 inch guns upon the frames of modern warships. For this purpose an exact reproduction of a section of the new battleship *Iowa*, with a 14-inch armor plate of Harveyized nickel steel, made by the Carnegie Company, bolted on to it, formed the target. This plate represented 24 others, weighing 620 tons, made by the Carnegie Company for the *Iowa*, now building at Cramp's Shipyard. The plate was 14 inches in thickness, 18 feet long by 7½ feet wide, and represented the portion covering the most vital parts of the vessel. Behind the armor was a backing of 5 inches of oak; and the "skin," or the inner and outer bottoms, of ⅝-inch steel plate, were fixed behind that again. Four feet further back was a ⅝-inch steel plate, representing the inner shell of the vessel; and between this plate and the "skin," the frames or braces, also ⅝-inch plate, were placed alternately 2 and 4 feet apart. The structure was covered by 2½-inch steel plate, representing the protected deck, and the whole erection was supported by heavy timbers resting on the side of the hill.

The first shot was fired from a 10-inch gun. It consisted of a Carpenter projectile weighing 500 pounds, propelled by 140 pounds of brown prismatic powder and attaining a velocity of 1472 feet per second and a striking power of 741,000 foot pounds. This shell was shattered by the force of the impact, only the point being imbedded in the plate, which was not otherwise injured. The backing and frames were found intact. In the second shot the charge of powder was increased to 216 pounds, giving a velocity of 1862 feet per second to a 500-pound projectile. This shell also was shattered without cracking the plate, although a larger portion of the projectile was imbedded in the armor. These two shots secured the acceptance of the lot of 24 plates.

Subsequently one shot was fired from a 12-inch gun. This was a Wheeler-Sterling projectile of 850 pounds, propelled by 400 pounds of powder and attaining a velocity of 1800 feet per second, or an average striking velocity of 1,530,000 pounds. While the shot in this case penetrated almost the entire depth of the armor and cracked it from top to bottom, the oak backing was scarcely disturbed and the skin and frames of the model were not in any way injured. All these shots were fired at a distance of 200 yards. The test was made under the direction of Captain Sampson, Chief of the Bureau of Naval Ordnance, and was witnessed by Secretary of the Navy Herbert and a number of naval officers and experts. A further test with a 13-inch gun is to be carried out at a later date. —*The Iron Age*, September 12, 1895.

E. ARTILLERY.

(a) The Maxim Solid Steel Gun.

We give herewith an account which Mr. Maxim has written at our request of a new system of making ordnance of solid steel. Shrinkage of the exterior so as to grip the interior and cause the former to bear its share of the strain set up on firing, is effected by means of chilling the interior and allowing the exterior to shrink on to it in cooling. Mr. Maxim refers to the Rodman gun as in its day a successful application of the system of interior cooling. It will be seen, however, that Mr. Maxim has adopted means which are, so far as we know, new in the perfection of his process. To put the matter briefly, solid guns are cheaper and more quickly made than those which are built up of concentric tubes, but the latter system offers the great advantages of enabling the exterior to bear its share of the strain by shrinking on to the inner tube, and it also enables the metal to be examined much more thoroughly for flaws; and lastly, should a flaw escape detection, its influence is limited to the tube in which it exists. All this applies with greater and greater force as the magnitude of the gun increases. Thus small pieces are made solid, but for guns of position and siege guns the built-up system has generally been considered necessary to develop the required strength and to guarantee safety. Consequently, while Mr. Maxim made smaller pieces on the system of interior chilling, attention would only be attracted in a limited questioning way; with 45-pounders of 5.7-in. bore, the question of competition with built-up guns is fairly opened.

The most natural objections to Mr. Maxim's system would perhaps be—(1) That the shrinkage obtained must in its nature be limited, and much less capable of control and adjustment than that given by building up. (2) That the piece would be liable to be contorted in the operation. (3) That tool work would be impossible on a bore specially hardened, and that consequently contraction of a finished and rifled bore involves peculiar trouble. How Mr. Maxim meets these objections will be seen by reading his description. Briefly, contortion is prevented by placing the gun vertically and making it revolve on its axis in the furnace. With this arrangement it has been found that the finished and rifled bore is only affected to an extent which can be rectified by lapping. The desired amount of shrinkage, and the relation of exterior to interior can, we imagine, only be arrived at by practice. The whole process, which Mr. Maxim allowed us to see at his works in Erith, is most interesting; and if the hardened bore resists erosion in the high degree expected, and realized, as we understand, hitherto, a great advantage is obtained which is not noticed in his description, which deals chiefly with the effect of the process on the interior condition and external form of the piece.

With regard to the manufacture of really heavy guns on this system, we think that most purchasers would require very convincing evidence to make them give up the advantages of building up both as to certainty in distribution of strain and power of detecting flaws and limiting the influence of any that may escape detection. This Mr. Maxim do doubt would admit as reasonable. The effects of torsion in the furnace, we should have thought, might have been more effectually prevented by suspending the gun than by setting it on end.

BALDWYN'S PARK, BEXLEY, KENT, August 6, 1895.

Yours of 31st ultimo is received. If I remember correctly, you wished to know the process by which we have lately made a number of 45-pounder guns from a solid piece.

Fifteen or twenty years ago large forgings of steel were not always reliable, but thanks to the recent improvements both in the process of melting and the pressing of steel into shape by hydraulic pressure, it is now possible to obtain perfectly sound forgings of any size that may be required. In fact, I was informed by Messrs. Vickers, Sons, and Co. that they would guarantee to furnish a forging of a gun all in one piece, weighing as much as 150 or 175 tons, providing it should be ordered of them, and they were willing to guarantee that every particle of the steel would be sound. It will be remembered that during the American civil war the American cast iron guns made on the Rodman plan were very much superior to those made in Europe—in fact, the Rodman guns, which were cast hollow and cooled from the inside, had every molecule of the metal pulling in the right direction. The inside of these guns was in a high state of compression and the outside in a state of tension. The consequence was that these cheap cast iron guns were quite equal to the wrought iron and steel guns which were made in Europe at the same time: and the fact that this was not altogether due to the superiority of the American cast iron is witnessed by the fact that two guns were made in the States, one cast solid in the same manner that English cast iron guns were made at that time, and the other cast hollow and cooled from the inside. They were both out of the same lot of metal, and it was found on firing that the gun made on the English plan showed signs of distress at the first discharge, and burst at the third discharge, while the American gun was fired 1000 rounds without any sign of distress at all.

Believing that this same principle could be applied to steel guns, I erected a very large and expensive tempering plant at Erith. The first guns treated were 45 pounders, having a bore of 5.7-in. The forgings were obtained from Messrs. Vickers, Sons, and Co., of Sheffield, and were of a steel which had sufficient carbon to receive a spring temper. The forgings are first rough bored, and turned approximately into shape; they are then mounted in a furnace, and while rotating were heated to a dull red and allowed to cool slowly in the furnace. This process of annealing removed all the internal strains in the steel. The gun was then put in a lathe, turned down to very nearly the correct size on the outside, smooth bored and rifled. It was then again mounted in the furnace in a vertical position, and while it was rotating in the furnace a current of coal gas was allowed to pass through the bore. The coal gas of course expelled all the air, and at the same time a small portion of the carbon contained in the coal gas was set free by the high temperature, and while in a nascent state combined with the interior of the gun, thus raising the quality of the steel and making it considerably harder. When the gun was red hot the coal gas was shut off, and a very large stream of cold oil under a high pressure was forced through the bore with compressed air, while the gun was still revolving in the furnace. The result was that the inside was very quickly cooled without decomposing more than half a pint of the oil, and the inside being cooled, the outside gradually shrunk upon it, so that when the gun was taken from the furnace it was found that the outside was in a very high state of tension, while the inside had been compressed about .02 of an inch. The careful treatment which the gun had received prevented it from bending; in fact, only a very slight deviation could be found in one of the guns, while another of the first two that were made was completely straight. In both cases the amount of distortion, as far as straightness is concerned, was extremely small. The guns were then lapped out until the bore was straight inside, it having shrunk more at the breech end than at the muzzle, and fired with increasing charges. With a short and rather small cartridge case, and a long and heavy projectile—45 ℔.—a muzzle velocity of 2200 ft. was obtained, with a pressure of about 15 tons to the square inch, but the proof charges were run up to 22½ tons per square inch.

One of the guns was not changed in the least by the firing, while the other was found to be .002 of an inch smaller at the breech end after the firing than before, showing that before firing the inside must have been in a very high state of compression, and the outside in a high state of tension, and that the enormous strain was sufficient when assisted by the shock of discharge to compress still more the inside layer of steel in the bore. This I think to be quite uncommon. I do not know of any authentic case where a gun fired at very high pressure has been found to be smaller after firing than before. As a rule, they all get larger by firing proof charges. Anyhow, the fact that the gun did get smaller shows that the strain set up by 22½ tons was not sufficient to put a permanent set into any portion of the gun.

I do not hesitate to say that these guns are the best that have ever been made, everything considered, and I do not hesitate to say that guns can be made on this plan which will be quite as reliable as they would be if they were of innumerable pieces, one shrunk upon the other. This means that a gun may be made with half the weight of steel, half the time, and at half the expense as heretofore, and I do not see any reason why it should not be applied to the largest guns in the service.—Yours truly,

Hiram S. Maxim.

—*The Engineer*, August 16, 1895.

(b) Raw-Hide Cannon.

A "raw-hide" cannon, invented by Frederick La Tulip, of Syracuse, N. Y., was tested at Sandy Hook on July 23, and successfully withstood a pressure of 30,369 pounds per square inch. This model gun was 5 feet 8 inches long, 2½ inches caliber, and weighed 456 pounds. The bore is a steel cylinder, ¾ inch thick at the muzzle, and 2½ inches at the breech. Over this is raw-hide, cut in 4-inch strips, and 1 inch thick at the muzzle and 3 inches at the breech, and outside of this were two layers of heavy copper wire. The gun was a muzzle-loader, and in four successive shots, with varying charges, resisted pressures rising from 5,417 pounds to 30,369 pounds per square inch. The carriage broke under the last shot, terminating the test. The only value in the gun seems to be in the reduction in weight as compared with steel.

—*Engineering News*, July 25, 1895.

F. MISCELLANEOUS.

(a) Nickel Steel and its Advantages Over Ordinary Steel.*

Before reading the paper that I have undertaken to do, on nickel steel, I should wish to explain that my knowledge of steel-making is limited, and that I do not desire in any way to enter into the question as to the advisability or not of the use of nickel steel. I merely want to bring before the notice of the members of the Institute some facts as to the uses of this material, feeling sure it will interest many attending this meeting to know what is now being done in other countries with this remarkable alloy. I am indebted for much valuable information to Mr. Thompson, president of the Oxford Copper Company, in America, and to Messrs. Lander and Larssen, of Birmingham, the agents of the Bofors Steel and Ordnance Works, in Sweden, whose managing director, Mr. J. C. Kjellberg, has favored me with some interesting statistics.

The use of steel in place of wrought iron for structural work, shipbuilding, rails, and other purposes, including armor and forgings for guns, met with an earnest and long continued opposition. Steel, while stronger and stiffer, was said to be untrustworthy, and it made its way but slowly. The old well-tried wrought iron was considered safer, although it required a greater section and weight than was required with steel. With the improvements in the manufacture of mild steel, greater uniformity was obtained in the product, and this reproach no longer existed. Now, it is unnecessary to remark, wrought iron has become almost a thing of the past for structural and other purposes, as steel of less section and weight gives the same strength and stiffness, with as great an elongation and safety. It is not necessary to state these admitted and well-known facts to the Institute, except for the purpose of recalling the reasons which led to the use of steel in the place of wrought iron, and to see whether these reasons cannot now be advanced with the same force for the use of a better material than ordinary steel. Nickel steel, containing about 3¼ per cent. of nickel, is now being produced with the same elongation, a tensile strength fully 30 per cent. higher than ordinary steel, and an elastic limit at least 75 per cent. higher. This material, although comparatively a new article of manufacture, possesses great uniformity, the nickel being uniformly distributed throughout the ingot, and is not liable to segregation like other of the ingredients of the steel.

For building and structural material the greater strength of nickel steel, and particularly its high elastic limit, make it far more advantageous than ordinary steel. It is the elastic limit that governs the section in this material. The elastic limit of the nickel steel is nearly double that of ordinary steel, while beyond the elastic limit there is a considerable range to the ultimate strength, with a large elongation. The use of nickel steel in beams, channels, bulb angles, etc., would, no doubt, lead to a change in the form of section, similar to that which was made when steel superseded wrought iron. In the case of the steel frame of a large building or other structure, the weight of the frame

* Iron and Steel Institute, August, 1895.

itself is a considerable part of the load, and any saving in the weight is a great gain.

New boilers for the United States cruiser *Chicago* are being made of nickel steel, which will give the necessary experience to determine what degree of advantage there may be in the use of this material for this purpose. Corrosion experiments have been made with specimens of nickel steel in competition with specimens of other kinds of steel, under conditions which would indicate its adaptability for use in boilers, and for the under-water hull plates of vessels. These experiments, while on a small scale, and consequently not conclusive, seem, however, to show for these purposes nickel steel possesses a marked advantage in being less corrodible. This is also confirmed by the experience obtained from the use of nickel steel propellers. The following results, giving the relative loss by corrosion of nickel and other steels under different circumstances, are taken from the results of some experiments, and appear to confirm the statement above made, with regard to the use of this material for boilers:

Percentage of Total Loss.

Kind of material.	Solvents. 10 per cent. salt water boiling for three months.	Steam for two months.
Nickel steel	1.00	0.27
Bessemer steel	1.81	0.58
Open-hearth steel	1.97	0.31
Open-hearth steel	2.00	0.36

Test pieces were 1 inch by 1 inch by ¼ inch, polished on all sides, and weighing approximately 1 ounce. The boiling water test was made in a flask placed in a stone bath, and kept almost at a boiling temperature, pure water being added to replace the water lost by evaporation. The steam test was made with steam at atmospheric pressure. The test pieces, after being exposed to the solvent, were carefully cleansed with a brush, washed with alcohol and ether, dried and weighed.

Experiments for flanging nickel steel plates of all thicknesses suitable for boilers show that this material is worked without any difficulty. It can be readily forged or pressed in dies without cracking, its large elongation enables it to be worked to great advantage. If the allowed pressure in a boiler is proportional to the ultimate strength of the material, a boiler of nickel steel would carry a pressure 30 per cent. higher than one of ordinary steel of the same weight; and if the corrosion experiments above referred to are confirmed by experience, the nickel steel boiler will have a decidedly longer life.

If the relative elastic limits of the two materials are considered, this allowed boiler pressure would be still greater. With the use of high-pressure steam for compound engines this ability to increase safely the boiler pressure makes nickel steel a very valuable boiler material. Not only for this purpose, but for all structural purposes, the high elastic limit of nickel steel is a peculiarly valuable feature, as the load is calculated for the elastic strength of the structures, not the ultimate strength. When the rule for the safe load is given in terms of the ultimate strength, it is merely for convenience, as the ultimate strength is always determined from the tensile specimens, whil the elastic limit is not always given. With ordinary mild steel the elastic limit is considered as one-half the ultimate strength, while with nickel steel in the form of structural material it is about three-fourths of the ultimate strength. If you could get an ordinary steel having as high an elastic limit as that of nickel steel, it would be a higher carbon steel, very deficient in elongation, and which could not be worked to any advantage, and which would not be considered suitable or safe. Nickel steel beyond the elastic limit has a sufficient range of increased resistance with fully as large an ultimate elongation as the much weaker mild ordinary steel.

The high limits of nickel steel, together with its large elongation, and particularly its high elastic limit, would indicate that this material would also be well suited for gun forgings. It is being tried for this purpose with every prospect of success. That nickel steel, giving when tested the ultimate strength, elastic limit, and elongation claimed for it in this article, can be produced with uniformity, is too well-known to need here a list of the results of tensile tests. Under the drop test nickel steel gives better results than ordinary steel, even in a greater ratio than exists between the results of the tensile tests of these two materials. This is also found in the toughness imparted to armor plate by the introduction of nickel. The ability to resist shock without fracture is not altogether a question of elongation. A built-up column of ordinary steel may break across in falling under its own weight, the fracture showing but little appearance of elongation, yet tensile specimens taken from this material close up to the fracture will show the required elongation, 15 per cent. or 20 per cent. Nickel steel is better able to stand this kind of sudden strain. For this reason, together with its greater strength and stiffness, it is being extensively used for shafts, piston-rods, bearings, propellers, etc.

In hull plates for vessels of nickel steel, with an elongation of 20 per cent., a tensile strength of 85,000 pounds, and an elastic limit of over 60,000 pounds, have been obtained. Similar material of ordinary steel would have a tensile strength but little over the elastic limit of the nickel steel, with an elastic limit about one-half that of nickel steel. In the case of a battleship, where the question of weight is of such vital importance, a hull of nickel steel of equal strength and stiffness to one of ordinary steel would mean a saving of weight of 500 to 600 tons at the lowest estimate; this weight, added to the armament, armor, coal, or divided between them, would add a large percentage to the efficiency of the ship.

Mr. Kjellberg, to whom I have previously referred as the managing director of the Bofors Steel and Ordnance Works in Sweden, tells me that they have found, from the trials made, the fullest confirmation of the fact that a suitable addition of nickel to steel exercises a highly beneficial influence on the steel. It causes a very marked increase in the elastic limit and tensile strength, while at the same time the elongation is greatly increased. As a general rule, they add about 3 per cent. nickel to steel containing 0.3 to 0.4 per cent. of carbon. The properties already referred to are those which show themselves in the testing machine, and as regards their nickel steel, which, after casting, is merely annealed, hardened in oil, and tempered, but neither rolled, forged, or otherwise manipulated, it may be stated in normal figures that its tensile strength is 70 kilos. per square millimeter—44.4 tons per square inch—elastic limit 45 kilos. per square millimeter—28.5 tons per square inch—and elongation 25 per cent. on a length of 200 mm.—7.87 inches. But all the physical properties of the steel do not, as a matter of course, show themselves in the testing machine; they can only be thoroughly ascertained by practical trials.

From the trials which have been made, they have arrived at the conclusion that the beneficial influence of nickel on the properties of steel is far greater than one might be led to suppose from the results obtained in the testing machine as taken by themselves. The following trial made by them is an interesting one: In one of their cast steel—nickel steel—gun tubes they placed an ordinary cast iron shell in such position that the center of the shell was 300 mm.—11.81 inches—from the muzzle of the tube. The shell was filled with compressed picric acid 170 degrees. When exploded the shell burst into little bits, but the gun tube did not burst; and the only effect of the explosion was that the diameter of the tube was expanded by 1¾ mm.—0.07 inch. Another similar shell, into which a similar quantity of picric acid had been poured, was placed in the same tube, and in exactly the same position as the previous one, and again exploded. The explosion had no effect whatever on the tube; it did not even increase the diameter further.

For the purpose of an armor plate trial, two nickel steel plates were cast 2440 mm.—88 inches long—and 1830 mm.—72 inches—wide, the one being 90 mm.—3.54 inches—and the other 96 mm.—3.78 inches—thick. Five shots were fired at each from a 12-centimeter—4.72 inch—rapid firing gun, the projectiles being of Bofors steel and weighing 21 kilos.—46 pounds. The charge of powder was 337 kilos.—7.3 pounds—and the velocity of the projectile at a distance of 46 m.—150 feet—was between 361.8 and 364.4 m.—1190 feet and 1200 feet. Each of the steel projectiles rebounded intact without having penetrated the plate farther than to the cylindrical parts of the shells, and upon examination of the plates, small cracks were with some difficulty found to have resulted from shot Nos. 2, 3, 4, and 5 on the 90 cm. plates, but none could be found on the 96 cm. plate. Seven more shots were afterwards fired with similar projectiles, but it was not until the eleventh shot that the plate broke. The twelfth shot was fired with a charge of 4.10 kilos.—9 pounds—of powder, the projectile having a velocity of 413 m.—1350 feet—and then the 90 cm. plate was at last penetrated. It is worthy of note that, according to Krupp's formula, a projectile such as this—that is to say, weighing 21 kilos., and having a velocity of 413 m.—ought to penetrate a wrought iron plate of

150 mm.—5.9 inches—in thickness; and it follows therefore that this 90 cm. nickel steel plate was 54 per cent. stronger than a wrought iron plate of 90 cm. A large experience in making steel for war materials satisfies Mr. Kjellberg that he never could have attained the results he has done without the assistance of nickel.

The *Iron Age*, published in New York on July 25th last, gives the following interesting account of some welding experiments made by the Canadian Copper Company, who have recently had some trials made in welding nickel steel. In each trial two pieces, each 1 inch square by 6 inches, were welded together with a lap weld, with the following results: No 1. Samples containing 2.05 per cent. nickel and 0.22 per cent. carbon cut like soft steel, welded perfectly, no sign of weld showing; bent twice at right angles at the weld when hot, the weld did not open, nor was any crack noted; bent at right angles when cold, failed to show any crack at the weld. No. 2. Samples containing 3.25 per cent. nickel and 0.16 per cent. carbon, worked exactly like No. 1 under the same test; no crack was developed, and the metal welded perfectly. No. 3. Samples containing 3.40 per cent. nickel and 0.31 per cent. carbon cut a trifle harder, also hammered like a harder steel; welded perfectly, bent hot and cold like No. 1, and showed no crack. The weld cannot be seen. No. 4. Samples containing 2.62 per cent. nickel and 0.19 per cent. carbon worked exactly like Nos. 1 and 2. The same tests did not show any weakness at the weld. No. 5. Samples containing 3.20 per cent. nickel and 0.54 per cent. carbon worked a little harder, but gave a perfect, solid weld. There was no cracks on bending hot and cold. No. 6. Samples containing 3.10 per cent. nickel and 0.96 per cent. carbon worked harder, *i. e.*, like a tool steel, welded perfectly, and showed no cracks on bending hot and cold. No. 7. Samples containing 4.95 per cent. nickel and 0.51 per cent. carbon worked like No. 5, but not so hard as No. 6. The weld was good, and no cracks developed on bending.

In general, the percentage of nickel does not affect the welding power at all. The steel must be treated like any other steel, using more care with the higher carbons. Having a material which has an elastic limit about equal to the ultimate strength of ordinary steel, with a tensile strength 30 per cent. higher and an equal elongation, together with very satisfactory uniformity, and better quanties for special purposes, such as greater ability to resist shock, and less liability to corrosion, why should not this material replace the ordinary steel of to-day, as it replaced wrought iron? There appears to be no answer to this but possibly one of cost.

With regard to cost, this has not, and will not, prevent the use of nickel steel in many cases where its better qualities make the increased first cost of the material a secondary consideration. Since the price of ordinary steel has been so greatly reduced in the last ten years by the improvement in the manufacture, will not this be the case with nickel steel? Nickel steel can now be furnished at the price of ordinary steel a few years ago. Will not the increased demand for this material, which it is certain will now come, cause a similar reduction in its price as soon as the manufacture of nickel steel becomes sufficiently extended and improved? This also will no doubt improve the quality of the nickel steel. Ordinary steel has had its innings. In this age of progress and development no material can long remain that exclusively or even principally used. When a better is known, it will be employed. Have we not in nickel steel a better material than the ordinary steel of to-day?

—*The Engineer*, August 30, 1895.

BOOK NOTICES.

The Standard Dictionary.

This dictionary of the English language published by Funk & Wagnalls, New York, deserves notice even in an artillery journal. Bound in a single volume, it is somewhat larger in bulk than Webster's International Dictionary. The price ranges from $12.00 to $17.00, according to the style of binding, and whether bought in one or two volumes.

Every effort has been made to make this lexicon complete and perfect within the limits of a single volume of convenient size for reference. The publishers tell us a million dollars were spent before a single volume was put on the market, and that 247 editors and specialists were engaged in the work with 500 readers for quotations. The aim was high and daring, the result is a remarkable success. The Standard Dictionary is a marvel of condensation, unequalled in comprehensiveness, concise, clear, accurate in definition, and by virtue of the high grade of scholarship employed, it is authoritative.

Its chief feature is its compass as a vocabulary. It records 301,685 words, exclusive of the appendix; Worcester records 105,000; Webster's International, 125,000; the Century, 225,000. Part of this surprising increase is due to a fuller investigation of current terms in the arts and sciences; part to a greater laxity in the character of the words admitted. The admission and rejection of words has not always been done wisely. The artillerist feels piqued to find *jump* and *bourrelet*, in their military application, missing; and yet see *jolly*, as a slang verb, transitive and intransitive, defined with elaborate care with illustrative phrases adjoined as to *jolly along*. In the quotations, by a curious perversity, the authors are generally of quite second rate, or third rate, or even of no rate at all. With what authority may we say "to sight a ship"? The Standard tells us the *New York Tribune* newspaper used it on October 15, 1891, in the first column of its first page; the Century gives the word in that sense and with equally clear illustration, in a passage from "a master-hand," Tennyson. This is not exceptional, but characteristic. While it is not easy to find a word other than some technical ones, that is not set down in this enormous vocabulary, the cast of the word is not so clearly established. Parvenus of vulgar origin are admitted indiscriminately with scions of ancient stems into this verbal House of Commons. The Standard Dictionary is unsurpassed as a vocabulary, though as a dictionary proper, that is as a guide to good diction, it is perhaps inferior to the International; and as a encyclopaedia dictionary, naturally it cannot equal the six volumes of the Century.

Special praise is deserved by the Standard for the attention given to synonyms. This is a part of a dictionary frequently consulted, and the Standard has given to it more attention than any of its rivals, adding to the synonyms a list of antonyms, or words of opposite meaning, a feature peculiar to this dictionary. The question of compound words has always been a knotty one for the lexicographer. It is not always easy to decide whether two words are properly a compound, and if a compound whether continuous or bound by a hyphen. The Standard has attempted to put this on a scientific basis, and on the whole has been successful. Another characteristic is the drift towards simplification in spelling. Honor, favor and the like are preferred to honour and favour, "e" is preferred in words fully anglicized to the dipthongs æ and œ, as in fetus, homeopathy, esthetics. Perhaps this simplification has been advanced too far in preferring sulfur, wo, quinin, still it is in the right direction.

The appendices to this dictionary are numerous, comprehensive and valuable for general reference. Some features in these, however, are to be regretted. Among others, it is incongruous and inconvenient to find the proper names of biography, geography, mythology and bibliography jumbled together in a single alphabetical order. It is more convenient for reference and for study to have these separate ; and this dictionary is distinctly inferior to the International in omitting from its biographical list the names of persons still living. There are reasons why an Encyclopædia Britannica should avoid criticizing living persons, but none exist for a dictionary omitting them from a reference roll.

In spite of some defects unavoidable in a work of such scope, this dictionary will take its place as the best dictionary of the English language published in a single volume. It is complete, succinct and authoritative. It has already become popular. G. B.

Précis de l'Art de la Guerre, ou nouveau tableau analytique des principales combinaisons de la stratégie, de la grande tactique et de la politique militaire, par le Baron de Jomini, Général en Chef, Aide de camp de S. M. l'Empereur de toutes les Russies. Nouvelle édition revue et augmentée d'après les appendices et documents du Général Jomini par F. Lecomte. Paris, Librairie Militaire de L. Baudoin.

This is a new edition of a familiar work. Jomini, though taking a notable part in the Napoleonic wars, lived until 1869, and among his last letters was one to Col. Lecomte, a Swiss compatriot, asking him to execute the task of modernizing the Summary of the Art of War. The result of this revision is the work now published. It appears in two octavo volumes, bound in paper with a third and slighter volume containing the illustrative maps and tables. The work is printed in large clear type on good paper.

As revised by Colonel Lecomte, the Summary of the Art of War stands now in the same high position it did when it first appeared sixty years ago During this interval, improvements in fire arms, the introduction of steam and of electricity have produced modifications in the art of war that necessitated a recasting by an efficient hand of a work that half a century ago was authoritative. The great principles of strategy are the same now as in the days of Hannibal, and these Jomini developed and illustrated with unrivalled clearness. As Jomini himself pointed out to Lecomte, if one should undertake to write afresh a compend of the art of war, it would be difficult to avoid repeating what he had already written. What was needed was a revision in the light of modern inventions, and Colonel Lecomte, like Jomini, himself practiced in war as well as in criticism, has performed this task in a manner that should earn the thanks of all military students. G. B.

The Naval Annual 1895, Edited by T. A. Brassey.

This, the ninth year of publication, gives a volume describing the progress of the principal navies, incidents of the war between China and Japan, and the resources of England for the supply of warship material and machinery and the manning of the same. There are also included tables and plans of the warships of the principal navies, comments on armor and ordnance, and the naval estimates of the principal naval powers.

We find given as the new features in the system of protection for the nine new battleships, building or to be built, by England, known as the *Majestic* class:—1st, Harveyized armor 9″ thick, 220 ft. long, and 16 feet deep, with 14″ armor bulkheads inclined forward to meet the 14″ pear shaped barbettes, thus forming an armored citadel more than 300 feet long, and so made in order to especially resist rapid fire and high explosive shells. The armored deck, 4″ thick on its curved sides, descends to the bottom of the side armor, thus giving a side armor equivalent to 15″ of steel up to the top of the armored deck. 2nd, An inner skin which extends to two bulkheads 8 or 9 feet forward and aft of the apices of the citadel. 3rd, The plated shelter deck having vertical plated walls connecting it with the upper deck so as to form a complete shelter for the upper deck crews from the observation of men stationed in the enemy's tops. (The decks are the sheltered, upper, main, and middle, the last being the armoredl). In offensive power, with their four 12″ 50-ton guns, twelve 6″ Q.F.—all in Harvey steel casemates,—sixteen 3″ Q.F., and twelve 3-lb. Q.F., it is declared that these battleships may have their equals or even superiors in the American and some Italian battleships, but in defensive qualities for close action they are claimed to be unrivalled.

We find it stated that the Chino-Japanese war proves that armor is indispensible to withstand the attack of modern guns. As to the effect of these guns it will be remembered that the Japanese had four 12″.6 guns. No special mention has been made in any correspondence so far published of the damage inflicted by these guns, and the question arises, did any projectile from them strike the only two ships (*Chen Yuen* and *Ting Yuen*) which can be called armor-clads, as they carried 12″ and 14″ compound armor.

This armor withstood the 6″ and 4″.7 guns at about 2200 yards, but, as the evidence shows, of 200 hits near the water line none over 3″ or 4″ in depth were found, it seems most reasonable that no 12″.6 armor-piercing shot or shell struck them.

The *Matsushima* was struck twice by 12″ shells; one, exploding, put her 12″.6 gun completely out of order, and the other, filled with *cement*, struck the ship in a weak part but did no material damage. This and other incidents of the fight on the Yalu show the great value of shell fire.

To the plans of the warship given in this number, a new feature, which is a most satisfactory one, has been included in that they now show the position and size of the various guns of the armament.

The subject of armor is treated in the Annual by comments on progress in the United States with due and complimentary reference to the advanced position of armor and authorities on armor in the United States, and by reference to Russian experiments.

The Annual believes that the English formulae for penetration of armor give results which are grossly wrong at high velocities, has therefore used Krupp's formulae for velocities over 2000 f. s., and awaits further experiments at high velocities before making a systematic change in the plates of the Annual, showing perforation of armor. As to ordnance all new guns for the English, save Howitzers for high angle fire, are now made on the wire system of construction. Twenty-six 12″ wire guns are being completed and nineteen more proposed for 1895-96 to complete the outfit and reserves of the nine battleships of the *Majestic* class. All new 6″ guns and smaller are to be made quick-firers, and those in existence are being converted into them. The manufacture of cordite is being extended to private firms. It has been adopted for the 12″ and 9″.2 guns, as well as for the quick-firers. It is believed a very safe powder. The electric motors for working 10″ guns have worked so well as to give good promise for that system.

As to the Annual it may be said that this number is an improvement over the preceding one by avoidance of duplication and by the new features introduced, though there are a number of errors in it which tend to detract from its general excellence and reliability. H. C. C.

DEPARTMENT OF SCIENTIFIC AND MILITARY INFORMATION.

Revue d'Artillerie.

(5 *Rue des Beaux-Arts, Paris, France. Monthly. Per year* 22 *Fr.*)

JULY 1895.—Unification of industrial units of measure. Theoretical study of the effects of shrapnel. Targets for artillery practice in Germany.

AUGUST.—The grand battery of the guard at Wagram. Graphical method for converging indirect sea-coast fire.

SEPTEMBER.—The museum of artillery. Mechanical fuzes. The French artillery corps.

Revue de Cavalerie.

(*Berger Levrault Cie, Rue des Beaux-Arts* 5, *Paris, France. Monthly. Per year* 33 *Fr.*)

JULY 1895.—The German cavalry and the Chalons army. Instruction and command of cavalry. The squadrons of couriers in Germany. Provisional regiments and detachments of cavalry, 1809–1813. Firing on horse-back, individual and in salvoes. "Tmiid Cavalry" (anonymous letter).

AUGUST.—Rezonville. The German cavalry and the army of Chalons. Trooper and horse. Observations on the French army from 1792 to 1808. The gaits of the horse.

SEPTEMBER.—A memoir of General Préval on the organization the cavalry (August 1811). The Austro-Hungarian cavalry. e division of the cavalry of the guard in the Italian campaign, ;9. The hussar brigade of Lieutenant Colonel Von Sohr de gny at Versailles (1805).

vue du Génie Militaire.

rger Levrault Cie, Rue des Beaux-Arts 5, *Paris, France. Bi-monthly. Per year* 27 *Fr.*)

JULY 1895.—Constructions in iron and cement. A cause of inge in aluminum. The installation of electric light for the litary school of St. Cyr.

AUGUST.—The German pioneers in 1870. The effect of Austrian torpedo shells on shelters. Gabions and demi-gabions. German military budget for 1895-6. Description of a bridge constructed by the English in 1880 over the Kabul river. Pigeons travelling over sea.

Revue Militaire de l'Etranger.

(*L. Baudoin, Rue et Passage, Dauphine* 30, *Paris, France. Monthly. Per year* 15 *Fr. Single number* 1 *Fr., plus postage.*)

JULY 1895.—The administrative personnel of the troops in Germany. The campaign of the English in Chitral. Present status of the work on the Trans-Siberian railway.

AUGUST.—Portugal in East Africa. Examination for promotion in England. The Chino-Japanese war (conclusion). Firing against captive balloons.

SEPTEMBER.—The Russians in the Pamir. Military service among the races of the Caucasus, and the organization of the native troops. Military organization of Greece. The Lee-Metford rifle.

Revue de l'Armée Belge.

(22 *Rue des Guillemins, Liége, Belgium. Bi-monthly. Per year* 13 *Fr.*)

MAY-JUNE 1895.—Studies upon the role of strong places in the defense of states. A historical glance upon the Congo country. Exterior ballistics. A Garcia Reynoso revolver system.

An interesting feature of this system is the adaption of the holster as a stock for the weapon by which the revolver may be aimed and fired with both hands. The revolver is attached to the small end of the holster, and the large end placed against the shoulder as the butt of an ordinary gun.

Creusot war material at the Exposition of Anvers. The Chatillon & Commentry Co. at the Exposition of Anvers. Infantry employed as a support to the cavalry on great distance service.

JULY-AUGUST.—Naval military art. Studies on the role of strong places in the defense of a state. The German, Russian and Austro-Russian frontier. Chartography, past and present.

La Belgique Militaire.

(*Rue St. Georges* 32, *Ixelles, Belgium. Weekly. Per year* 12.50 *Fr. Single copy,* 5 *centimes.*)

AUGUST 4, 1895.—The defense of states and fortifications in the 19th Century. The step and gait in different armies.

Revue Militaire Suisse.

(*Escalier-du-Marché, Lausanne, Switzerland. Monthly. Per year* 10 *Fr. Single number* 1 *Fr.*)

JULY 15, 1895.—Swiss military reorganization. Rôle of the cavalry pursuant to the order of August 31, 1894 (continued). Movements of the 1st Army Corps. Military society proceedings at Basle. The cavalry society.

AUGUST 1.—Swiss military reorganization (Lecomte).

SEPTEMBER 16.—Some pages of Swiss military history (1838). Concentration of troops, 1895.

Mémoirs de la Société des Ingénieurs Civils.

(10 *Cité Rougemont, Paris, France. Monthly.* 30 *Fr. per year.*)

JUNE, 1895.—The metallurgy of iron and steel at the expedition of 1889 at Paris, and of 1894 at Lyons.

JULY.—Comparative trials of the work absorbed in cables and belts.

Le Génie Civil.

(6 *Rue de la Chaussée d'Antin, Paris, France. Weekly. Per year* 45 *Fr. Single copies,* 1 *Fr.*)

JULY 6, 1895.—Increasing the wholesomeness of the Seine water. Triple expansion Corliss engine, Frikart system.

JULY 13.—The iron industry in Brazil. Tramway traction by compressed air (continued). Reservoir dams.

JULY 20.—Resistance of materials. The international railway congress at London, 1895.

JULY 27.—A crane with a gas motor. Traction on tramways by compressed air motors.

AUGUST 3.—Gold mines.

AUGUST 17.—Architecture of the Montesson establishment, a professional school for young convicts. Study of reservoir dams (continued). (The Johnstown dam catastrophe is reviewed in this paper.)

AUGUST 24.—Railroads in America.

SEPTEMBER 7.—The central electrical station at Nice.

SEPTEMBER 14.—Construction of a new bridge over the Weichsel, at Dirschau. Electricity at the exposition of 1900.

SEPTEMBER 28.—The progress of the Britannic fleet. Manufacture of metallic tubes.

Mémorial des Poudres et Salpetres.

VOL. 7.—Manufacture of nitric acid in the service powder works. Report of the commission of explosives for 1893. Theory of explosives (Sarrau).

Memorial de Artilleria.

(*Farmacia, num.* 13, *Madrid, Spain. Monthly. Per year* 18 *pesetas. Single copies*, 1 *peseta*).

JUNE, 1895.—Metallic cartridges. Memoir upon the change in draft horses and the trials of the new harness collars, etc. Military considerations upon the Cuban campaign (continued). Memoirs of the 2d of May.

JULY.—Plan of a cartridge for the Mauser gun. Regulation lances. Steel horse shoes. Naval fuzes. Lesson in chemistry and its military application explained in the superior war school.

AUGUST.—Small artillery material for the Cuban campaign. Smokeless powders. To Cæsar that which is Cæsar's. Lectures upon mathematical geography.

L'Avenir Militaire.

(13 *Quai Voltaire, Paris, France. Semi-weekly. Per year* 18 *Fr. Single number* 5 *centimes.*)

JULY 5, 1895.—General inspections. The fourth corps, August 16, 1870. School for commissioned officers.

JULY 9.—Recruiting the cavalry. Rochefort and the defense of the coast.

JULY 12.—The law on espionage.

JULY 16.—The Madagascar expedition.

JULY 23.—The Legion of Honor. Irregular nominations.

JULY 26.—The German war plan. The reduction of the age for the higher officers. The results of firing. Paris a military port.

JULY 30.—The responsibilities in Madagascar. Service of the *Gendarmerie*. The new naval artillery.

AUGUST 2.—The English language and French administration. The three year's service in the artillery. Parade and fire.

AUGUST 6.—A gloomy outlook for Europe. The question of horses in artillery. Italy and Ménélik.

AUGUST 9.—Madagascar transports. Too many examinations. The times of mobilization calls.

AUGUST 13.—The autumn maneuvers. Napoleon and the society of his times.

AUGUST 23.—Maneuvers and war. Roumania and the triple alliance. The small caliber rifle. The sick soldiers at Madagascar.

AUGUST 27.—What to do in Madagascar. Japanese strategy. English influence at Tananarive. Junior officers' mess.

SEPTEMBER 6.—Junior officers' mess.

SEPTEMBER 17.—Modern naval tactics. The French autumn maneuvers.

SEPTEMBER 20.—Military justice.

SEPTEMBER 27.—The raid on Tananarive.

Revue du Cercle Militaire.

(37 *Rue de Bellechasse, Paris, France. Weekly. Per year* 27 *Fr. Single copies,* 50 *centimes.*)

JULY 6, 1895.—Prussian military annual for 1895. Passage of the Balkans by General Gourko, December, 1877. Italian methods for mountain transports (continued).

JULY 13.—*En route* for Madagascar, journal of an officer of the expeditionary corps. Passage of the Balkans (continued). Italian mountain transport (continued).

JULY 20.—The passage of the Balkans by General Gourko, in 1877.

JULY 27.—Journal of an officer of the expeditionary corps *en route* for Madagascar. After the campaign of Lomlok.

AUGUST 3.—Our new infantry regulations and German critics. Madagascar.

AUGUST 10.—The folding bicycle applied to maneuvers around fortified places. Our infantry regulations anu German critics.

AUGUST 17.—Maneuvers of the groups of armies for 1895. Our infantry regulations and German critics (conclusion).

SEPTEMBER 7.—The Swiss army in 1894. The infantry and the artillery duel. The English militia.

SEPTEMBER 14.—The French army maneuvers.

SEPTEMBER 28.—The reform of the war office.

Le Yacht—Journal de la Marine.

(55 *Rue de Chateaudun, Paris, France. Weekly. Per year* 30 *Fr. Single copies,* 60 *centimes.*)

JULY 6, 1895.—The naval assembly at Kiel (E. Weyl). The French squadron at Kiel. The naval maneuvers of 1895. The German Emperor's racing yacht *Vineta.* The institution of naval architects in Paris. The trials of the *Bouvines.* The maritime postal services in the Mediterranean.

JULY 13.—The Danish navy. The naval evolutions. The naval architects in Paris. *Valkyrie III* (photographed).

JULY 20—The navy budget, 1895. The English evolutions. The French evolutions. The *Valkyrie III* and the *Defender.*

JULY 27.—On the subject of recent publications. Launching of the 1st class battleship *Masséna.*

AUGUST 3.—The naval maneuvers and mobilization. The great naval maneuvers in the Atlantic. A scheme for signaling cruisers at night and in fog.

AUGUST 24.—How I took part in forcing the entrances to Cherbourg. Launch of the battleship *Masséna.* The steering apparatus of the *Defender.* The English regattas.

AUGUST 31.—Modern naval tactics. The *America* cup in 1895.

SEPTEMBER 7.—Modern naval tactics. The French squadron of the North. The *America* cup. Organization of the transport service between France and Indo-China.

SEPTEMBER 14.—Modern naval tactics. The *America* cup in 1895. The schooner yacht *Velox.*

SEPTEMBER 28.—The new twenty-three knot cruiser. List of ships in commission with their stations.

La Marine Française.

(23 *Rue Madame, Paris, France. Semi-monthly. Per year* 30 *Fr. Single copies* 1 *Fr.* 50 *centimes.*)

JULY 10, 1895.—The squadron evolutions in the Mediterranean. Sea coast defense. Plans of two new corsair cruisers.

JULY 25.—Our military program. Maritime war bases for our navy. Upon the necessity for a specialized combat fleet. The Abyssinian question. The Niclausse multi-tubular boiler. Naval chronicle, home and foreign.

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Revue Maritime et Coloniale.

(*L. Baudoin, Rue et Passage, Dauphine* 30, *Paris, France. Monthly. Per year* 56 *Fr.*)

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Boletin del Centro Naval.

(438 *Alsina, Buenos Ayres, Argentina Republica. Monthly. Per year* $11.00.)

MARCH–APRIL, 1895.—The squadron of evolution. Vocabulary of powders and explosives. Steel for heavy guns (continued). Special maritime geography.

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Circulo Naval,—Revista de Marina.

(*Casilla num.* 852, *Valparaiso, Chili, S. A. Monthly*).

JUNE, 1895.—The necessity for establishing a school of divers in the fleet of the Republic. The Mangin and Schuckert projectors on board the *Capitan Prat.*

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Revista da Commissao Technica Militar Consultiva.

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Revista Maritima Brazileira.

(*Rue do Conseheiro Saraiva n.* 12, *Rio de Janeiro, Brazil. Monthly. Per year,* $10.00. *Single number,* $1.00).

Report upon shells, fuzes, etc., Lieutenant A. M. G. Ferraz. Extracts from the report of Rear-Admiral Julius Cæsar de Neronha. The port of Tamandaré. The Map of England.

Rivista di Artiglieria e Genio.

(*Tipografia Voghera Enrico, Rome, Italy. Monthly. Per year,* 30 *lira*).

JUNE, 1895.—A general view upon existing artillery (Moch). Upon a correction in shrapnel fire.

The author treats the subject analytically, applies the equations of exterior ballistics and shows the method of making corrections.

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Rivista Marittima.

(*Rome, Italy. Monthly. Per year*, 25 *lira. Single number*, 5 *lira*).

JULY, 1895.—The English maritime power during the French revolution and the empire. The Mediterranean military situation (continued). The naval ability of Cervantes. Letters to the Director.

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(*Mohren Strasse*, 19, *Berlin*, *W.* 8, *Germany. Monthly. Per year* 32 *M. Single number* 3 *M.*)

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United Service Gazette.

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Journal of the United Service Institution of India; Simla, India.

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The Physical Review.

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