that they are uniform; second, two together; third, three together. In this way three equations are found containing three unknown quantities: heat resistance of the material, that of the surface exposed to the air, and that of the surface in contact with another surface, which equations can be solved.

He also submitted the following table, showing the heat resistances of substances computed from the conductivity :—

Heat Conducting and Resisting Values of Different Insulating Materials.

Insulated Material.	Conductance, B.T.U. per Square Foot per Day per Degree of Difference of Temperature.	Coefficient of Heat Resistance.
1. ⅞-in. oak board, 1-in. lamp-black, ⅞-in. pine board (ordinary family refrigerator)	5.7	4.21
2. ⅞-in. board, 1-in. pitch, ⅞-in. board	4.89	4.91
3. ⅞-in. board, 2-in. pitch, ⅞-in. board	4.25	5.65
4. ⅞-in. board, paper, 1-in. mineral wool, paper, ⅞-in. board	4.6	5.22
5. ⅞-in. board, paper, 2½-in. mineral wool, paper, ⅞-in. board	3.62	6.63
6. ⅞-in. board, paper, 2½-in. calcined pumice, ⅞-in. board	3.38	7.10
7. Same as above, when wet ..	3.90	6.15
8. ⅞-in. board, paper, 3-in. sheet cork, ⅞-in. board ..	2.10	11.43
9. Two ⅞-in. boards, paper, solid, no air space, paper, two ⅞-in. boards	4.28	5.61
10. Two ⅞-in. boards, paper, one air space, paper, two ⅞-in. boards	3,71	6.47
11. Two ⅞-in. boards, paper, 1-in. hair felt, paper, two ⅞-in. boards	3.32	7.23
12. Two ⅞-in. boards, paper, 8-in. mill shavings, paper, two ⅞-in. boards	1.35	17.78
13. The same, slightly moist ..	1.80	13.33
14. The same, damp	2.10	11.43
15. Two ⅞-in. boards, paper, 3-in. air, 4-in. sheet cork, paper, two ⅞-in. boards	1.20	20.00
16. Same, with 5-in. sheet cork	0.90	26.67
17. Same, with 4-in. granulated cork	1.70	14.12
18. Same, with 1-in. sheet cork	3.30	7.27
19. Four double ⅞-in. boards (eight boards), with paper between three 8-in. air spaces	2.70	8.89
20. Four ⅞-in. boards, with three quilts of ½-in. hair between papers separating boards	2.52	9.52
21. ⅞-in. board, 6-in. patented silicated strawboard, finished inside with thin cement	2.48	9.68

Analysing some of the results given in the last column of the Table, we observe that, comparing Nos. 2 and 3, 1 in. added thickness of pitch increased the coefficient 0.74; comparing Nos. 4 and 5, 1½ in. of mineral wool increased the coefficient 1.11. If we assume that the 1 in. of mineral wool in No. 4 was equal in heat resistance to the additional 1½ in. added in No. 5, or 1.11 reciprocal units, and subtract this from 5.22, we get 4.11 as the resistance of two ⅞-in. boards and two sheets of paper. This would indicate that one ⅞-in. board and one sheet of paper give nearly twice as much resistance as 1 in. of mineral wool. In like manner any number of deductions may be drawn from the Table, and some of them will be rather questionable, such as the comparison of No. 15 and No. 16, showing that 1 in. additional sheet cork increased the resistance given by four sheets 6.67 reciprocal units, or one-third the total resistance of No. 15. This result is extraordinary, and indicates that there must have been considerable differences of conditions during the two tests.

In conclusion, the author said :—

The writer would propose to engineers and others who have to make tests in which heat transmission is involved the adoption of a standard for expressing heat resistance or the heat-insulating power of various substances as follow :—

The coefficient of heat resistance of a substance is equal to unity divided by the number of British thermal units transmitted in one hour by a slab 1 square foot in area and 1 in. thick per degree Fahr. of difference of temperature between the two faces of said slab, both surfaces being exposed to still air.

It should be noted that the coefficient of resistance thus defined will be approximately a constant quantity, for a given substance under certain fixed conditions, only when the difference of temperature of the air on its two sides is small—say, less than 100 deg. Fahr. When the range of temperature is great, experiments on heat transmission indicate that the quantity of heat transmitted varies not directly as the difference of temperature, but as the square of that difference. In this case a coefficient of resistance with a different definition may be found—viz., that obtained from the formula $a = \frac{(T^1 - t)^2}{q}$, in which a is the coefficient, $T-t$ the range of temperature, and q the quantity of heat transmitted in British thermal units per square foot per hour.

The subject of the heat-insulating power of different substances is of immense importance in refrigerating work, and it is to be hoped that when further experiments with such substances are made, their results may be reported in the manner here suggested, and that conclusions be drawn by the experimenters from the reciprocal values or "coefficients of heat resistance" here described.

There was no discussion of this paper, and yet there was many a man who would have enjoyed getting back at the author to salve old wounds inflicted by him; so either lack of flaw in the statements, or a lack of courage to attack, resulted in acquiescence, or, at least, in silence.

(To be continued.)

THE RUSSIAN CRUISER "BOGATYR."

WE begin the publication this week by a two-page plate of a series of drawings of the Russian first-class protective-deck cruiser Bogatyr, built by the Stettiner Maschinenbau Actien-Gesellschaft Vulcan, of Stettin. This vessel is one of three for which competitive designs were invited by the Russian Government, under certain stringent conditions of power, speed, and stability, and the Vulcan Company not only complied with these, but increased the protection of the armament by placing the bow and stern chasing pairs of 15-centimetre guns in turrets, and by protecting four other weapons of the same calibre in casemates, instead of providing shields only for all 15-centimetre guns. The result was that in addition to ordering the Bogatyr from the Vulcan Company, the Russian Government began the construction of four cruisers on the Bogatyr plans in Russian yards—a compliment to the Vulcan Company and its directorate, which was not depreciated by the substantial remuneration to the company for the use of the designs.

We will defer our detailed description until further illustrations are given; but here it may be said that the length over all is 439 ft. 7½ in.; on the water line, 433 ft.; and between perpendiculars, 416 ft. 8 in. The maximum breadth is 54 ft. 5½ in.; and the moulded depth, 34 ft. 1½ in. On a mean draught of 20 ft. 8½ in. the displacement is 6750 tons, and thus loaded the Bogatyr maintained the high "mean of mean" speeds on the measured mile of 23.45 knots, with 20,161 indicated horse-power, although the air pressure in the stokeholds was only ½ in.; while the mean speed on two separate six-hours' trials was 24.15 knots, with 20,270 indicated horse-power, the coal consumption being 1.43 lb. per indicated horse-power per hour. Two sets of four-cylinder triple-expansion balanced engines drive the twin-screw propellers, and the steam is generated in sixteen Normand "Express" boilers.

The armament, which is well shown in the longitudinal section and deck plans, reproduced on the two-page plate with this issue, is as follows :—Twelve 15-centimetre (5.9-in.); twelve 7.5-centimetre (2.95 in.); and eight 4.7-centimetre (1.85 in.) quick-firers. For use in the boats there are two 1.46-in. and two 0.28-in. machine guns, with two landing guns of 2.56-in. calibre. There are two submerged torpedo-tubes; four above water—two on each broadside, one through the ram bow, and the other in the stern; and there are two other tubes for boat duty.

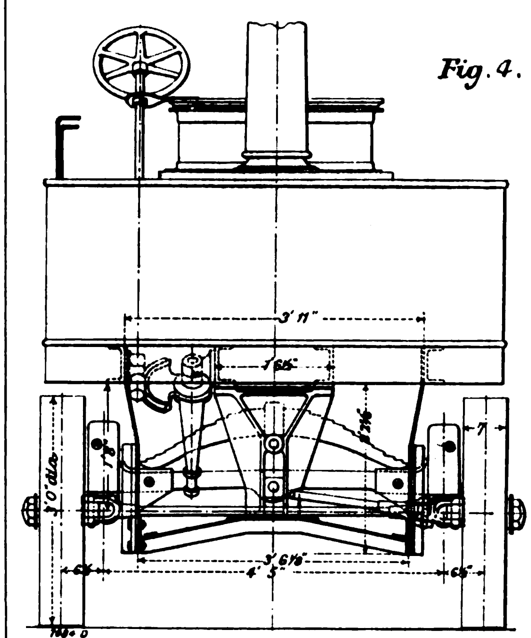
THORNYCROFT STEAM WAGON AND PETROL CAR.

ON pages 144 and 145 we illustrate two interesting vehicles which will form prominent features in the Automobile Exhibition which opens to-day at the Crystal Palace, and which will close on Saturday, February 7. It may be stated in passing that this Exhibition promises to be the most important show of automobiles yet held, at any rate in this country. We are informed by advertisement that "the ground floor of the Crystal Palace is twice the size of the Grand Palace, Paris, and is all let." We shall have more to say about the Show generally next week, and for the present confine ourselves to a notice of what will doubtless be one of the most interesting features.

We have frequently described in these columns the steam wagons manufactured by the Thornycroft Steam Wagon Company, of Chiswick and Basingstoke.* Hitherto the firm have confined themselves largely to the heavier class of weight-carrying self-propelled vehicles. These have all been driven by steam; but the company have for some time past been making experiments and getting out designs for a petrol-driven car, and the result is the vehicles now illustrated. We will describe the steam-driven vehicle first. This is a new type of wagon, designed especially for colonial purposes, and is illustrated in Figs. 1, 2, 3 on page 144. Although it bears some resemblance to former vehicles, it differs in several essential features. It has a compound engine, which will give 40 brake horse-power. The cylinders are 4½ in. and 7 in. in diameter by 7 in. stroke. This is a larger and more powerful engine than has been fitted to former wagons of this type. The boiler, which is of the usual water-tube type fitted in the Thornycroft wagons, has 132 ft. of heating surface and 4½ ft. of grate area. The gearing is entirely enclosed in two dust-proof and oil-tight gear cases. The engine is bolted underneath the framing of the car in a horizontal position, as shown. The crankshaft drives through a drag-link coupling (which serves as a flywheel) on to a pinion shaft. The latter carries two pinions, which gear into spur-wheels on the second-motion shaft to give the two speeds required. This part of the gear is in one casing. The second-motion shaft is in three parts, there being an intermediate length between the driven wheels of the second-motion shaft and the driving pinion of the same. This intermediate length has a universal coupling at each end; the flexibility needed to allow for the movement between the driven spur-wheels (fixed to the wagon frame) and the pinion (which is carried by the gear case attached to the axle) is thus provided for. This part of the design has been very ingeniously devised, and is the subject of a patent owned by the company. The arrangement allows the old perch frame, formerly used for wagons with spur gearing where springs intervene, to be dispensed with. This is a great convenience, as the perch frame is not only heavy and a good deal in the way, but it adds considerably to the noise and rattle of the vehicle. By the position of the engine and the arrangement of gearing to which reference has just been made, the required flexibility of drive is obtained without the use of chain and sprocket wheel—a device always subject to drawbacks for the conveyance of heavy powers in such situations. This part of the mechanism is best shown on the plan (Figs. 2 and 3).

The road wheels are of steel, and are of larger diameter and wider than usual, the rear or driving wheels being 4 ft. in diameter and 10 in. wide on the tyre, whilst the leading wheels are 3 ft. in diameter and 7 in. wide. The steering arrangement is shown in the front elevation (Fig. 4). It is generally of the Acker-

Fig. 4.



man type, and is actuated by a hand-wheel from the driving platform. A worm on the hand-wheel shaft gears into a worm quadrant which turns on a pin suitably attached to the front transverse member of the frame. Bolted to the quadrant is a steering arm, to the lower end of which is attached, by means of a trunnion-block, a connecting-rod. This connecting-rod is shown broken off in our illustration. The wheels are each mounted on a short axle arm, which has a vertical extension projecting up into what is known as the axle socket. The latter forms part of the main front axle, which, of course, does not turn. The vertical extension of the axle arm and the axle socket thus form a bearing to allow for the partial rotation needed when the wheel is deflected in steering. Returning to the connecting-rod, this at its outer end is attached to a coupling-rod, the latter in turn being attached to two horizontal arms projecting forward about 9 in. to 10 in., and which are rigidly attached to the axle arms. So far, this is the general design of the Ackerman steering device. In order to allow for the movement of the wagon spring, and the consequent play between the axle and the wagon frame, horn-blocks and guides are provided.

* The following references to former illustrations of Thornycroft steam vehicles may be found of use in connection with our present notice. ENGINEERING, vol. lxxii., pages 776 and 793, military lorries; vol. lxxi., page 736, for steam lorries in Liverpool trials, 1901; vol. lxviii., page 358, brewer's dray and steam passenger car; vol. lxv., page 726, five-ton lorry, page 628, tip wagon; vol. lxii., page 47, steam road van.

that in that case the motion of the back piston is not *absolutely* the reverse of that of the piston over the shaft. Though the difference of displacement of this piston from the required position is, in the earlier design, never more than a very small fraction of an inch, he very properly avoids the risk of an approximate balance when it can so easily be made perfect.

To make clear the mechanical advantages of this design over that for which it is substituted, I will quote from my last year's paper:—

"The bearing surfaces in this and the merchant engine design have all been increased. Though the surfaces in the earlier design seem ample, the increase puts the long running of the engine without readjustment beyond question.

"By bringing the main guides to the outsides, their accessibility is considerably increased, and it also allows the levers, though raised, to be kept closer together with their centre bearings outside them and in easy reach. Making a centre front column leaves the engine perfectly open over the main bearings, so that not only these, but also the main crossheads, front links, and centre lever bearings, can be easily got at, even when the engine is running. To make this easier at the after end, the after back column of the second intermediate-pressure cylinder is moved a few inches aft of the centre of the corresponding main bearing. As strength is easily provided, this shift may be made without fear. Also, to give better head-room above the intermediate platform, the high-pressure and first intermediate-pressure valves are worked from above. This is also improved by dispensing with the jaw guides of these gears, as shown in the view of the valve gear, Fig. 26.

"The extra length of back piston-rod required by the modification of the design is 25 in., but this weight is almost entirely saved by the shortening of the links. In any case, its inertia at full speed only increases the pressure on the main bearings by $2\frac{1}{2}$ lb. per square inch, so that the addition is unimportant.

"The travel of the levers above and below the horizontal position is made unequal. This in no way affects the balance, but by preventing the lever and links from drawing so nearly into line when the crank is at the top makes the adjustment of the whole connection less delicate. The links have also been so designed that they can be kept exactly to length. The levers can readily be withdrawn to the back. The back links and glands of back cylinders are in easy reach.

"The cross-ties are attached so that the expansion of the cylinders will have no sensible effect.

"Some of the weight saved by bringing down the back cylinders is added to the front columns and some to the front of the bedplate, so that the total is not much altered.

"The front cylinders are held from fore-and-aft movement by a jaw cast on the low-pressure cylinder, which holds, by sliding contact only and without bolting, the foot for the centre back column of the front cylinders.

"The front of the engine may now be toward the centre of the ship, as is usually most convenient; and the hatches, instead of coming close together, will leave a wide passage on deck between them. The hatches do not now require to come much beyond the centre of the back cylinders, which will leave these openings of about the ordinary width, and give broad outboard passages on deck.

"The high-pressure and first intermediate-pressure valves draw up, those of the second intermediate pressure and low pressure draw down. This not only suits the design, but also the narrower hatches."

If, in making the balance, a little weight had to be added to the moving parts of the back cylinders, I think it might, in some cases, be well to add it partly by lengthening the piston-rod, and thus bringing up the back cylinders to the same level as the front ones. The framing would thus be improved, and the upper athwartship bolts rendered unnecessary.

I need not refer to the long discussion of the admissibility of the lever, further than to say that we on this side of the Atlantic know it and are not afraid of it.

If the lever is all right, if we adopt it here, we can realise a complete solution of the vibration problem. If we decide against it, we can make no further progress in this direction with the reciprocating engine. Its adoption gives us also a lighter engine, a simpler engine, and one which takes up much less room in the ship. The non-vibrating engine is also necessarily the better and safer to run.

As Macalpine shows, in a figure in his paper which he drew at my request, the engine occupies very much less space in the ship. I found that a triple-screw arrangement could be made very conveniently with this engine when it was hardly possible with the ordinary four-crank engine, as the machinery space became so long.

POSSIBLE TORSIONAL BALANCE.

The engine, as shown in Figs. 24 to 26, has an unbalanced inertia torsional couple. By placing the cylinders tandem, or adding a third cylinder on the other side of the vertical line through the shaft and also connecting it with a lever, any increase of unbalanced torsional couple over that in ordinary forms of engine is avoided. But these arrangements are not to be commended for shipboard.

Macalpine long ago pointed out to me that by increasing the number of cranks almost perfect torsional balance can be attained. Take three cranks at 120 deg., and make the moving masses alike for each of the three cranks. The first-period torsional couple for the forward crank may then be represented by $C_1 \cos \theta$; and the total torsional couple from the three cranks will be

$$C_1 \cos \theta + C_1 \cos (\theta + 120°) + C_1 \cos (\theta - 120°) = 0$$

Similarly, for second and fourth-period torsional balance, we have:

$$C_2 \cos 2\,\theta + C_2 \cos 2\,(\theta + 120°) + C_1 \cos 2\,(\theta - 120°) = 0$$
$$C_4 \cos 4\,\theta + C_4 \cos 4\,(\theta + 120°) + C_4 \cos 4\,(\theta - 120°) = 0$$

Similarly, the valve gears for each crank may be balanced. This gives perfect torsional balance for first, second, and fourth periods.

For very large engines it would probably be advisable to adopt three cranks and six cylinders. In such cases it is usual to decrease the size of the largest cylinders by increasing their number.

With four cranks in opposite pairs, at right angles, we could only have first and second-period torsional balance.

EFFECT OF TORSIONAL UNBALANCE.

But I do not believe the complication of three cranks and six cylinders to be in any way necessary for balance, as no sensible torsional vibrations arise. Of this, in the last section, I have given the strongest practical proof. I will now recall, very briefly, the theoretical examination given in both my paper and Macalpine's of the effect of the unbalance of his two-crank engine.

The periodic time of torsional vibration of a circular, uniform tube, there being two nodes—the gravest torsional vibration that would occur—is, in seconds:

$$T = l\sqrt{\frac{n\,\rho}{g\,\mu}} \quad . \quad . \quad . \quad . \quad (8)$$

l = length of the tube in feet
g = 32.2
ρ = the weight in pounds per cubic foot of the elastic material of the tube = 500 for steel
μ = the modulus of rigidity in pounds per square foot = $12 \times 144 \times 10^6$ for steel.

The elastic tube, at each section, is supposed symmetrically loaded with inelastic material, till its moment of inertia is increased to n times that of the unloaded tube. Thus the elastic structure of the ship is loaded with woodwork, machinery, and cargo, which contribute little to the elastic reaction. From figures supplied by his friend, Professor F. P. Purvis, Macalpine concluded that for a ship n will range from about 3 to less than 2, the figures for warships being nearer the lower limit.

Take a tube (ship) 400 ft. long, having an engine running 112.5 revolutions, and take n = 2, 3, and as high as 4. We readily find, using equation (8)—

n = multiplier for moment of inertia	2	3	4
N = number of vibrations per minute	1119	913	791
S = number of synchronizing period	9.9	8.1	7.0

In order that the ship may act like the tube, what we require is to make a torsionally stiff structure—that is, so to stiffen it that the sections can change shape but very slightly when the twisting couple is applied. This is amply done in a ship by means of the frames, beams, and bulkheads; so we may be sure the above result does not differ greatly from the truth for a ship. Especially is this the case since the time of one vibration lengthens in the same proportion as the square root of the elastic reaction diminishes. We see, then, that the proportionate change in the period is much smaller than that of the elastic reaction.

This synchronism only occurring with high-period torsional couples in the engine, one naturally inquires—

What increase is there in the torsional couples of the various periods in this engine over the ordinary engine? Macalpine gives fully the details of this calculation, comparing the increase of torsional couples from two cylinders acting on one crank, arranged as in his system, over that of both cylinders acting direct.

The results are:—

Period.	Percentage Increase.
2nd	25.7
3rd	0
4th	7
5th	0
6th	3.4
7th	0
&c., &c.	

Thus, in those high periods which will synchronise, there is no sensible increase over the torsional couples for an ordinary engine. Hence we need not fear these vibrations, as they do not occur with an ordinary engine.

We have still to examine the very large first-period torsional couple produced by this engine, but which scarcely exists in the direct-connected engine. It will produce no elastic torsional vibrations, as it only applied from a seventh to a tenth as quick as the slowest of these vibrations; but it will rotate the ship as a rigid body.

If ϕ_1 is the greatest angular rotation of the ship from its undisturbed position, and b the half-breadth of the ship, the greatest vertical linear displacement at the side of the ship is—

$$\phi_1 b = \frac{m\,r\,D\,b}{I} \quad . \quad . \quad . \quad . \quad (9)$$

due to one pair of cylinders.

m = the reciprocating mass for each cylinder.
r = the crank radius.
D = the athwartship distance between the cylinder centres.
I = the moment of inertia of the ship about the longitudinal axis for these vibrations.

The engine, Figs. 24 to 26, is about the same power as each of the engines of the United States battleship Alabama. Taking the weights from the earlier design, which are little different from those of the design figured here, Macalpine deduces from equation (9) that the two pairs of cylinders would give for the Alabama

$$\phi_1 b = .0045 \text{ in.},$$

or a total movement of less than one hundredth of an inch.

Aiming a gun athwartship at a target three miles distant, there would be an apparent movement of the sight on the target—

$$= \frac{1}{100} \times \frac{3 \times 5280}{36} = 4.4 \text{ in.}$$

36 ft. being the half-breadth of the ship.

The rigid body second-period vibrations will be, relatively to the first period, very small. And, for ships in every way similar, the angular displacement ϕ_1 will be constant, and $\phi_1 b$ proportional to b. Thus, even in small high-powered ships, $\phi_1 b$ will remain small.

I believe this system is correct, both theoretically and practically; that by its adoption we would get over all the very serious difficulties arising from unbalanced engines. If I err, I err in good company—my opinion coincides with that of Philip Watts and Macfarlane Gray.

(To be continued.)

THE RUSSIAN FIRST-CLASS CRUISER "BOGATYR."

In accordance with the high aims of the new naval scheme, the Russian Government invited, in the spring of 1898, tenders for the construction of a protected cruiser of approximately 6000 tons displacement. The mean speed of two trial runs, each lasting six hours, was to be 23 knots, and this speed was to be realised under certain defined conditions. The cruiser was to carry the normal complement of 580 men, provisions for 60 days, water for 10 days, a normal load of 720 tons of coal, 76 tons of engine-repairing materials or spare parts, and an armament as follows:—

Ship Guns:

Twelve 15-centimetre (5.9 in.) quick-firing guns, 45 calibres long, with ammunition for 2160 shots.
Twelve 7.5 centimetre (2.95 in.) quick-firing guns, 50 calibres long, with ammunition for 3600 shots.
Eight 4.7-centimetre (1.85 in.) quick-firing-guns, 50 calibres long, with ammunition for 4860 shots.

Boat Guns:
Two 3.7-centimetre (1.46 in.) quick-firing guns.
Two 6.5 „ (2.56 in.) landing guns.
Two 7-millimetre (0.28 in.) machine guns.
All with ammunition and accessories.

Torpedo Armament:
Two submerged broadside torpedo guns.
Four torpedo guns.
Two boat torpedo guns.

The cruiser was to have bunker space for 1100 tons of coal. With normal load the metacentric height was to be guaranteed at 750 millimetres (29.5 in.), and with all the coal on board it was to be 700 millimetres (27.6 in.). Of German firms the Germaniawerft Friedr. Krupp, of Kiel, F. Schichau, of Elbing, and the Vulcan Company, of Stettin, participated in the competition; of foreign firms, Messrs. William Cramp and Co., of Philadelphia, and others. As the result of the competition, the Russian Government entrusted each of the three firms, Cramp, Krupp, and Vulcan, with the construction of one protected cruiser.

While Messrs. Krupp and Messrs. Cramp conformed almost entirely to the design outlined by the Russian Government, and fitted shields for all the 15-centimetre guns, the Vulcan Company suggested a modification in the mounting and protection of these guns. Four of those guns were to be placed in turrets, two in each, one at the forward end, and the other in the poop; four in the casemates, and four only behind shields. It is scarcely necessary to enforce the enormous superiority of the casemate over a shield as a means of protecting gun, ammunition, and crew, and the attainment of the high speed and the high gunpower results with this important modification becomes a matter of considerable interest. All the smaller guns were likewise protected by shields.

In view of the great amount of ammunition carried, and the large complement of marines required under the conditions of the Russian Government—the full complement of the ship being 580 officers and men—and further because of the modifications due to the turrets and casemates for the guns, the Vulcan Company proposed a considerably increased displacement, namely, of 6750 tons, in order to be able to comply with all the other stipulations made; but at the same time they agreed to the same speed, &c. The result was the building of the Bogatyr, the vessel which forms the subject of the present article. With our issue of January 30 we published a two-page engraving, containing a longitudinal section and three deck plans of this ship, and this week we give another two-page plate, and further illustrations on pages 208 and 209.

The modified design carried out by the Vulcan Company, with the approval of the Russian Government, proved so satisfactory to the Russian Government that they at once began the construction of four sister-ships of the Bogatyr, on the Vulcan plans, in their own shipbuilding yards. The compliment thus paid to the Vulcan Company and its directorate was not depreciated in any degree by the substantial monetary remuneration received by the company for the use of the designs. The chief dimensions adopted by the Vulcan Company were:—

Length over all	134 metres	(439 ft. 7½ in.)
Length in the water line...	132 „	(433 ft 0 in.)
Length between perpendiculars	127 „	(416 ft. 8 in.)
Breadth, maximum, between frames	16.6 „	(54 ft. 5½ in.)
Depth, moulded	10.4 „	(34 ft. 1½ in.)
Draught	6.3 „	(20 ft. 8$\frac{1}{16}$ in.)

The guns and torpedo armament were exactly to stipulation.

The contract speed of 23 knots, it was calculated, called for engines indicating 19,500 horse-power. Preference was given to two, instead of three, propeller shafts, for the following reasons:—

1. Simplicity in working.
2. Greater control of the installations.
3. Simpler engine signalling service.
4. Less weight; or, with the same weight, stronger construction of engines and boilers.
5. Considerable saving in space.
6. Increased efficiency of the whole installation, since three propellers influence one another disadvantageously.

The twin-screw arrangement, too, rendered more space available for large and accessible ammunition magazines, which are shown on the plan (Fig. 7). The arrangement of only three groups of boilers instead of four led to a further saving in space forward, where ammunition accommodation was wanted. It thus became possible to construct the magazines of large dimensions. Large ammunition chambers are in themselves a great advantage for any warship, as in such case the working of the ammunition hoist is much facilitated. The upper deck (Fig. 3) has also profited from the good distribution of the guns and of the ammunition hoists, and the well-designed arrangement of the engine and boiler plant. Clear space for drilling the sailors and marines, such as we find on both sides of the Bogatyr, from poop to forecastle, can, as a rule, only be met with on regular naval liners.

The deck-houses on the poop and on the main deck for the officers, and in the waist of the ship and forecastle for the men, afford spacious and well-ventilated accommodation. The arrangement of the hospital is a specially noteworthy feature in the design and general arrangement of the living quarters.

The cruiser is fitted with two steel masts, with pitch-pine tops, rising 37 metres (121 ft.) above the water-line. There are three yards on each mast: a lower yard and a Mars yard, both of pitch-pine, with a signal yard, of steel tubing.

The use of wood has been limited to the lowest possible amount in order to reduce all fire risks.

Steel Construction.

Turning now to the constructional work, which is shown on the series of cross-sections reproduced on pages 208 and 209 (Figs. 13 to 24), it may be said at the outset that it was stipulated that the tensile and compression stresses on the hull must not exceed 10 kilogrammes per square millimetre (6.35 tons per square inch). In calculating the strengths, the customary assumption was made that the wave length is equal to the ship length, and the wave depth equal to 0.05 of the length. The stresses were calculated for the ship when in several positions on a wave crest and in a wave hollow; the maximum resulting stress was 9.80 kilogrammes. Reduction to the least possible dead mass, allowing full utilisation of the material, is always aimed at in the construction of cruisers. The trials to which the Bogatyr has been submitted demonstrate that this problem has successfully been solved by the Vulcan Company.

The sternpost, which is made of two steel castings, has been provided with a heel for the rudder bearing, as shown in the longitudinal section of the ship, Fig. 1. It was not thought advisable to dispense with the addition of this heel, as is often done in warships, as it forms an essential element in securing the strength of the stern. Three eyes, it will be seen, are also cast to the post to guide the rudder; the horizontal portion of the post is fitted with strong flanges for the purpose of fixing the shaft brackets (Fig. 7). The latter consist of two arms of elliptical sections, and extend with their upper ends into the ship, where they are braced by angles connecting them with the steel skin. The Vulcan Company applies this construction by preference to war ships, and has found it once more advantageous in the case of the Bogatyr. The rudder, which is balanced, is built up with steel plates, and is filled with pine.

The stem is a two-part steel casting, and has the shape of a ram post. Provision is made for joining it to the armour plates and the decks, and there is an opening for the bow torpedo tube which lies above the water line (Fig. 1).

The chief point to be studied in designing the double bottoms which are shown in the various cross-sections was to secure strength to stay the vital parts of the cruiser against ramming. For this reason, and in the interest likewise of an augmented transversal strength, the inner bottom, which has a length of 96 metres (315 ft.), has been carried from the level of one armoured deck to the other for a length of the ship over a distance of 63 metres (207 ft.)—that is, much more than half the full length. There are also longitudinal bunkers next to the boilers (Fig. 7), and these two arrangements protect the boilers and engines against ramming, and further afford some protection against torpedo attack. It is the first time that the Vulcan Company has adopted this construction, which, having been fully approved of by the Russian Navy, will probably be imitated.

As regards bulkheads, the subdivision into many compartments follows the universal practice. The bedplates for the main engines have their longitudinal girders on the plane of the girders of the double bottom (Fig. 19). Bending stresses are avoided in this way, and the stresses are uniformly transferred to the skin plating, and further to the covering of the double bottom.

The cofferdam, which has a length of 78 metres (256 ft.), extends from the armoured deck to one metre above the 6.30 metres water-line. It reaches aft beyond the boiler and engine-rooms, and is divided by the watertight bulkheads. Of these transverse watertight bulkheads, twelve extend from the inner bottom to the armoured deck, and nine from the armoured deck to the upper deck. Further provision against sinking is to be found in the high-level double bottom, in the watertight longitudinal and cross-bunker walls, the longitudinal walls of the ammunition chambers, and in the cofferdam.

Armour.

For the protection of the engines and boilers, the steering engine, and the ammunition, an armoured deck extends over the whole length of the ship. It is horizontal in its middle portions, as shown on the cross-sections, and inclined to an angle of 34 deg. at the sides. When the ship is drawing 6.30 metres (20 ft. 8 in.) of water, the armoured deck is 1.35 metre (49 in.) below the water-line at the slopes, but 0.75 metre (30 in.) above it in its middle portion. The armoured deck is built of two layers of plates. The lower layer has a thickness of 15 millimetres (0.59 in.), and is riveted watertight; the upper layer of special plates is bolted to the lower, the thickness being 18 millimetres (0.7 in.) in the middle horizontal portion, 54 millimetres (2.13 in.) at the slopes, where the deck covers in the engines and boilers, and 39 millimetres (1.53 in.) at the forward and aft ends. The part of the engines which projects above the armoured deck is protected by a dome (Figs. 1 and 19). The sides of this dome consist of two layers of plates; the lower one 15 millimetres thick and riveted watertight, and the upper one of 70 millimetres nickel steel; the horizontal top is formed of two layers of plates, the lower one 15 millimetres and the upper one 18 millimetres (0.7 in.) in thickness. All the plates which exceed 30 millimetres (1.18 in.) in thickness have been submitted to gun tests.

The engine-room skylights are fitted with massive fighting screens, easily movable by hoists. As a rule, armoured gratings are used for this purpose; they have on the Bogatyr been applied only as narrow lateral bars, where the hot air is to escape.

Protection of Armament.

The turrets, which are placed on the poop and forecastle (as shown in Figs. 1, 2, 14, and 21), are fitted in front with a hard nickel-steel mantle-plate 125 millimetres (5 in.) in thickness. The rear half of the circumference is formed by nickel-steel plates of 90 millimetres (3.54 in.), not hardened. Floor and ceiling are made of 25-millimetre (1 in.) armour-plates. The tubes for the ammunition hoist, from the armoured deck up to the poop or back, consist of 73-millimetre (2.87 in.) unhardened nickel steel.

Unhardened nickel steel, 80 millimetres (3.15 in.) in thickness, is also applied for the front plates of the four casemates on the upper deck (Figs. 3 and 23); the sides and backs are formed of two layers of ship-plates, 17.50 millimetres (0.69 in.) in thickness. The floors and ceilings are made in thicknesses of 25 millimetres (1 in.).

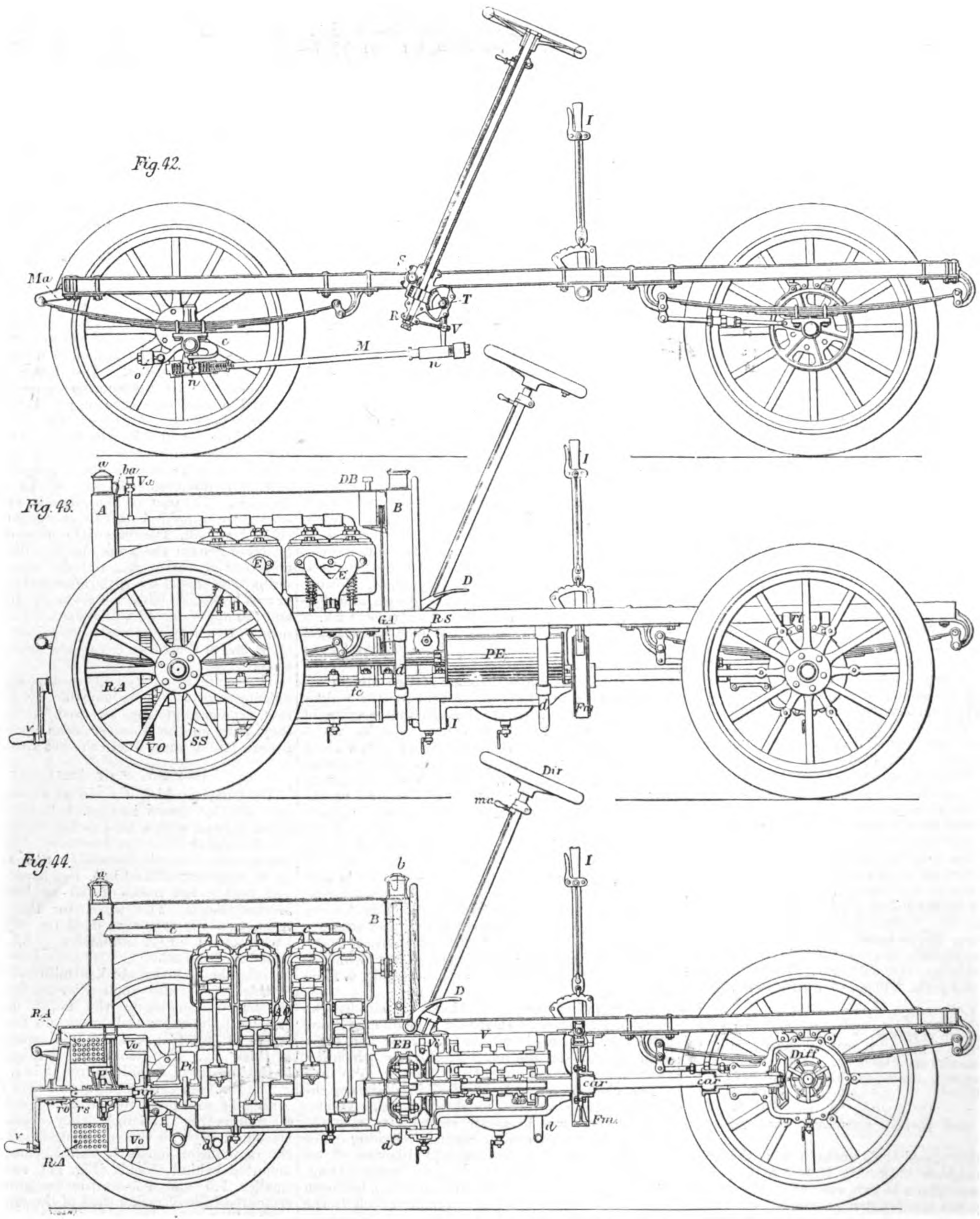
The shafts of the ammunition hoists for the four casemates are built up of nickel-steel plates of 60 millimetres (2.36 in.); they extend from the armoured deck to the upper deck. The shafts of the ammunition hoists for the 15-centimetre guns mounted behind shields (Fig. 14), and for all the smaller 7.5 and 4.7-centimetre guns have an armoured tube of nickel steel of the same thickness—60 millimetres; this tube is carried to a height of 1200 millimetres (47 in.) above the water-line.

The conning-tower, of elliptical shape, 3890 millimetres by 3200 millimetres (153 in. by 126 in.) internal dimensions, stands on a strong foundation upon the deck under the lower bridge. The wall-plates have a thickness of 140 millimetres (5.51 in.), the plate protecting the entrance being 90 millimetres (3.54 in.) thick. All are made of hardened nickel steel. The floor and ceiling are formed of 25-millimetre (1-in.) ship armour-plates. The portions of the floor and ceiling near the compass are made of chrome nickel steel.

An armoured trunk, made of forged steel 70 millimetres (2.76 in.) in thickness, and having a diameter of 590 millimetres (23 in.), protects the

THE PARIS AUTOMOBILE EXHIBITION.

(*For Description, see Page* 206.)



FIGS. 42, 43, 44. FOUR-CYLINDER MOTOR CARRIAGE; MESSRS. HAUTIER AND CO.

signal wires and communication tubes between the armoured deck and the floor of the conning-tower.

The armour on the boiler uptakes and funnel base between the armoured deck and the intermediate deck is of a thickness of 40 millimetres (1.58 in.), and consists of a lower layer of water-tight ship-plates of 10 millimetres (0.39 in.), and an upper layer of 30 millimetres (1.18 in.) of unhardened nickel steel.

ARMAMENT AND AMMUNITION TRANSPORT.

While two 15-centimetre guns are mounted in each of the turrets forward and aft, one is placed in each casemate on the upper deck at the four quarters (Fig. 3), the remaining four being placed on the boat deck, and protected by shields (Fig. 2). The position of the twelve 7.5-centimetre guns is also shown on the deck plans.

The disposition of the guns is such that a uniform and strong fire can be maintained from bow and stern, while the broadside is heavy for this size of ship. Four of the 15-centimetre guns, four of the 7.5-centimetre and two of the 4.7-centimetre guns train forward; sternward there point four of the 15-centimetre, two of the 7.5-centimetre, and four of the 4.7-centimetre guns. From each of the broadsides there can be simultaneously fired eight of the 15-centimetre, six of the 7.5-centimetre, and four of the 4.7-centimetre guns. The revolving guns turn through an arc of 240 deg.; the casemate and side guns have a radius of 120 deg.

The eight 4.7-centimetre guns have been distributed as follows:

- Two on the upper deck, available for the stern fire.
- Two on the after bridge.
- Two on the forecastle.
- Two on the upper deck, pointing forward.

As shown in Figs. 2 and 3, they have all a range of 120 deg This effective distribution of the

THE PARIS AUTOMOBILE EXHIBITION.

(*For Description, see Page* 206.)

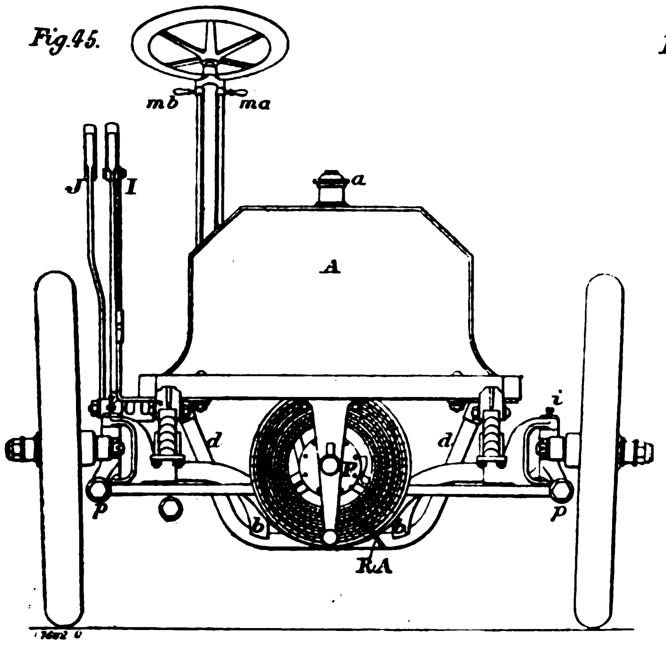


FIG. 45. FRONT ELEVATION OF CAR.

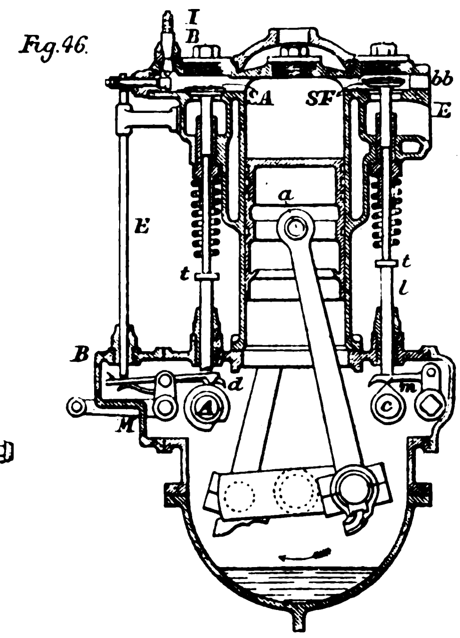
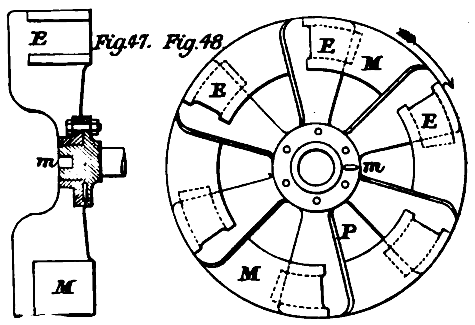
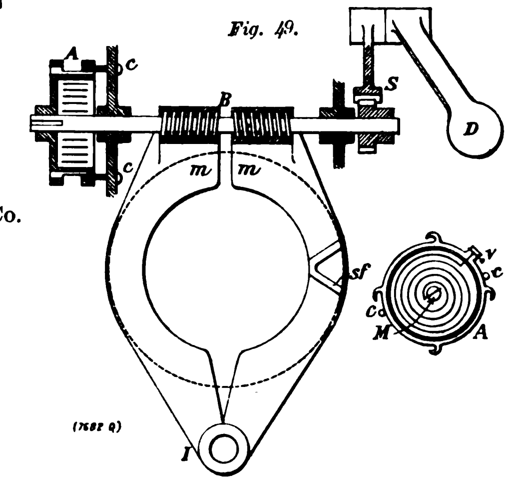
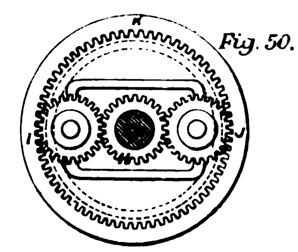


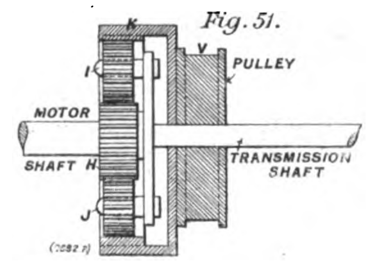
FIG. 46. MOTOR; MESSRS. HAUTIER AND CO.



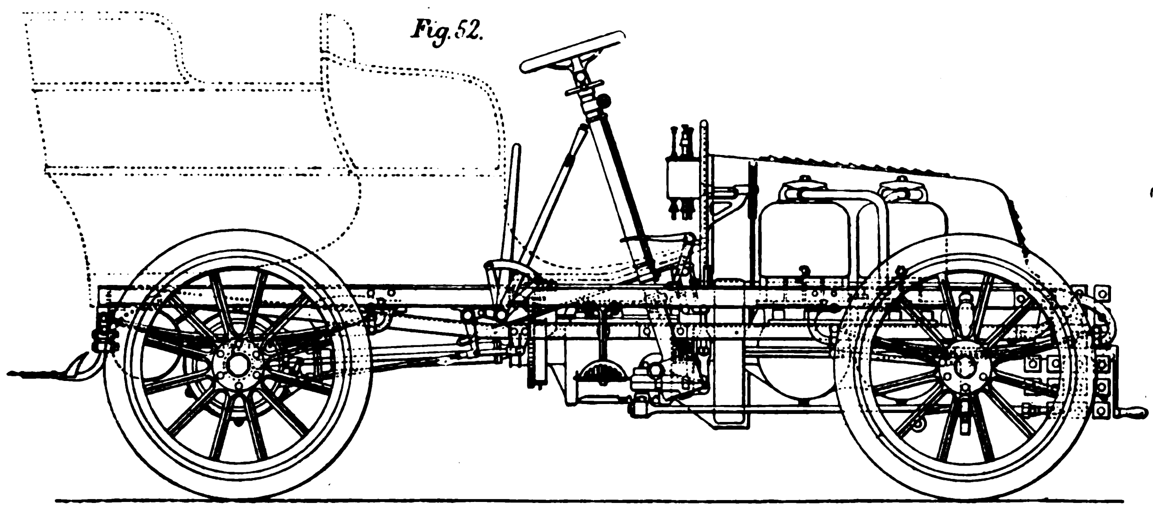
FIGS. 47 AND 48. FLYWHEEL; MESSRS. HAUTIER AND CO.

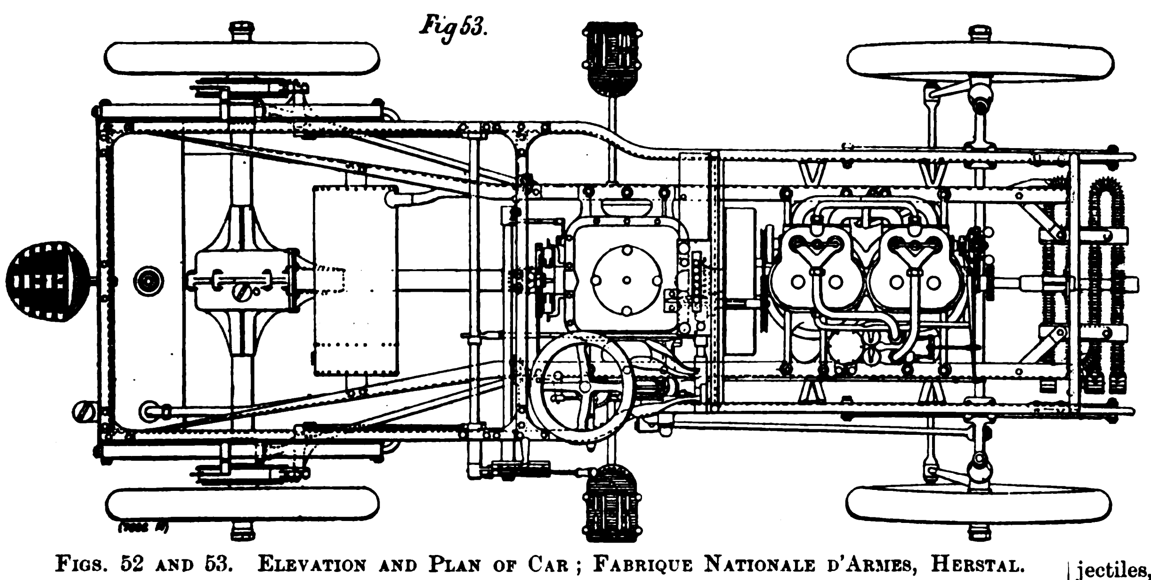






FIGS. 49, 50, AND 51. ENGAGING GEAR; MESSRS. HAUTIER AND CO.





FIGS. 52 AND 53. ELEVATION AND PLAN OF CAR; FABRIQUE NATIONALE D'ARMES, HERSTAL.

ordnance is enhanced by the considerable elevation at which the guns are placed. Their levels are :—

Front turret, 9.15 metres (30 ft.) above water-line.
Front casemates, 7.75 metres (25.5 ft.) above water-line.
Broadside guns, 5.40 metres (17¾ ft.) above water-line.
Rear casemates, 5.40 metres (17¾ ft.) above water-line.
After turret, 8.45 metres (27¾ ft.) above water-line.

Particular care has been bestowed on the ammunition transport. There are the following ammunition hoists :—

For 15-Centimetre Guns :—
Two hoists for the turrets.
Four for the casemates.
Two for the upper deck guns.

There is, further, one hoist for every three of the 7.5 or 4.7-centimetre guns.

All these hoists are worked electrically, but can be operated by hand; and there are, further, spare hand-hoists. The electrical appliances permit of supplying each 15-centimetre gun with six charges per minute, each 7.5-centimetre gun with twelve, and each 4.7-centimetre gun with twenty shots per minute. An ammunition transport passage has been built under the upper deck, by means of which each of the respective guns can easily and conveniently be served from one hoist. The 15-centimetre projectiles are transported four at the time, in metal baskets, complete with explosive charge; the 7.5-centimetre projectiles, sixteen at the time, likewise with powder. The preparatory ammunition is stored on the upper deck in spacious boxes for all calibres. All these arrangements, the distribution of the guns, the efficient hoists, and the rapid and convenient transport of the projectiles, make the cruiser eminently fit for offensive warfare.

The torpedo outfit of the Bogatyr comprises two lateral submerged tubes, placed between the rear and the middle boiler-rooms (Fig. 17); four tubes above the water-line; two of these permit broadside attack, one being placed on the first intermediate deck, near the engine-pit; the other two are fixed respectively in the stem and stern-post. The torpedo ammunition consists of 14 Whitehead torpedoes. Torpedo nettings are provided for each side (see Fig. 4).

SPACE DISTRIBUTION IN THE SHIP.

The length of the cross-bunkers, engines, and boilers aggregate 58 metres (190 ft.)—*i.e.*, 45.7 per cent. of the total length of the vessel). The longitudinal bunkers have a length of 41 metres (134.5 ft.). The remaining space below the armoured deck in the after part is utilised for the ammunition chambers and the Brown steam steering engine; the fresh-water tanks and the oil tanks have also been placed in this portion, below the I-platform deck. Forward there is, in addition to ammunition magazines, space for the provisions for the crew, and, further, the cooling plant. The torpedo-tubes are built into the platform deck, between the after and the intermediate boilers; below is the middle ammunition chamber (Figs. 1, 6, and 7).

The space above the armoured deck, up to the intermediate deck, is utilised for various purposes in the following order, reckoning from aft to fore: Provisions for commander and officers; boats for the crew; holds for the torpedo nets, &c.; coal bunkers; provisions for the crew; ammunition chamber; engine stores; chain boxes; and boatswain's inventory. On the deck plans reproduced on our two-page engravings, however, each item is clearly marked, so that the reader will easily be able to follow the details.

The lower deck (Fig. 4) accommodates aft the stern torpedo and the officers' cabins, baths, &c. In the middle portion are the cabins and mess for the deck officers, as well as the exceptionally large engineering workshop, and the wash and bath-rooms for the stokers and crew. The space extending from the after boiler uptake is exclusively reserved for the crew; we find here also the large hospital.

The poop, which has a length of about 30 metres (100 ft.), contains the state-rooms of the commander and the first officer; further only the officers' dining-room (Fig. 3). The forecastle is fitted up for the crew, as shown in Fig. 3.

All the cabins and social rooms are unusually spacious for a cruiser.

THE AUXILIARY MACHINERY.

The anchor-hoisting gear, with its three capstan-heads, is mounted on the upper deck, and is driven from a steam engine situated on the armoured deck. The centre one of the three capstan spindles is carried through the forecastle deck, and there is one capstan on this deck as well (Fig. 2). This capstan is worked by hand. The whole machinery is sufficiently powerful to pull the anchor out of firm ground with steam of 8 atmospheres (114 lb.) pressure, and to raise it, together with its chain of 100 metres (330 ft.). At the maximum load the gear must raise the chain at a speed of 12 metres (40 ft.) per minute.

The stern capstan stands on the rear end of the poop; it is fitted for steam or hand power, and is stopped by means of a pinching mechanism.

The boat outfit consists of:

Steel.			
2 steam launches	12.8 m.	(42 ft.)	in length.
1 long boat...	11.58 ,,	(38 ,,)	,,
1 working cutter	9.14 ,,	(30 ,,)	,,
1 motor boat	11.00 ,,	(36 ,,)	,,
Wood.			
1 officers' cutter	9.14 ,,	(30 ,,)	,,
1 commander's gig ...	8.43 ,,	(27¾ ,,)	,,
1 life-gig	8.53 ,,	(28 ,,)	,,
2 yawls	6.10 ,,	(20 ,,)	,,

10 boats in all, and their positions on board are shown on the boat deck (Fig. 2).

The steam launches are raised and lowered with the aid of a boom; the operation of the boom and the swinging of the boat is effected by means of two powerful windlasses, placed on the upper deck in front of the poop (Fig. 3).

The steam steering engine, of the Brown type, is so dimensioned that, with an admission pressure of 10 atmospheres (142 lb.) the helm can be turned from 35 deg. on the one side to 35 deg. on the other, within 30 seconds, when the ship is running at a speed of 23 knots. There is a spare hand steering gear. The steam steering gear is actuated by motors from a distance with the aid of: 1. A hand-wheel in front of the apparatus. 2. A hand-wheel in the front conning-tower. 3. A hand-wheel on the front upper bridge. The change-over slide of the mechanism can further be actuated electrically from the conning-tower.

The electric installation supplies light to all the rooms in the cruiser, the signal lamps, compasses, and the search-lights of a diameter of 75 centimetres (30 in.). There are four steam-driven dynamos, each of 640 amperes, at 105 volts, in the auxiliary engine-room below the armoured deck, and two more dynamos, each of 320 amperes, above the armoured deck (Fig. 6). The lamps number altogether 850.

The signal service comprises 35 telegaphones, speaking-tubes, and telegraph apparatus of approved German systems.

The high-pressure steam-heating plant adopted is that of the German Navy.

There are two galleys for the officers and for the men. The former has a capacity for 40 officers, the latter for 550 men. Among the appliances we notice two baking ovens and five large samovars.

VENTILATION.

Each ammunition magazine is fitted with a separate ventilator, which could renew the air contained in the chamber six times within one hour. In rooms which are likely to become very hot, the whole air is renewed every 3 or 4 minutes. In all the other rooms the air renewal takes place in periods of 10 or 12 minutes.

The boiler-rooms alone contain fourteen fan engines. The engine-rooms receive their fresh air through two large ventilating shafts, and there are, further, two electric fans. Those rooms above water level, whose efficient ventilation is especially desirable, are fitted with Utley windows. The gases from the bunkers are discharged into the funnels.

(*To be continued.*)

THE PARIS EXHIBITION OF AUTOMOBILES.

(*Continued from page* 169.)

MESSRS. DARRACQ AND Co., of Suresnes, had a number of automobiles of 8, 12, and 20 horse-power. The motors have either two or four cylinders; the valves are worked positively, and a throttle valve is fitted in the inlet pipe. The radiators are of the beehive pattern. The underframe of their 12 horse-power vehicle is of wood with iron fittings, and in front are grouped the motor, the receivers, the radiator, &c. The motor is vertical, and its speed varies from 200 to 1220 revolutions. The consumption of essence is about .28 pint per mile. The rear axle is driven by the large steel bevel-wheel of the differential gear; it revolves in a steel tube fitted to the differential gear casing.

We illustrate in Figs. 36 to 39, page 201, two automobiles and sections of the motor built by the Gobron-Brillié Company, of Boulogne-sur-Seine. This firm manufacture a special type of methylated-spirit carburettor, mechanically controlled. The methylated-spirit supply is governed by cells cut round a conical plug which turns in a shell. The motor is stated to work satisfactorily at speeds varying from 200 to 1200 revolutions. It consists, as shown in Figs. 38 and 39, of two vertical cylinders, m and m^1, placed side by side and open at both ends. The cylinders contain four pistons, e, e^1 and $f\,f^1$, coupled two by two, which move in opposite directions, the explosion taking place in the chamber m and m^1, at the central part of the cylinders. The rods of the lower pistons work the crank-shaft direct at c and c^1, the top pistons working it through a crosshead h and connecting-rods t and t^1. The motor is four-cycle, and the cycles are alternate in order to give a motive impulse per turn. The Gobron-Brillié underframe is either of wood, with iron fittings, or metallic throughout. The motor is placed in various positions, and the transmission is either by chain or toothed-wheel gearing. The automobiles shown by these manufacturers were of 18 and 27 horse-power; and it is stated that they have a racing car now in course of completion carrying a 100 horse-power motor with four cylinders and eight pistons.

The Gladiator Company, of Pré St. Gervais, near Paris, exhibited several cars. The frame is of wood, with cross-stays for stiffening. All the mechanical parts are carried on a false frame; the motors are generally of the Aster or Clément system.

Messrs. C. E. Henriod, of Neuilly, had a very complete exhibit; they are well-known manufacturers, especially, perhaps, in conjunction with their "Universal" axle, which acts as a speed transformer, and can be used with any motor. They claim as advantages for this axle the reduction in the number of mechanical parts, a maximum effect for the motor, great facility of erection, and the doing away of all twisting strains. The Henriod cars are shown in elevation and plan in Figs. 40 and 41. The *châssis* is built up of steel tubes; the motor is in front and the change-speed gear in the middle. The motor is with two or four cylinders, and the governor allows the speed to vary from 200 to 2000 revolutions. Messrs. Henriod have recently completed a 60 horse-power four-cylinder motor.

We illustrate in Figs. 42 to 51, pages 204 and 205, various detail parts of the automobiles built by Messrs. Hautier and Co., of Paris. These manufacturers appear to have aimed at simplifying their types by reducing the number of pipes to a minimum. They build four, two, and one cylinder motors. The *châssis* is of steel channels, and is slightly curved; when under no load the rear rises slightly, horizontality being obtained when it is loaded. The centre of motion is on the front axle; the motor flywheel is in the front of the cylinders. The crankshaft and the drive and change-speed gear are enclosed in a large casing. When the motor shaft runs at 1000 revolutions, the speed of the driving-shaft is only 200. The motor speed is not slowed down for throwing in the differential gear; the working bevel pinion and the toothed rim on the axle gearing in each other are equal in diameter. The coupling constitutes a universal joint, to which are connected the motor shaft and the driving-shaft. A pinion is keyed on the end of the motor shaft (Fig. 50, page 205), the transmission shaft ending in a double arm fitted with two loose pinions gearing with that on the motor shaft. The whole device is contained in a box fitted with an inside toothed rim, which remains geared with the two pinions of the double arm. When the motor is working, the first pinion effects the rotation of the two loose ones; the transmission shaft remains motionless; but the toothed rim revolves round it, driven by the two pinions. In this case the mechanism is out of gear. But when pressure is exerted on the drum fitted on the side of the box that contains the toothed rim, the latter is held fast; the two loose pinions do not turn round their journals, but round the toothed rim, carrying with them the transmission shaft. The speed of these pieces is in proportion to their diameter, generally in the ratio of 1 to 5. The progressive effect of the coupling-up gear is insured by the more or less sliding action of the drum in the jaws until the latter hold it fast. The jaws (Fig. 49) are jointed at their lower part and are fitted at top with right and left-handed screws at B; a strong spiral spring, shown at A and M, tends to cause the spindle to turn for the tightening action. The box containing the spring is held fast at c and c. The opening of the jaws for disconnecting is obtained by the action of a foot lever; this is connected to a rack which gears in a pinion keyed on the other end of the spindle. The motor flywheel acts also as a ventilator in conjunction with the radiator, and to this effect it is constructed as shown in Figs. 47 and 48. The motor is shown in section in Fig. 46, the references to which are the following:—

B. Ignition interrupter.
m. Follower for exhaust cam.
d. Follower for inlet cam.
b b. Socket for ordinary ignition plug.

The cylinders are 3.93 in. in diameter, with a 4.52 in. stroke. The governor acts on the time of lift of the valves, and not on the height of lift; the compression remains, therefore, the same. Fig. 45 is a front elevation of the Hautier car, in which the references are:—

A. Water-tank.
b, b. Motor supports.
d, d. Tubular cradle.
i, i. Journal lubricators.
m a. Carburetting handle.
m b. Ignition handle.

The Belgian Gun Factory, of Herstal, near Liège, were among the foreign exhibitors, and their display contained motor-bicycles of an improved type. In these, the motor—of 2 horse-power—is placed vertically in the lower part of the frame and in a closed casing, formed of the lower front tube. The carburettor is automatic, of the constant-level type. With regard to automobiles, the Herstal factory, after a series of experiments which extend over a number of years, have adopted a type, of which the following is a brief description. The motor is vertical, with four cylinders, of 16 horse-power nominal, and its normal speed is only 650 revolutions. It is therefore practically silent working and runs very smoothly, with but very little wear and tear. Each pair of cylinders is cast with a water-jacket, oval in section; the cylinders are bolted to a crank casing made of partinium, the latter being supported by a false frame fitted to the underframe. The motor weighs about 33 lb. per horse-power. The gas inlet is throttled by a tubular regulator controlled by a rod, the latter being connected to a slide actuated by the governor. A second rod prevents the governing action when a higher power, up to 20 horse-power, is required of the motor. The inlet pipes are kept at a constant temperature by a bell-shaped heating device, which contains metal filings kept hot by the escape gases. The ignition device is placed within sight of the driver, in the rear of the hood, under a glass cover. As is usually the case, there are three speeds, and the maximum speed is by direct gearing. The change-speed gear is of a special type, and consists of two triangular pieces which can be made to turn to the right and to the left, and which are cut in the centre to afford space to the third shaft of this gear. When the two triangular pieces are vertical the gearing is direct by the central shaft.

According as they are shifted, different wheels are made to gear with the toothed wheels on the central shaft, and corresponding speeds are obtained. The changing of the speed is carried out noiselessly. An expansion joint is fitted on the transmission gear. Special precautions have been taken to prevent, as far as practicable, all shocks on the steering mechanism; and with this object the pivots have been given a suitable incline. Figs. 52 to 56, page 201 and 205, show the Herstal car and carburettors.

(To be continued.)

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

(FROM OUR OWN CORRESPONDENT.)

(*Continued from page* 143.)

FINE SCREW THREADS.

The next paper read was a plan for "Finer Screw Threads," by Charles T. Porter. It is due to Mr. Porter's position and experience that he should have the full use of ENGINEERING's columns, especially as he is never prolix; hence we present this paper practically in full:—

1. I have for several years felt a growing conviction that the pitches of our machine screw threads are far too coarse, and ought to be changed. They reduce the area of the bolt unnecessarily. The Sellers thread made a considerable gain in this respect; but in the larger bolts the reduction of area is still two or three times as much as it needs to be. Again, the inclination of the thread permits the nut to be jarred loose easily. For

Fig. 1.

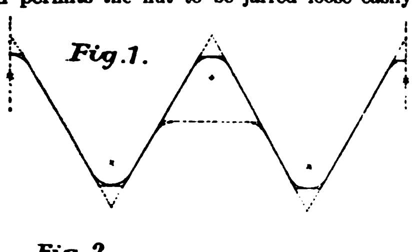


Fig. 2.

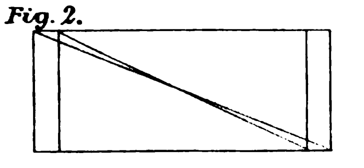
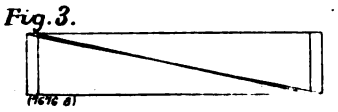


Fig. 3.



these two reasons threads of much finer pitch seem to be called for. Finer threads will also be stronger to resist stripping, the circle on which the shear must take place being larger. This, however, is of no practical consequence, as the strength of threads to resist stripping in nuts of standard height is now more than twice the strength of the bolt.

2. The gain in strength of the bolt by the use of finer threads is shown in detail in the following table, and the reduction of the inclination is illustrated in the diagrams. The system there represented is one that I have contemplated for my own use. Other engineers may think it will be useful for them also.

It will be observed that fractions and odd numbers are avoided, and that the coarsest thread is six to the inch. Sharp angles at the bottom of threads—even the obtuse angles of 120 deg. in the Sellers thread—invite fracture, especially in steel. A very small arc, preserving continuity of surface, will remedy this defect. In this system the angles will be rounded and filleted to the radius of .0045 in.

Proportions of Porter's Screw Threads.

Number of Threads to the Inch.		Diameters			Areas			Increase of Area.	
		Of Bolt.	At Bottom of Thread.		Of Bolt.	At Bottom of Thread.			
Present.	Proposed.	Inches.	Present.	Proposed.	Square Inches.	Present.	Proposed.	Square Inches.	Per Cent.
			in.	in.		sq. in.	sq. in.		
20	24	1/4	.185	.1958	.04908	.027	.03	.003	11.11
18	24	5/16	.240	.2583	.07669	.045	.0525	.0075	16.66
16	22	3/8	.294	.3160	.1104	.068	.0785	.0105	15.44
14	22	7/16	.344	.3785	.1503	.093	.1125	.0195	20.96
13	20	1/2	.400	.435	.1963	.126	.1488	.0228	18.09
12	20	9/16	.454	.4975	.2485	.162	.1943	.0323	20
11	18	5/8	.507	.5525	.3067	.202	.240	.038	18.81
10	18	3/4	.620	.6775	.4417	.302	.361	.059	19.53
9	16	7/8	.731	.794	.6013	.420	.495	.075	18
8	16	1	.837	.919	.7854	.550	.663	.113	20.54
7	14	1 1/8	.940	1.0315	.9940	.695	.837	.142	20.43
7	14	1 1/4	1.065	1.1565	1.227	.895	1.051	.156	17.43
6	14	1 3/8	1.160	1.2815	1.484	1.06	1.289	.229	21.6
6	14	1 1/2	1.284	1.4065	1.767	1.297	1.555	.258	19.89
5 1/2	12	1 5/8	1.389	1.5165	2.073	1.518	1.808	.290	19.1
5	12	1 3/4	1.490	1.6415	2.405	1.743	2.115	.372	21.34
5	12	1 7/8	1.615	1.7665	2.761	2.05	2.45	.400	19.51
4 1/2	12	2	1.712	1.8915	3.141	2.305	2.81	.505	21.9
4 1/2	10	2 1/4	1.962	2.12	3.976	3.025	3.53	.50	16.69
4	10	2 1/2	2.175	2.37	4.908	3 720	4.41	.69	18.54
4	10	2 3/4	2.425	2.62	5.939	4 62	5.38	.76	16.45
3 1/2	10	3	2.628	2.87	7.068	5.43	6.47	1.04	19.15
3 1/2	10	3 1/4	2.878	3.12	8.295	6.52	7.65	1.13	17.33
3 1/4	8	3 1/2	3.100	3.337	9.621	7.55	8.75	1.20	15.89
3	8	3 3/4	3.317	3.587	11.044	8.65	10.10	1.45	16.76
3	8	4	3.566	3.837	12 566	10.00	11.58	1.58	15.8
2 7/8	8	4 1/4	3.798	4.087	14.186	11.33	13.13	1.80	15.88
2 3/4	8	4 1/2	4.027	4.337	15.904	12.75	14.80	2.05	16.07
2 5/8	6	4 3/4	4.255	4.534	17.720	14.20	16.15	1.95	13.73
2 1/2	6	5	4.480	4.784	19.635	15.78	18.00	2.22	14.06
2 1/2	6	5 1/4	4.730	5.034	21.647	17.52	19.90	2.38	13.58
2 3/8	6	5 1/2	4.953	5.284	23.758	19.28	21.90	2.62	13.58
2 3/8	6	5 3/4	5.203	5.534	25.967	21.25	24.05	2.80	13.18
2 1/4	6	6	5.423	5.784	28.274	23.10	26.3	3.20	13.85

The accompanying outline (Fig. 1) represents the finest thread, twenty-four to the inch. This arc, of .0045 in. radius, it will be seen, rounds this thread completely. The bottom of the coarsest thread, six to the inch, is also represented, on the same scale, in a dotted line. It shows the efficiency of this arc to avoid the breaking angle in all threads. This last feature I shall apply also to pipe threads.

3. It will be observed that in the bolts most commonly used the increase of strength averages about 20 per cent., and that in all the bolts above 2½ in. the strength of each bolt, threaded on the system here proposed, will equal or exceed the strength of the next larger bolt, threaded on the existing system.

4. The reduction of inclination effected by the proposed system will be best shown by the graphical method. For this purpose I have selected the 1-in. bolt. If a right-angled triangle be drawn, the base of which is equal to the circumference of the top or of the bottom of the thread, and the height equals the pitch, the hypothenuse will represent the inclination of the thread and its length in one revolution.

But these angles are too small for distinct illustration. In Figs 2 and 3 I have therefore drawn the diagrams to two scales. The horizontal scale is full size; the vertical scale is ten times full size. In these the relation of the inclinations to each other can be accurately observed. It will be seen that while the reduction of the inclination at the top of the thread in this bolt is 50 per cent., its reduction at the bottom of the thread is considerably more than 50 per cent. Any one who is so inclined can compute these inclinations in each of the thirty-four bolts. The above illustration seems sufficient for the purpose of my argument.

5. In conclusion, I take pleasure in acknowledging my obligation to Mr. H. F. J. Porter for valuable aid in the preparation of this paper; especially for the suggestion to round the angles of the threads.

PAYING WORKMEN.

The next paper was entitled "Gift Propositions for Paying Workmen," by Frank H. Richards. This paper, which was in opposition to the bonus or piecework system, seemed to rest on a series of assumptions rather than on experience. It contained imaginary conversations between the "boss" and the workmen, but omitted an important one which would undoubtedly have been the sequel to the others, and that was between the walking delegate and the men. As the paper assumes data, so this may be assumed:—"Delegate: 'See here, men, I am looking after your interests; don't you see your employer is making all the profit on your extra amount of work, and the union has fixed your output at ten wheels and if any chap turns out one more, he'l' be fined or expelled; and if the boss don't like it, we will order a strike till he does." In this manner the lazy workers are always protected against the energetic. There were several written discussions to the effect that the premium system was always in favour of the energetic man. Another argued that the piece-work system frequently showed that piece-work based on day labour was too high, and that without cuts it was unpractical, so that the premium plan avoiding this was a satisfactory solution. Another said:—

Under this system the objects are to find out the best way of doing work, put the results of the investigation in the form of instruction cards, then offer the workman sufficient bonus for working according to these instructions to make it worth his while to do so. He stated that if the work is light, this bonus may be as low as 20 per cent.; if the work is heavy, it must be 30 to 50 per cent.; and if conditions are unpleasant, it may need to be as high as 80 per cent. He gave his experience, and particularly described some systems of planning work and of getting work through the shop which tended to result in increase of production and prevention of delay, due to the waiting of one department on another for material or parts.

One of the speakers stated that he had inaugurated the premium plan in many places in which it had been taken up, and that he believed that the best way was to be honest with the workman, paying him well, and to expect him to be honest. That the thing which manufacturers wanted in many cases was not a system of increasing production slightly, but a system of finding out costs quickly. The speaker further argued that the best way to get the co-operation and interest of the workman is to make him a stockholder.

This view seems to have found favour with the greatest organisation of modern times—the United States Steel Corporation—and after a little hesitancy always incident to accepting an offer from an employer to an employé for the latter's benefit, due to suspicion that it is not all it seems, the employés of that corporation are subscribing freely to the stock. Your correspondent always maintained, when he had control of men, that the alliances should be between the company and its employés, and not among employés hired by various and rival concerns. He succeeded at one time in establishing just such an alliance, while superintendent of a mine, and it worked to mutual advantage as long as he was in charge. This would be a most happy solution of the labour question if it could be applied on a large scale, and the United States Steel Corporation's plan will be watched with much interest by all employers of labour and their employés as well. A little more liberal spirit on the part of the employers, and a modicum of confidence on the part of the employés, will go far to solve the vexed relations of labour and capital.

DEFLECTION OF BEAMS.

The final paper for the morning session was entitled "The Deflections of Beams by Graphics," by W. Trinks.

This is an argument for the design of machinery on the basis of deflection permissible rather than strength, and for the use of graphical methods for determining the amount of deflection. The working out of the equations and their reduction to graphical form are shown, and also the application of these graphical forms to the solution of a problem on the deflection of a shaft. The system involves the understanding of the methods and equations of the calculus in order to follow the working out of the principle; but, like most graphical methods, the practical application can be reduced to drawing-board operations, which, although somewhat complex, are very much easier than the analytical computations for the same purpose. Two different methods of graphical working are shown—one by rectangular ordinates, the other by a polar method.

The paper, being an argument based on mathematics, cannot be condensed, nor will space permit its presentation in full. Those interested can obtain it from the secretary of the society.

SMOKE PREVENTION.

One of the topical questions followed: "Smoke Prevention." This was certainly in New York City a burning question, and the Board of Health has had it under consideration all last fall, since we could not obtain anthracite coal, and must either use bituminous coal or stop business. The Langer system of Germany was cited:—

In this system heated air is introduced above the fire, and the firing is done at regular and stated intervals, only a small amount of coal being thrown on at a time, so that the furnace is never cooled down, the introduction of cold air, lowering the temperature of the furnace, being what

THE RUSSIAN FIRST-CLASS CRUISER "BOGATYR."

CONSTRUCTED BY THE STETTINER MASCHINENBAU ACTIEN-GESELLSCHAFT VULCAN, BREDOW.

(*For Description, see Page 202.*)

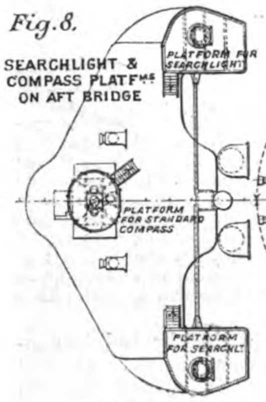


Fig. 8. SEARCHLIGHT & COMPASS PLATF^MS ON AFT BRIDGE

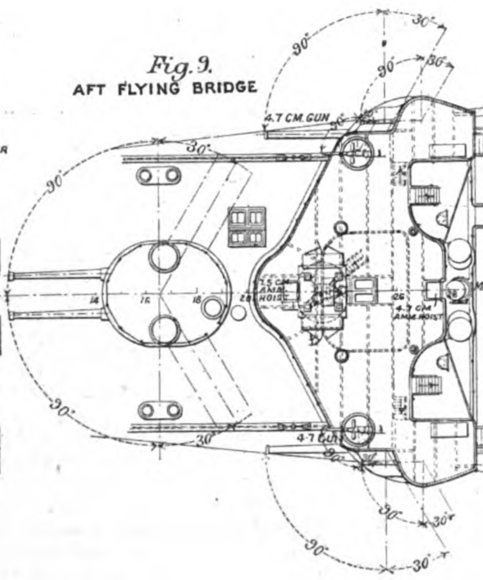


Fig. 9. AFT FLYING BRIDGE

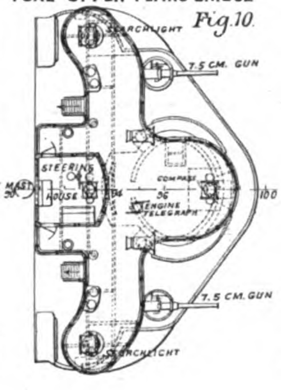


Fig. 10. FORE UPPER FLYING BRIDGE

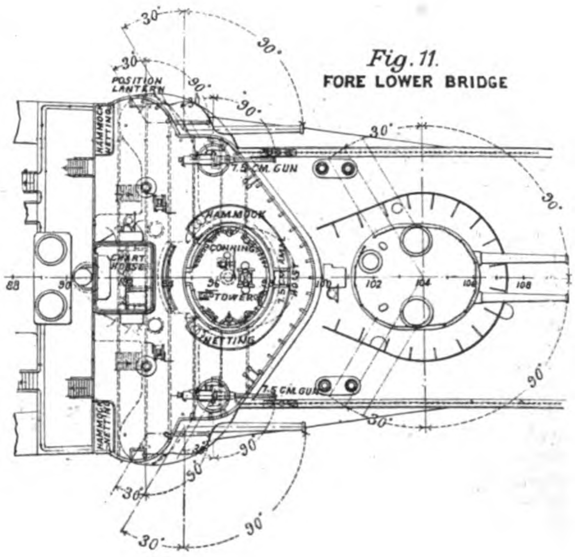


Fig. 11. FORE LOWER BRIDGE

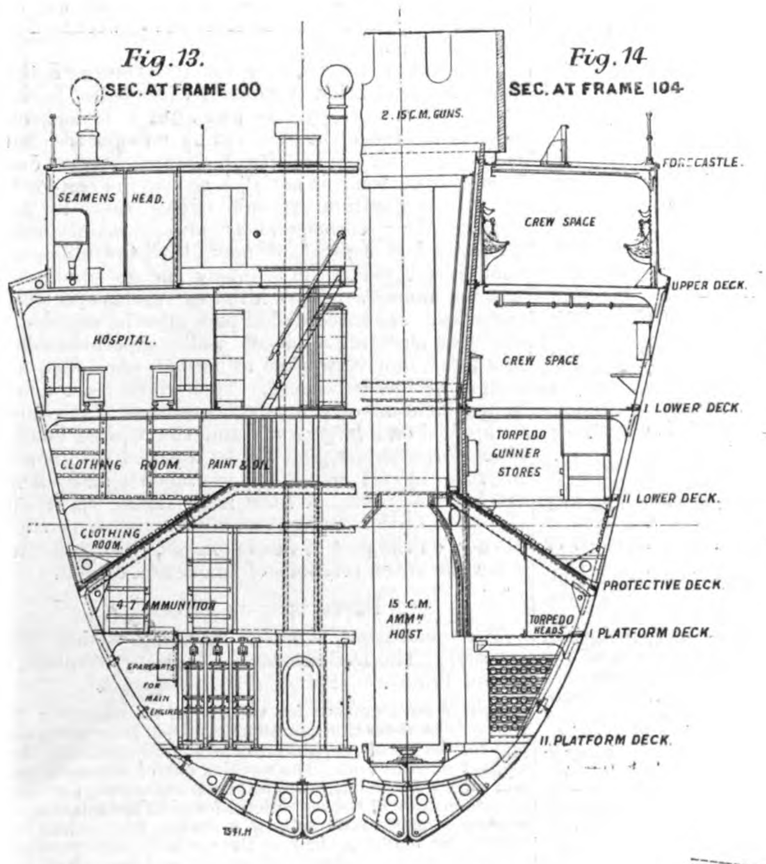


Fig. 13. SEC. AT FRAME 100 — Fig. 14. SEC. AT FRAME 104

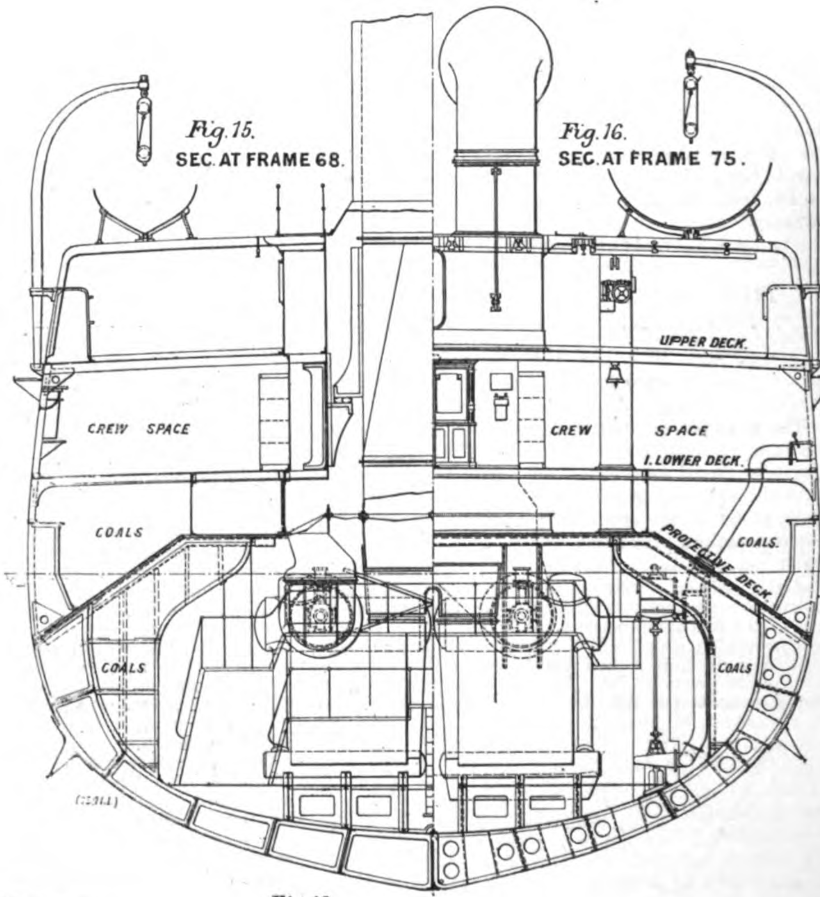


Fig. 15. SEC. AT FRAME 68. — Fig. 16. SEC. AT FRAME 75.

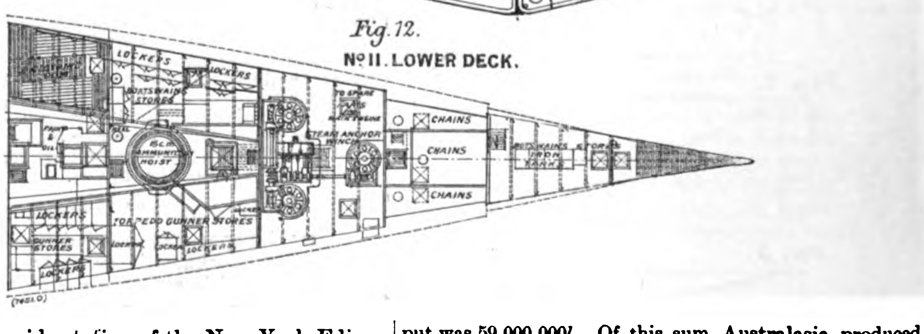


Fig. 12. Nº II. LOWER DECK.

causes smoke. In some investigations made it was found that when the boiler door was opened until smoke appeared at the top of the furnace, it took about half a minute after the door was closed for the furnace to become heated, so that no smoke appeared; by this was meant that there was absolutely no discoleration, although the coal in use was of poor quality.

The St. Louis method, introduced after the anti-smoke ordinance was passed, was described :—

Here the Illinois coal of low grade, which was previously fired in a thick bed all over the fire, and produced large quantities of smoke, was thrown on a space about 16 in. wide, near the front door, and, after coking, pushed back with a hoe, and spread over the whole fire. By this method only a slight grayish smoke was visible at any time coming from the chimney, and the engineer succeeded in effecting a saving of fuel over the old process.

Luncheon was then thoroughly enjoyed, and the members visited the power stations of the Inter-Urban Street Railway Company at Ninety-Third-street and East River; the Manhattan Railway Company at Seventy-Fourth-street and East River; and the Waterside station of the New York Edison Company at Thirty-Eighth-street and East River.

(*To be continued.*)

THE OUTPUT OF GOLD.—On Tuesday evening, at the Royal Victoria Hall, Lambeth, Mr. Bennett H. Brough gave a popular lecture on the world's gold mines. Notwithstanding the temporary diminution in the supply caused by the South African War, the world's gold production last year was greater than in the previous year. Mr. Brough estimates that the value of the world's output was 59,000,000*l*. Of this sum, Australasia produced 27.2 per cent.; the United States, 27 per cent.; the Transvaal, 11.8 per cent.; Russia, 10 per cent.; Canada, 6.5 per cent.; India, 3.5 per cent.; Mexico, 3.2 per cent.; Rhodesia, 1.2 per cent.; China, 1 per cent.; and other countries, 8.6 per cent. In 1898, when the Transvaal was the world's largest producer, its share in the world's output was 27.6 per cent. The present conditions and prospects of the more important mines in Africa, Australasia, United States, Canada, and other countries were discussed, the conclusion arrived at being that there were no signs of falling off in the world's gold production.

THE RUSSIAN FIRST-CLASS CRUISER "BOGATYR."

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(For Description, see Page 202.)

Fig. 17. SEC. AT FRAME 60. Fig. 18. SEC. AT FRAME 94.

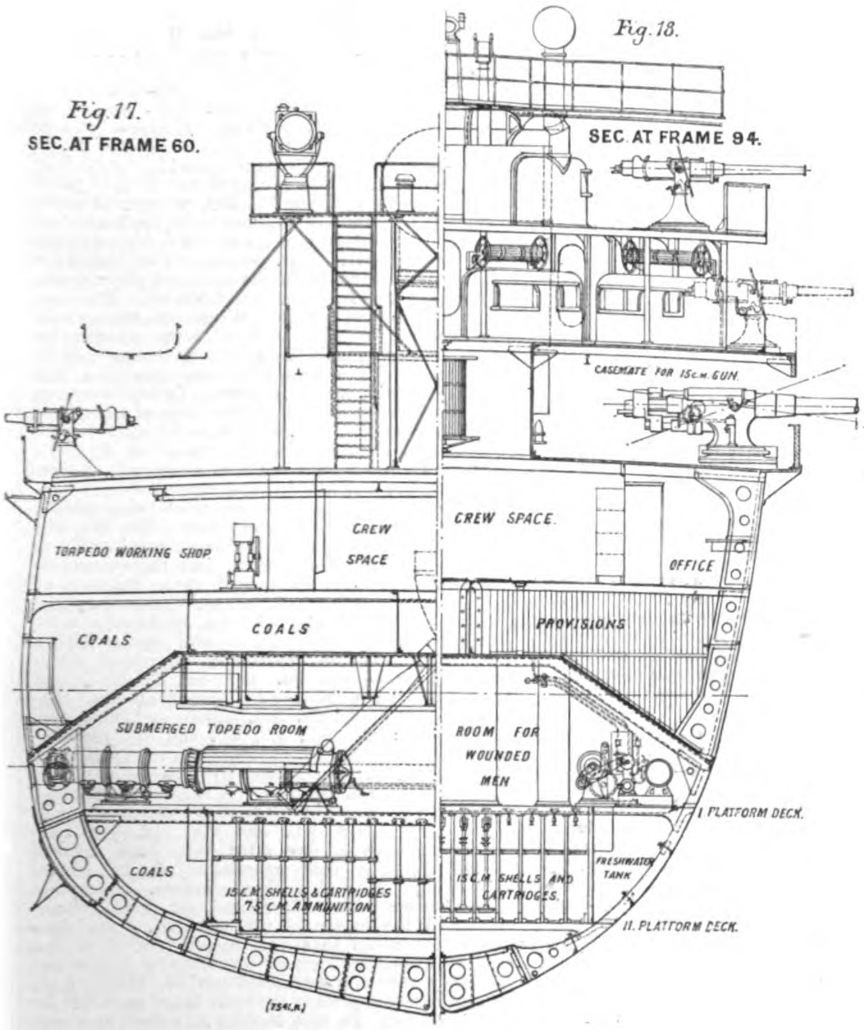


Fig. 23. SECTION AT FRAME 26. Fig. 24. SECTION AT FRAME 28.

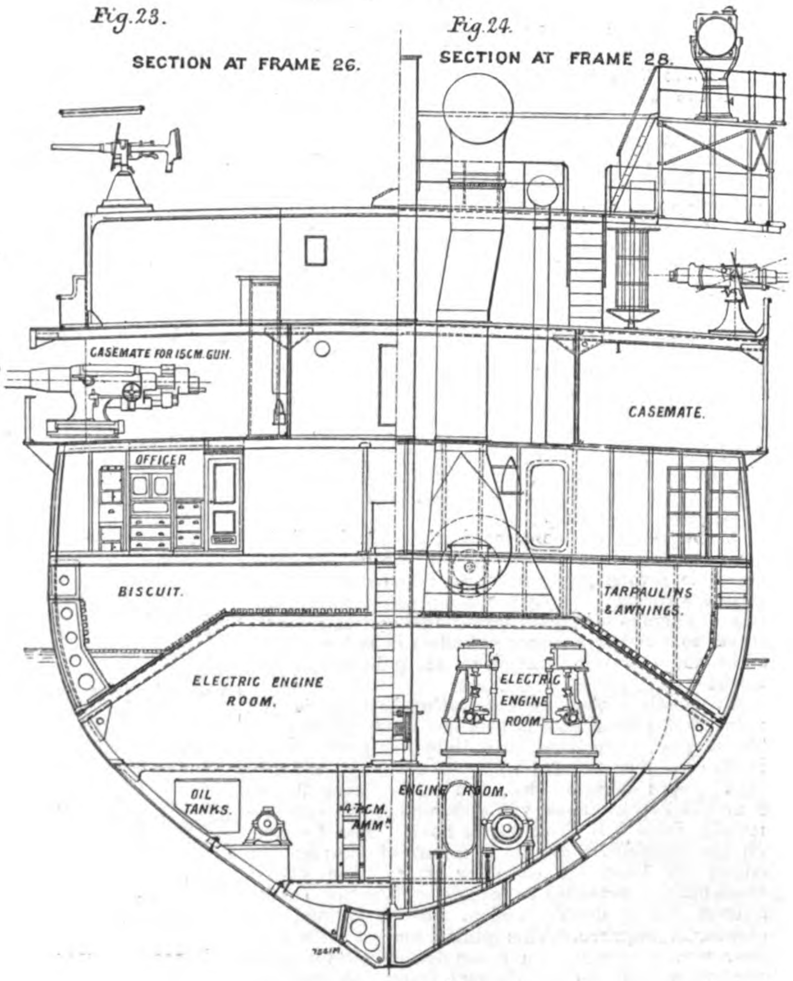


Fig. 19. SEC. AT FRAME 42. Fig. 20. SEC. AT FRAME 48

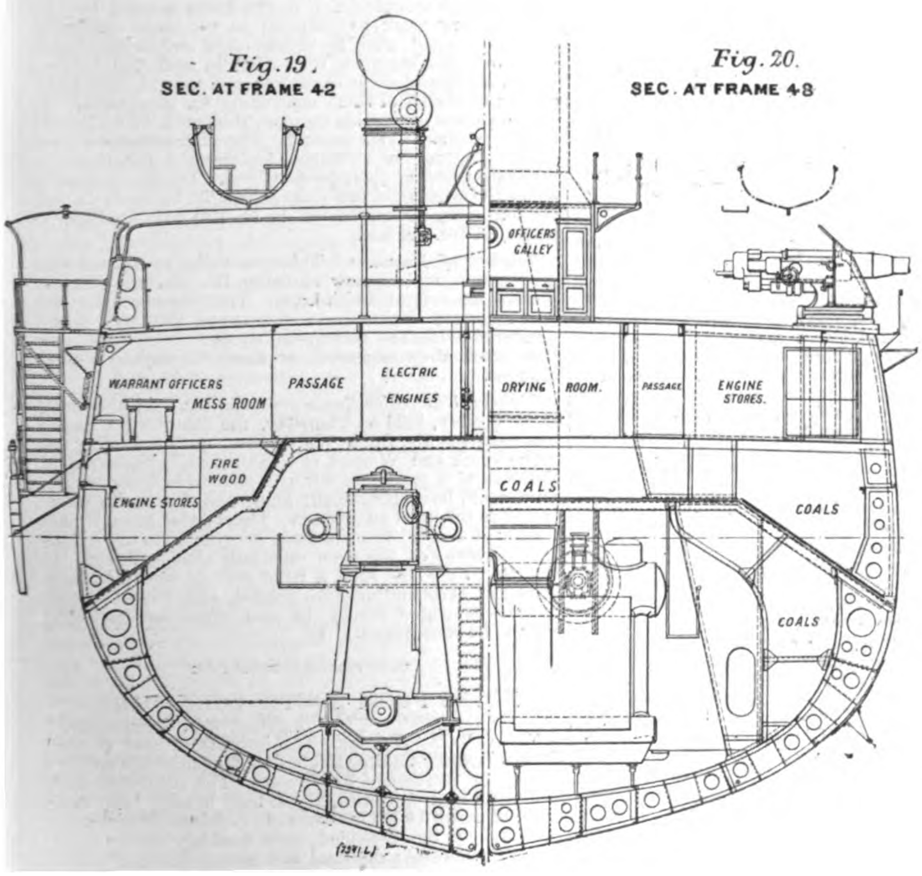
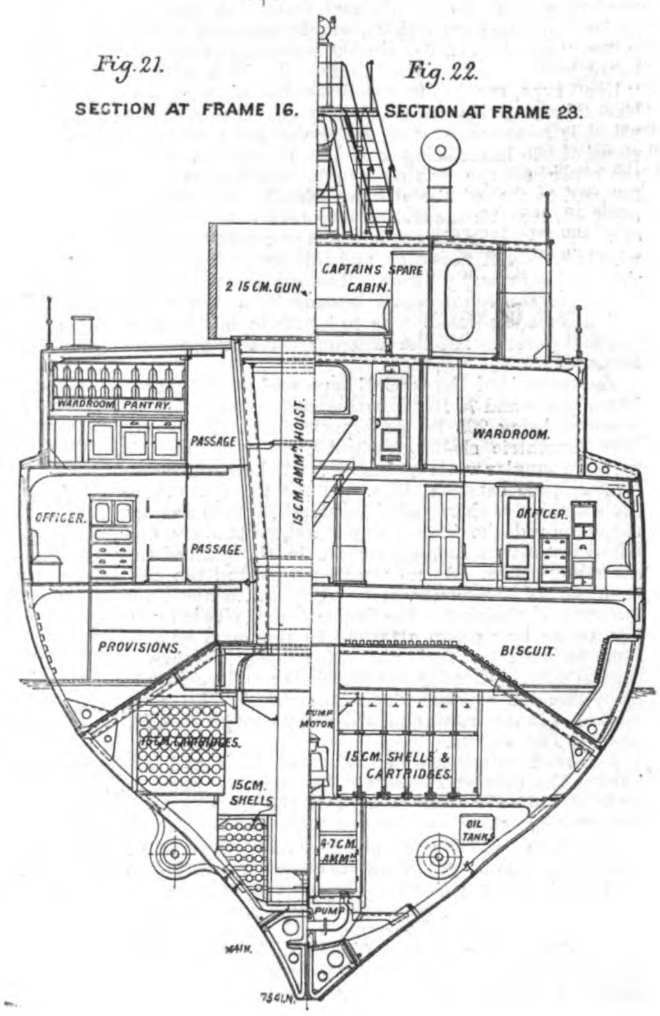


Fig. 21. SECTION AT FRAME 16. Fig. 22. SECTION AT FRAME 23.



STEAM WAGON.

On page 212 we illustrate a steam wagon exhibited at the recent Crystal Palace Automobile Show by the Straker Steam Vehicle Company, of 8, Bush-lane, E.C. As stated in our general notice of the show (see page 184 *ante*), this firm exhibited three large wagons and a *châssis*, and we then stated that we proposed to illustrate one of these vehicles later, and to give fuller details.

The Straker standard 5-ton wagon is 18 ft. long and 6 ft. 6 in. wide, the wheel-base being 10 ft. and the gauge 5 ft. 3 in. from centre to centre. With a full load the designed maximum speed is 7 miles an hour, whilst an ascending grade of 1 in 6 can be negotiated on ordinary roads. A trailer carrying 2 tons can also be drawn on fairly level roads. The frame is constructed of steel channel bars braced together by transverse members of channel steel, tee-bars, and angles. The body is constructed of timber, the construction being strengthened by angles, plates, and bends. The length is 12 ft. and the width 6 ft., thus giving an area of 72 ft. The driving axle rotates in bearings which carry the back part of the wagon, the springs being interposed, and which are connected to the frame of the vehicle by adjustable radius rods. The forward end of the frame is carried by the front axle, there being a spring cradle of special design, the arrangement of which is well shown in Fig. 2 on page 212. The axle, it will be seen, is mounted on a central pivot so that a three-point support for the frame is secured in order to relieve it from twisting strain. The central bearing is made a ball bearing in order to give ease in steering.

A compound engine is used, the cylinders being 4 in. and 7 in. in diameter by 7 in. stroke. A single eccentric reversing gear has been adopted so that the engine space may be as free as possible from valve rods. There is a by-pass for admitting high-pressure steam to the low-pressure cylinders in order to give additional power in starting on steep hills and bad roads.

A complete system for lubricating bearings is provided, and a lubricator is attached to the steam pipe. The engine is enclosed in a light dustproof casing. It can be disconnected so as to run idly, and two speed gears are provided, the ratios being 9.2 to 1 and 16.7 to 1. These will give road speeds approximately from 3 to 7 miles an hour. The flywheel on the crankshaft affords a means of turning the engine by hand for changing gear. The engine crankshaft is extended in square section and carries a steel sliding double pinion, thrown in and out of gear as required. This pinion meshes with steel gear wheels mounted on a countershaft, rotating in bearings secured to the channel frame. A sprocket pinion is on the countershaft, and by means of a compound "silent" roller chain the power is transmitted to the back axle as shown in Fig. 3. This is of the "live" type, turning in axle-boxes having phosphor-bronze bearings fitted with grease pads. The sprocket wheel is mounted on the differential gear, one bevel wheel of the latter being keyed to the back axle and the other to the driving sleeve, which is securely fastened to one of the driving wheels. An arrangement is fitted on the end of the back axle by means of which a locking-pin can be made to connect up both wheels in case of necessity, and this can be done with the wheels in any position. The axle-boxes are connected to the countershaft bearing by a radius rod which is made adjustable as to length by means of a nut and screw. All the wearing surfaces are case-hardened.

The boiler is of the vertical type, and has 2.2 square feet of grate and 70 ft. of heating surface, the working pressure being 205 lb. per square inch. There are four concentric shells arranged vertically. In this way two annular water spaces are formed, with an annular flue space between them. In the flue space there are a number of short radial tubes, which thus connect the outer and the inner annular water chambers, and afford water-tube heating surface in the path of the ascending gases. As no rivets are used in the construction of the boiler, it is easily taken apart for purposes of cleaning. The boiler is fed either by an injector or by a pump attached to the main engine. Coke is used for fuel, the firing being through a central door. There is a superheater and a reheater for rendering exhaust steam invisible. The coke bunker is in the front, and will carry enough fuel for about a 6 hours' run.

The road wheels are of mild steel, with cast-iron hubs. The driving wheels are 3 ft. 6 in. in diameter by 9 in. wide, the tyres being ⅞ in. thick. The leading wheels, which are bushed with gun-metal, are 2 ft. 6 in. in diameter by 5 in. wide, the tyres being ⅝ in. thick. The tyre plates are cut in sections, so as to provide for expansion. The steering wheel is of aluminium, and is on an inclined spindle, the steering motion being conveyed through steel worm and segment. There is a powerful block-brake which the driver can apply from his seat by a screw and a crank lever. The engine can also be reversed so as to act as a brake, and will in this way stop the vehicle on hills under all reasonable conditions.

The 7-ton wagon also shown at the Crystal Palace is of heavier and stronger build than the 5-ton vehicle, as it will transport 10 tons in all when dragging a trailer carrying 3 tons. The length is 21 ft. 6 in. over all, the wheelbase being 11 ft. 6 in. The body has an area of 84 ft., the length being 14 ft. and the width 6 ft. The engine is of the compound type, having cylinders 4 in. and 7 in. in diameter by 9 in. stroke, and runs normally at 400 revolutions per minute. It is estimated to develop about 60 horse-power. The maximum speed on the level is 7 miles an hour, and hills of 1 in 8 can be ascended. The boiler is of the same type as that described, but has 3.3 square feet of grate and 77 ft. of heating surface. The gear ratios are 22 to 1 for slow speed, and 17 to 1 for the higher speed. The driving wheels are 3 ft. 10 in. in diameter and 12 in. wide, the front wheels being 3 ft. in diameter and 7 in. wide. There is a water supply tank of 180 gallons capacity. In general design this wagon resembles the 5-ton vehicle.

SOCIETY OF ELECTRO-CHEMISTS AND METALLURGISTS.—The new Society of Electro-Chemists was successfully inaugurated on Wednesday, the 4th inst., at the general meeting held at St. Ermin's Hotel. After a few introductory remarks had been made by Mr. James Swinburne, Pres. Inst. E.E., the formal motion that the Society be formed was moved by Mr. Joseph Swan, F.R.S., and seconded by Mr. Alexander Siemens. It was stated that similar organisations for the promotion of electro-chemical science and practice had been in existence for a considerable time both in Germany and the United States. The seriousness of adding to the already very great number of existing scientific societies had been keenly felt by the provisional committee, but up to the present, at any rate, owing to the peculiar nature of the science of electro-chemistry and electro-metallurgy, no satisfactory *modus vivendi* had been arrived at for affiliation with an existing organisation. The following council was unanimously elected:—President—J. W. Swan, F.R.S.; Vice-Presidents—Professor A. Crum-Brown, M.D., D.Sc., F.R.S., Lord Kelvin, F.R.S., G.C.V.O., Sir Oliver T. Lodge, D.Sc., F.R.S., Ludwig Mond, Ph.D., F.R.S., Lord Rayleigh, D.C.L., F.R.S., Alexander Siemens, M. Inst. C.E., J. Swinburne, Pres. Inst. E.E., M. Inst. C.E.; Council—George Beilby, Bertram Blount, A. J. Charleton, Pres. Inst. M.M., W. R. Cooper, M.A., B.Sc., Sherard Cowper-Coles, F. G. Donnan, M.A., Ph.D., Professor A. K. Huntington, R. A. Lehfeldt, D.Sc., F. Mollwo Perkin, Ph.D., W. S. Squire, Ph.D., O. J. Steinhart, Ph.D. Intending members are requested to send their names to the hon. sec., Mr. F. S. Spiers, 82, Victoria-street, S.W.

SEWER VENTILATION.—A meeting of the Incorporated Association of Municipal and County Engineers was held at Birmingham on Saturday, the 31st ult., under the presidency of Mr. T. H. Yabbicom, C.E., Bristol. Short papers on the subject of "Sewer Ventilation" were read by, or for, Mr. T. C. Caink (city surveyor of Worcester), Mr. R. Read (city surveyor of Gloucester), Mr. W. J. Steele (deputy city engineer, Bristol), Mr. H. H. Humphries (surveyor to the Erdington District Council), and Mr. C. Chambers Smith (surveyor to the Sutton, Surrey, District Council). Mr. Caink first discussed the point, which he admitted had already been debated *ad nauseam*, whether it was necessary to ventilate sewers at all; and he came to the conclusion that if the sewers were properly laid in the first instance, with proper joints, it was not necessary that they should be ventilated. Ventilating shafts had proved a failure, owing to the interference of wind pressure; and mechanical destructors had also failed. The solution of the problem would be found in checking the too rapid discharge of sewer gas from drains, and he described a process by which he had secured a satisfactory result by passing the air out of sewers through a layer of cotton wool in an enclosing cylinder, changing the cotton wool every three months. He advocated the entire separation of house drains. Mr. Cross described the system adopted by his council of erecting outside pillars, with hexagonal heads and aluminium flaps to prevent reverse currents, used in connection with a water spray, which washes the gas. In the opinion of Mr. Humphries, the best solution of the problem was a judicious combination of surface and shaft ventilation, the surface ventilators acting as inlets and the shafts as outlets. Mr. Read said it was difficult to fix on any universal remedy because of the difference in fall and rate of flow, but he was convinced that intercepting traps were both absurd and dangerous. The real safeguard for the inhabitants of a house lay in the soundness of the drains. Interceptors paralysed the flow from the house drains, caused the drains to become coated with putrid sewage, and absolutely prevented proper ventilation of the sewers. He would leave out these traps or interceptors altogether from house drains, and so secure a better current throughout the sewers. Mr. Chambers urged that atmospheric influences alone would never remedy the evil of sewer gas; mechanical means must be resorted to, and he recommended the Shone system of fans driven by electricity, which forced air through sewers. Mr. Steele described in detail the system approved in Bristol, of not intentionally providing any means of communication between the sewers and the atmosphere, and he contended that figures showed that the system had no perceptible effect on the death-rate. Open manhole sewers he regarded as worse than open sewers.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—A moderate amount of business was done last Thursday. In the forenoon, however, only one lot of 500 tons of Cleveland was done at 47s. 5½d. one month, and the quotation closed 1d. down at 47s. 1½d. per ton cash buyers. Scotch warrants were quoted 1d. per ton better at 53s. 3d. cash sellers, while Cumberland hematite iron was quoted at 58s. 0½d. cash per ton sellers. In the afternoon about 4000 tons were dealt in, and quotations were practically round the forenoon close, and the settlement prices were: Scotch, 53s.; Cleveland, 47s. 1½d.; and Cumberland hematite iron, 58s. per ton. Business was reported on Friday at 53s. 3d. for Scotch iron, 47s. 2d. for Cleveland, and at 58s. 2½d. for Cumberland hematite iron, but really very little was done, and the settlement prices were: 53s. 1½d., 47s. 1½d., and 58s. 1½d. per ton. A moderate amount of business was reported as having been done in the "ring" on Monday, and the tone was firm, the cash price of Cleveland gaining 1½d. per ton. The makers of Coltness and Dalwellington brands advanced their quotations by 1s. per ton for Nos. 1 and 3 irons. The production of iron at the Clyde Iron Works was temporarily suspended, owing to the great flood of the surrounding district by the breaking of the Clyde in several places. Some moderate sales of Scotch foundry iron have just been made for shipment to America. In the forenoon the market was very idle, only 1000 tons of Cleveland being dealt in at 47s. 4½d. one month, with buyers over, being just the turn harder than on Friday; and Scotch warrants were quoted unaltered at 53s. per ton cash buyers, but in the afternoon no business was done in Scotch, the transactions being wholly in Cleveland. The settlement prices were: 53s., 47s. 3d., and 58s. per ton. Business in the iron market on Tuesday was practically at a standstill, and the quotations were unchanged. Scotch was quoted in the forenoon at 53s. per ton cash, and 53s. 2½d. sellers. No transactions took place in Cleveland, but the quotations were 47s. 3d. per ton cash buyers, and one penny higher per ton sellers. In the afternoon Cleveland alone was in demand at 47s. 5d. per ton 23 days, and Cumberland hematite iron was quoted at 58s. 1½d. per ton cash buyers, and 47s. 3½d. sellers, and the settlement prices were: 53s. 1½d., 47s. 3d., and 58s. per ton. Business was more active to-day, and the tone was very firm, the dealing being confined to Cleveland, which changed hands at 47s. 6d. cash. A small business was done in the afternoon, all in Cleveland. The settlement prices were: 53s., 47s. 6d., and 58s. 4½d. per ton. During the past week, day after day, each market report has been a bald repetition of its predecessor—nothing but dull, listless markets, sometimes not a transaction taking place, and yet it is difficult to understand the reason of this position. American demand, so far, is all that was expected of it at this season. Continental reports are undoubtedly better, and look as if they were to improve still further. Hence trade reports are showing greater strength than most of the prophets predicted. In fact, looking all round, the year is opening in a fairly auspicious manner, and it is to be hoped that the speculative activity fast developing in the London metal market may soon spread northwards. Evidently a little speculation is all that is wanted.

Finished Iron and Steel.—Fresh business in the malleable iron department continues very small; and in respect of steel there is little doing in the home market beyond the ordinary work as required to complete orders at present in hand, such as shipbuilding and bridge-building; but the inquiries from Canada and the United States are considerable in volume, and there is said to be every probability of them continuing for some time. In fact, once the navigation reopens, the trade with Canada will more than likely expand. The circumstances seem to the steelmakers sufficient justification for them to maintain prices at their present level. Prices are quoted about the same as of late: angle-bars, 5*l.* 5s. to 5*l.* 7s. 6d. per ton; ship-plates, 5*l.* 10s to 5*l.* 12s. 6d.; and boiler-plates, 6*l.* 10s. per ton.

Sulphate of Ammonia.—This commodity continues firm in demand, and is now realising 12*l.* 15s. per ton for present delivery at Leith f.o.b. The shipments for the year to recent date show a decrease of 1576 tons when compared with the corresponding period of last year. Last week they amounted at Leith to no more than 163 tons.

Glasgow University Engineering Society.—At a meeting of the Society, held on Thursday, the 5th inst., a paper was read by Mr. John Ward, Sen., of Dumbarton, on "The Work and Worries of a Shipyard." Speaking of the work of a yard, the lecturer showed how the wages-costs could be systematically kept, and the results interpreted to practical advantage. The worries arose from a variety of causes, not the least of which was the irregularity of many of the men, especially after holidays. It was sad to see how such a large part of the high wages earned in shipbuilding were wasted, and mutual benefit schemes managed jointly by employers and employés were to be encouraged.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

The Hull Coal Returns.—The imports of coal to Hull during January totalled 253,504 tons, against 220,976 tons in 1902, an increase of 32,528 tons. The coastwise trade was fairly well sustained, 21,838 tons having been dealt with, of which 14,770 tons went to London. The exports, favoured by the extended open weather, show a considerable increase; the total last month reached 131,915 built of steel section-bars, and carrying the motor and change-speed gear. The motor has four cylinders, cast in one piece with the cylinder heads. The automatic regulator of carburation—which can also be worked by hand—allows slowing down to 150 revolutions and gradually rising up to 1000. The mixture can be enriched as the quantity supplied to the cylinders is reduced. The inlet valves are controlled. Ignition is by a magneto, rotating at a low speed; the induced coil is fixed; there is therefore no collector. Each cylinder can be isolated to ascertain the working of the motor. Fig. 6 is a diagram of the Rochet-Schneider change-speed gear. The intermediate shaft, driven by friction clutch from the motor, carries a set of sliding pinions, as also does the transmission shaft, and each set is shifted by a fork. The fork for shifting the pinions on the intermediate shaft is held fast on its rod, while that for the transmission shaft gear slides on the same rod, its action being controlled by a spring.

There were at the exhibition a number of automobiles built by Messrs. Renault Frères, of Billancourt, near Paris, and exhibited by several London automobile agents. Among them may be mentioned the 20 horse-power car which won the Paris-Vienna race, and which was also shown at the Paris Exhibition. At the Crystal Palace this car was to be seen at one of the stands of the Roadway Autocar Company, Limited. The Renault frames are comparatively light, though built of wrought iron for all ordinary detail parts, and of hardened steel for all pieces exposed to friction. The springs are of large dimensions and are under no tractive strains. The rear axle is joined to the frames by a double stay, and is rendered independent of the springs by means of bearing-blocks. The frame is of steel tubes; it is shown in Figs. 7 and 8, the references to which are the following:—

A. Motor.
B. Carburettor.
C. Flywheel.
D. Friction clutch.
E. Change-speed gear.
F. Transmission shaft.
G. Change-speed driving.
H. Foot-lever brake.
I K. Differential gear, pinion, and wheel.
L. Brake drum.
M. Brake rods.
N. Essence-receiver.
O. Change-speed lever.
P. Steering wheel.
Q. Ignition handle.
R. Brake lever.
S. Steering rack.
T. Water tank.
U. Oil-receiver.

Fig. 9 is an end view of the Renault frame, showing:—

A. Motor.
B. Carburettor.
T. Water-tank.

The Renault motors have one, two, or four cylinders. The motor of the car shown at the Crystal Palace has four cylinders, developing 20 to 25 horse-power at 1500 revolutions. The inlet-valve springs can be adjusted to alter the speed and power of the motor without deranging carburation. The speed governor acts on the inlet, and it can be cut out by means of a pedal accelerator. The motor can thus be made to revolve at different rates of speed, the consumption of essence being, as usual, proportioned to the power used.

The interesting display made by the Thornycroft Steam Wagon Company, Limited, was fully described in one of our preceding issues.* We may mention, in passing, that the Thornycroft steam lorries, municipal service dust and water carts and trade vans, formed a unique feature of the exhibition of automobiles held in Paris last December.

Figs. 10 and 11, page 316, reproduced from photographs, are two views of cars built by the Wolseley Tool and Motor Car Company, of Birmingham. This company's exhibits were referred to in our previous article on the Crystal Palace Show, as also were the exhibits of a number of other British firms.†

The "Voiture Pipe," one of which was exhibited by the London Motor Garage Company, Limited, is built in Belgium for this company. The frame is of wood strengthened by steel plates; the motor and change-speed gear are carried on a supplementary frame. The motor has four cylinders, cast in pairs.

The Continental Automobile Company, Limited, exhibited, among others, three "Fiat" cars; these are built by the Fabrica Italiana di Automobili, of Turin. A "Fiat" car recently won a race from Figueira to Lisbon—a run of about 95 miles on more or less indifferent roads. The frame is of wood, strengthened by iron fittings and cross-stays; it is carried by rollers and springs on nickel-steel axles. The wheels are of wood, with steel rims. The motor is in front; it has two cylinders for the 8 horse-power type, and four cylinders for those of 12 to 40 horse-power. The motor frame is of aluminium; it contains, besides the motor, the carburettor, governor, magneto, and pump. The carburettor is on the constant-level type, and contains additional hot and cold-air ports; a centrifugal automatic mechanism insures the lead and lag of ignition.

* See page 143 *ante*.
† See page 183 *ante*.

THE RUSSIAN FIRST-CLASS CRUISER "BOGATYR."

(*Continued from page 206.*)

PROPELLING ENGINES.

THE engines and boilers are placed in four compartments, the engine-rooms extending from frame 28 to frame 45 (see Fig. 1 on the two-page plate published with our issue of January 30). In addition to the engine compartment, there are three boiler-rooms extending respectively, the rear one from frame 46 to 58, the middle one from frame 64 to frame 75, and the front compartment from frame 77 to frame 89. The coal-bunkers surround all the boiler-rooms, so that coal is everywhere conveniently at hand. The general arrangement of the engine and boiler-rooms is shown on the plan of hold (Fig. 7 on the two-page plate published with our issue of February 13) and on the cross-sections given in pages 208 and 209 *ante*.

The two four-cylinder triple-expansion engines, which are illustrated on the two-page plate given with this number, and by the engravings on pages 312 and 313, are erected in a common compartment without intermediate bulkhead. The main dimensions are:—

Cylinder diameters:—		
High-pressure	1030 mm.	(40.5 in.)
Intermediate-pressure ...	1530 ,,	(60.2 ,,)
Two low-pressure (each)	1780 ,,	(79 ,,)
Stroke, common	900 ,,	(35.4 ,,)

The engines are of very solid construction, as will be appreciated by reference to the elevations and plans (Figs. 25 to 27). From a strong bedplate of cast steel there rise on the one side four forked standards of cast steel which support the cylinders and bear the crosshead guides; on the other side—the condenser side—each cylinder is supported by two forged steel columns, bored hollow. The high-pressure cylinder is provided with a forged steel liner (Fig. 28); the other cylinders have no liners. The high-pressure cylinder has one piston valve, the intermediate-pressure cylinder two such valves; the low-pressure cylinders are fitted with balanced flat valves. Stephenson's link gear is applied. The reversing gear is actuated by an engine operating through double worm gear, as can be seen in Fig. 26. Hand reversing gear has also been provided. The turning wheel, which is driven by a single-cylinder engine working through a double worm gearing, is fixed to the coupling flange in the middle of the engine, as shown in Figs. 25 and 27.

The crankshaft of each set of engines is made in two parts, and is of best crucible steel. The engines are successfully balanced on the Schlick system; no vibrations of the hull were noticed at any power during the trial runs. The crankshaft is directly joined to the thrust shaft, then follow a connecting shaft and the propeller shaft. The propeller shafts are themselves subdivided, the two parts being joined by a two-part coupling outside the ship (Fig. 7). This construction has been decided upon, in view of the great length of the propeller shafts and of possible difficulties in case of renewal. Outside the ship, and within the bronze stern-tube, the shafts are covered with rubber between the bearings. The shafts are made in best crucible steel, the propellers in manganese bronze. Each propeller has three blades, is of a diameter of 4.9 metres (16 ft. 1 in.), and of 5.5 metres (18 ft.) pitch.

(*To be continued.*)

THE MECHANICAL HANDLING OF MATERIAL.

AT the ordinary meeting of the Institution of Civil Engineers, held on Tuesday, February 24, Mr. J. C. Hawkshaw, M.A., President, in the chair, the paper read was "Mechanical Handling of Material," by Mr. G. F. Zimmer, Assoc. M. Inst. C.E.

Mechanical appliances for the conveyance of material from one point to another were undoubtedly of the first importance, owing to the economy which they effected; and, in round figures, the saving of one man's wages warranted an outlay of 1000*l*. in machinery. The paper treated only of such methods as dealt with material continuously—that was, which received and delivered it in an uninterrupted stream; and passed over such methods as light railways, ropeways, &c. The appliances were described under three heads, viz.:—

(*a*) Appliances for lifting in a vertical direction, or from one level to another, called elevators;

(*b*) Appliances for moving material in a horizontal direction, called conveyors;

(*c*) Appliances which combined the two former operations.

Elevators in a primitive form had been known and used for a considerable time, and since their introduction had undergone little alteration except in details. They consisted of endless belts or chains, to which suitably shaped buckets were attached, and which ran over two terminal pulleys, fixed at different levels. Grain elevators were usually vertical, and were encased in wooden and iron trunks; while mineral elevators were generally in a slanting position, at an angle of 45 deg. to 60 deg. Grain elevators were fitted with leather or textile bands, while mineral elevators had malleable or wrought-iron chains as support for the buckets. Grain elevators, travelling at a speed of 250 ft. to 350 ft. per minute, according to the size of their terminal pulleys, could deliver satisfactorily if in a vertical position; while mineral elevators, which travelled at the rate of only 50 ft. to 160 ft. per minute required the inclined position, so as to discharge their load clear of their own buckets. Inclined elevators were more easily driven than vertical elevators, on the principal of the inclined plane. In vertical elevators, in order to effect perfect discharge, the centrifugal force must be sufficient to overcome the gravity of the material; so for a specifically heavy material it was necessary to have a higher centrifugal force, that was greater speed of elevator, than for a specifically lighter material. While it was usual to run coal elevators at 90 ft. to 130 ft. per minute, according to the friability of the coal, coke-elevators ran at only 50 ft. to 90 ft. per minute. On the other hand, minerals which did not deteriorate through breakage could be elevated at the rate of 120 ft. to 160 ft. per minute. A very rational form of elevator was that fitted with a continuous chain of buckets. It was of much larger capacity than an ordinary elevator of the same dimensions. It received and delivered the feed more uniformly, and as the buckets need not plough intermittently through the contents of the elevator-well, slightly less driving-power was required.

The types of conveyor were numerous, and some of them were of great antiquity. The oldest type was undoubtedly the Archimedean screw, worm, or spiral conveyor. It consisted of a continuous or broken blade screw described round a spindle, revolving in a suitable trough, and thus propelling the material slowly from one end of the trough to the other. The ratio of the diameter to the pitch of all worms depended upon the kind of material to be conveyed. It ranged from a pitch of one-third of the diameter to a pitch equal to the whole diameter of the worm, and even more. The greater the pitch the greater the driving power required. A detail of great importance in all worm conveyors was the intermediate bearing. This, if cumbersome, obstructed the passage of the material, a result which was to be carefully avoided. Delivery of the material from a worm conveyor could be effected at a number of points: it was only necessary to provide a suitable outlet. The principal advantages of the worm-conveyor were its simplicity and small first cost; it was, moreover, of great service where a mixing of the material to be conveyed was desired. The chief disadvantage was the large amount of driving-power required, and the breakage of the material conveyed.

Conveyors of the drag or push-plate type consisted of a fixed open trough. The material to be conveyed was deposited in this trough, and was pushed or dragged along by a series of plates attached to an endless chain. The speed of travel ranged from 60 ft. to 180 ft. per minute. The cable conveyor consisted of a V or U-shaped trough, through which was dragged a wire rope with disc-like attachments. The speed of travel was 100 ft. to 120 ft. per minute.

Band conveyors had been introduced a little more than twenty years ago, and were now one of the best means of conveying large quantities of almost all kinds of material, especially for long distances. They consisted of a band which ran over two terminal pulleys. Early band conveyors had been almost entirely used for conveying grain. The tightening of a band conveyor was done in a similar manner to the tightening of elevators. In long conveyors the tightening gear consisted of a pulley held in tension by weights over which the belt passed. The tight side of the band was the one which should preferably be used for conveying the material. To withdraw the feed of a band conveyor at an intermediate point, a throw-off carriage was employed. The speed at which band conveyors for grain were run varied from 450 ft. to 600 ft. per minute. The lower speed was for oats or other grain, which contained a quantity of chaff that would be blown off the band at a speed exceeding 500 ft. Maize, beans, and heavier seeds were conveyed at the highest speed of 600 ft. per minute. Band conveyors for heavy materials, such as coal, coke, minerals, &c., were very similar to those previously described, with the exception that all the fittings were much more substantial. The principal advantages of band conveyors were the small amount of power required to drive them, and the fact that they did not injure the material conveyed. The disadvantages were that a great many small bearings had to be oiled and kept in repair.

The continuous-trough or travelling-trough conveyor consisted of an endless trough, the sections of which were riveted to the links of suitable chains. The endless trough travelled over two terminal pulleys. These conveyors travelled at 75 ft. to 100 ft. per minute. They were in their construction very similar to the push-plate conveyor, but each section of trough took the place of a push-plate on the endless chain.

The vibrating-trough conveyor was of the latest type, and consisted of troughs which received the material at one end and delivered it to the other, by means of a succession of suitable backward and forward movements of the troughs. These might, therefore, be classed together with the two previous types, the band and the travelling-trough conveyors, as in all three the material was, so to speak, conveyed in a trough without the action of a stirring or pushing element, as was the case with worms, push-plates, and cable conveyors. It was obvious that all kinds of materials which deteriorated through rough treatment should be conveyed on appliances of the last three types. The support of the trough in its reciprocating motion had been effected by flexible legs in an oblique position. For considerable lengths and capacities the conveyors were balanced. The load could be fed into or withdrawn from any of these conveyors at any number of points, without cessation of work. The material travelled at the rate of 40 ft. to 70 ft. per minute.

Under the heading (c) there were only two types to be mentioned—the travelling- or tilting-bucket conveyor and the pneumatic conveyor. The former consisted of two endless chains or ropes, held at certain distances apart by suitable bars which were fitted with small rollers at each end. Every link, and sometimes every second link, carried a bucket, so that the whole was an endless chain of buckets, which were not, however, fixed like an elevator bucket, but were movable, and suspended above their centre of gravity; so that they were always in an upright position, whether they were moving horizontally or vertically. Each bucket carried its load to the point at which delivery was required, and here it was met by an adjustable device which tilted each bucket in its turn, and thus emptied the contents. The material to be conveyed was not injured in the least. Such conveyors required little driving-power, and one main drive was sufficient for a whole installation. The second and last appliance under this head was the pneumatic elevator. Mr. F. E. Duckham, M. Inst. C.E., had designed the apparatus which had been in use at the Millwall Docks, and in docks of other ports since 1895. The plant consisted of an air-tight tank from which a pipe was connected to the bulk of material to be conveyed. The air was withdrawn from this tank by means of a second pipe connected to an exhauster, and as the air passed through the first-named pipe it drew the grain with it into the tank. The arrangement for removing the grain from the tank without destroying the vacuum was described and illustrated. The Bolinder timber conveyor was also described.

Provision was made in many modern power-stations, gas works, and mines for automatic handling of the materials; and there was no reason why labour-saving appliances should not be employed in dock works, &c., for the handling of the excavated material.

The paper was illustrated by diagrams, and accompanied by numerous tables of data as to the capacity of elevators and conveyors of different sizes and speeds, and the amount of power required for working them.

THE METRIC SYSTEM.

To the Editor of Engineering.

Sir,—I have read with much interest the reports of the discussions at the Institution of Electrical Engineers, and your article on the metric system in your issue of February 20, also I have followed the arguments of the advocates and opponents of the system which have from time to time been published.

Very few who have taken part in the discussion appear to have used and to be familiar with both the English and the metric systems, which latter appears to be considered the only decimal system in existence. During many years I have used both systems, and I am equally familiar with both. Perhaps you will permit me to trespass on your valuable space while I draw attention to some interesting points.

The length of the standard metre is taken at one ten-millionth part of a quadrant of the meridian; this was calculated more than a hundred years ago; if the length of this quadrant were again surveyed and calculated, there can be little doubt that, with modern improved appliances, the measurement would be made with a greater degree of exactitude, and that an error would be found to exist in the length of the existing standard; it follows that the exact length of the metre is not known, and that if the standard, which is kept at Paris or elsewhere, were lost or destroyed, it could not be replaced, and the present metre would not only cease to exist, but it could not be replaced; in this respect, therefore, the metric system is no better than many other systems.

The standard for weight—viz., the "gramme"—is the one-thousandth part of the weight of distilled water contained in the standard of liquid measure called the "litre," the litre being the one-thousandth part of a cubic metre; hence, if the metre is incorrect, the standard "gramme" and "litre" are also incorrect.

The advocates of the metric system strongly advise its adoption because it has the merit of easily interchanging the measurements of length into those of capacity or weight, and *vice versâ*: a very little consideration will show that this facility of interchange does not exist under the metric system any more than under the English system; for it is essential, when converting the measurement into weight under the metric system, to use a multiple (specific gravity) which differs for every substance; therefore it is necessary, in every case, to have a number connected with each substance; this is no easier to remember than the number required for ascertaining the weight of a cubic inch of the same substance. There is, in this respect, little difference between the two systems, except that the calculation will require fewer figures in the case of the cubic inch.

The advocates of the metric system claim the great advantage that it is a "decimal system," and that it is used as such, whilst the English system is purely a "fractional system," but they fail to define the meaning of these expressions. Those who use the metric system certainly do not use it purely as a decimal system founded on multiples of the metre, &c.; the tonnage of a vessel is not either calculated nor expressed in grammes, the "ton" of a million grammes is adopted as the standard of measurement, followed by one or two decimals to denote a fraction of a ton, in just the same way as an English vessel is described in tons and decimals of a ton. For apothecaries' weights the one-hundredth part of a gramme is adopted as the standard of weight, and a prescription is described as containing so many hundredth parts of a gramme.

In like manner the metre is not always used as the unit of measure; thus the unit of distance is commonly taken as the kilometre, and for small measurements the millimetre is as commonly taken for the unit; as, for instance, in your issue of the 20th inst. you gave the diameter of the one-pounder Hotchkiss gun as the "37-millimetre automatic gun," and not as the 0.0037-metre automatic gun, which would be as absurd as to describe an English 6-in. gun as a 0.166-yard gun.

In countries where the metric system is used, the metre is only a theoretic standard measure, just the same as the yard is the theoretic standard measure in England; both are used when convenient, but not otherwise. The English system has the advantage of sub-division into feet and inches, which can be further sub-divided into fractions or decimals, according to the nature of the calculation to be made.

For retail trade the kilogramme, or one thousand grammes, is not found convenient for sub-division; to avoid mistakes, it is not uncommon for the half kilogramme to be called a pound, the quarter kilogramme a half pound, and the one hundred grammes is often spoken of as the ounce. Thus for the prices of retail goods, the computation is comparatively not difficult when the grammes are a multiple of centimes; thus two centimes per gramme is easy, but when the price is two and a quarter centimes per gramme there is always trouble.

Workmen engaged in the engineering trades commonly describe a length as so many metres, centimetres, and millimetres; but not as metres and millimetres. The metric system has a very great disadvantage over the English system, in that there is a very great liability to error; upon the metre measure the divisions are counted and not read. This entails frequent mistakes, and consequent loss of time and materials. To such an extent is this the case that, when employing workmen in countries where the metric system is in force, I have found it very advantageous to supply 2-ft. rules to some of the men, and to teach them their use. This only requires a very few days' practice, when I have always found a considerable diminution in the number of mistakes made by men who had hitherto been accustomed, all their lives, to the metre measure, and had never previously handled a 2-ft. rule.

The English system of measures lends itself readily for calculation by means of decimals; in fact, it is quite as easy to work out a sum in inches and decimal sub-divisions of an inch, as in the decimal sub-divisions of a metre; or where weights are being calculated, the difference between using decimal fractions of an English or a French ton is purely imaginary. Grains also are as easy to calculate as grammes; in fact, there is little, if any, difference in this respect between the two systems.

For interchanging weight into capacity, 1 gallon of distilled water weighs 10 lb., which is as easy to remember as that a cubic metre of distilled water weighs 1000 kilogrammes. In the case of all other substances, when it is desired to obtain their weight from linear measurements a constant number is required for every separate substance under both systems; and in this respect neither system has any advantage over the other.

In making calculations for which decimals are used there is absolutely no advantage gained by one system over the other, provided the calculations are made on paper; but for mental calculations fractions are much simpler, and entail much less risk of error than decimals, which commonly run into many figures. The English system is far more convenient for these mental calculations than the metric system, as anybody who has tried both knows full well.

The difficulty of the whole question appears to be the grounds upon which any reasonable arguments in favour of the metric system can be grounded. Sir Frederick Bramwell has stated that the principal advocates for it now are scientific men who have fed themselves on French and German books; probably he is correct; certainly electrical engineers are in favour of the metric system, but then it must be remembered that they derive their knowledge from calculations made by foreigners using the metric system, and the translators of foreign books have not converted the calculations into English measures. Therefore the students of this branch of engineering are only acquainted with the metric system; if some industrious person converted the electrical equivalents and formula from the metric into the English system, in the course of a very few years there would be few advocates of the metric system left; except, of course, those who know nothing about the subject, but talk for the pleasure of hearing their own voices.

The length of the standard metre was originally adopted in France at a time when that country was at war with England, and therefore everything English was hated; except for this state of affairs, it is very probable that the English yard would have been adopted as a standard.

If it were essential to adopt one universal standard, this could very soon be effected, if the countries using English standards prohibited the importation of any articles not manufactured to those standards.

A change to the metric system would involve very great difficulties in engineering; the mere making of new leading screws to lathes, &c., and the re-making of a few gauges would be as nothing compared to the difficulty in the case of manufactured machines, which would have to be repaired under the English system until they are worn out; it would be necessary to have stores of both kinds of screws, and to maintain machines for doing both kinds of work, for screws and nuts for the two systems cannot be cut by the same machine.

The desire on the part of electrical engineers and others who have drifted into the use of the metric system to make it universal, and thus to make others suffer the same inconveniences as themselves, somewhat resembles the story of the fox who had lost his tail, and tried to persuade the other foxes to cut off theirs, because it was so comfortable without a tail.

Yours, &c.,
France, February 28, 1903. DECIMUS.

To the Editor of Engineering.

Sir,—Permit me to join with you in your smile at the remarks of your correspondent, Mr. Hugh F. Wright, which appeared in your last issue, upon the above subject.

The amount of humour, intentional or otherwise, which Mr. Wright manages to infuse into a letter upon a serious subject, in spite of (or is it on account of?) the fact that his observations, for the most part, have little or no bearing upon the main points at issue, is marvellous. He must forgive me when I say that I entirely fail to see what possible bearing his remarks upon the dimensions of bricks and drawing-paper can have upon anything which appeared in your article. Mr. Wright speaks of bias. The term, not to use a stronger one, applies to his own letter more than to any opinion on the metric system which I have yet seen published.

It is not to be supposed that you, Sir, or any sensible person, imagines for a moment that the metric system is without its imperfections; but absolute perfection is, we all know, unattainable. It is an undeniable fact, however, that this system, whatever its shortcomings, is built upon a scientific basis, and certainly possesses the merit of being a connected system, which is more than can be said of the one with which we are at present inflicted, if, indeed, that wonderful conglomeration of weights and measures can be called a system. As for the greater or less ease of designing in millimetres, I myself have used that system, the fractional inch system, and the decimal inch system, and so long as there is no calculation to be performed see very little to choose between them; but when any figuring has to be done, then the difference in the case of manipulation becomes very marked. Possibly Mr. Wright likes to juggle with 32nds, 16ths, and 64ths, and other fearsome quantities. I do not. Like the boy in the nursery rhyme, "fractions drive me mad." Personally, I never try to carry out any calculation in fractions, but always convert to decimals, and then, if necessary, reconvert the result, and I do not think I am alone in this. Surely it is worth while doing away with the necessity for these conversions.

Mr. Wright's argument that it is easier to arrive at $\frac{9}{16}$ths of a total than 56.25 per cent. thereof will not hold water. If a man is always in the habit of thinking in fractions, he will, no doubt, find some difficulty in recognising an occasional decimal; but I can assure Mr. Wright that it is very easy to acquire the habit of thinking in decimals or even in both, and to the man accustomed to decimals .5625 conveys quite as much meaning as do the figures $\frac{9}{16}$ to the other man. I venture to think, also, that if the average man desired to discover what was $\frac{9}{16}$ths of $\frac{11}{12}$ths, for instance, he would require the aid of a pencil and paper quite as much as, or perhaps more, than if he sought .5625 of .5156.

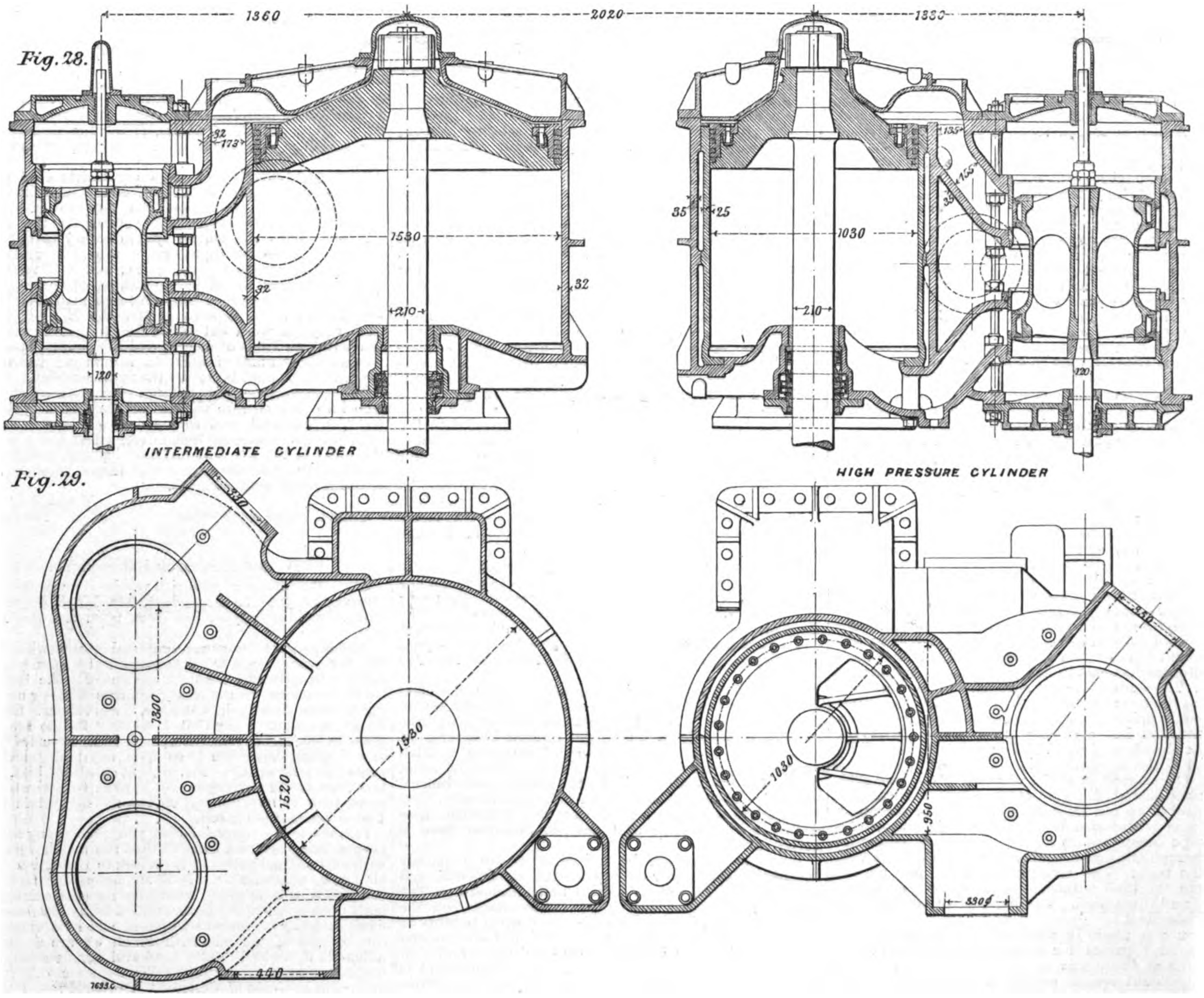
I take it that the need for a change is due mainly to commercial reasons, and in that case what benefit are we likely to derive from inventing an entirely new system, however theoretically perfect it may be? The change would be just as costly, perhaps more so, than that to the metric system, and, when made, would leave us in precisely the same relation, with regard to foreign countries, in which we stand at present. If, as one would suppose, a world-wide uniformity with regard to weights and measures is what is being aimed at, where is the advantage in making matters worse by introducing fresh complications in the shape of new systems?

According to *The American Machinist*, of February 28 last, amongst the resolutions adopted at a meeting of the American Chamber of Commerce in Paris on December 3 1902, was the following:—

DETAILS OF ENGINES OF THE RUSSIAN PROTECTED CRUISER "BOGATYR."

CONSTRUCTED BY THE STETTINER MASCHINENBAU ACTIEN-GESELLSCHAFT VULCAN, BREDOW, STETTIN.

(*For Description, see Page* 310.)



"Whereas, the metric system has been adopted by countries having a population of 480,000,000 inhabitants, and has universally proved beneficial."

A perusal of the remainder of these resolutions, by the way, should prove edifying to Mr. Wright.

Now, if the metric system has already been adopted by 480 millions of people, is it not common-sense, if we wish to do business with any of these, to adopt the same system ourselves? We cannot expect them to abandon their own system to adopt anything which we may invent; and if England does not supply them with what they require, they will, not unnaturally, purchase their goods elsewhere.

The whole matter seems to me to be one of compromise, and the most desirable system to adopt is, for obvious reasons, the one which is, or is likely to become, the most universal. It may not be perfect, but it is better than our own, and it is the one used by 480 millions of persons who are possible customers. Mr. Wright's example of the Central Asiatic and his plough is scarcely relevant. I was not aware that ploughs were sold by weight; but apart from that, a plough, like other things, is liable to breakage, and if our Asiatic friend found when he had broken his plough that he was put to unnecessary trouble and expense to have it repaired, owing to the fact that it was constructed to a standard unknown in his locality, the odds are that the next plough he or his neighbours bought would be built to a standard of measurement with which they were more familiar, which would probably be the metric system.

With regard to "Hy. J. T.'s" criticisms. He views the whole subject from the draughtsman's standpoint alone, which is by no means the main consideration. Moreover, I do not follow his objection to the use of 2.5 or 7.5, or, as he puts it, 2½ and 7½, which, by the way, clearly shows how he clings to the old fractions in spite of his five years' experience of the metric system, as intermediate dimensions between 0 and 5 and 5 and 10. If "Hy. J. T." were accustomed to fine work, he would not find it so easy to avoid using 32nds of an inch, and when, as is more often than not the case, it is necessary to work to thousandths of an inch, scaling and drawing becomes an impossibility, and one might just as well use 50ths of a millimetre.

By all means, Sir, let us have a system in which such anomalies as 1 oz. of silver being heavier, and 1 lb. of silver lighter, than the ounce and pound of iron, are impossible, and do not let us permit the "old dogs" to hamper us in the learning of new and useful tricks.

I am, Sir, your obedient servant,
HUBERT C. CLARK.

187, Golden Hillock-road, Small Heath, Birmingham,
March 2, 1903.

ELECTRICAL APPLIANCES AND FIRE PREVENTION.

TO THE EDITOR OF ENGINEERING.

SIR,—The importance of fire telegraphy, fire alarms, and fire telephones in connection with the fire service, as also the importance of electrical control systems for watchmen and others, makes it a matter of considerable interest to all associated with electrical engineering that the electrical section of the forthcoming Fire Exhibition should be thoroughly representative of the appliances now in use for this character of electrical work.

It is also of general importance to the community to encourage in every possible way the equipment of cities, villages, factories, shops, hotels, &c., with electrical fire alarms and fire telegraphic apparatus, as it is the "early call" of the fire-fighting forces that plays such an important part in the effectual extinguishing of fires.

Besides questions of electrical telegraphy as connected with fire-fighting, there are, however, the two preventive problems of the electrical safeguard in electrical installations and the safeguard for protection from lightning, which both considerably affect the electrical industry in its relations to the general fire protection of the country.

The attention of the electrical trade is hence particularly called to the impending International Fire Exhibition; and it is suggested that an effort should be made by all electrical firms in any way associated with the work to exhibit what they consider to be most practicable in this direction.

The International Fire Exhibition at Earl's Court will be visited on this occasion not only by general exhibition visitors, but by a large number of professional men, public officials, and municipal delegates interested in the subject; while the International Fire-Prevention Congress, to be held in July, will alone bring together a large number of those seriously concerned in the matter, both from at home, the colonies, and abroad.

Further, the National Fire Brigades' Union Tournament, organised by the National Fire Brigades' Union—which has a membership of over 500 provincial brigades—will bring to the Exhibition a very large number of fire-brigade officers and men, all anxious more or less to improve their local resources. Again, there will probably be an Ambulance Congress, which will bring together many of the leading officers in the various ambulance services, who are becoming more and more interested in the question of rapid intercommunication of a similar character to that of fire telegraphy.

Regarding awards, diplomas for gold, silver, and bronze medals will be accorded by sections and sub-sections, on a system to be approved by the electrical committee, and a jury of a thoroughly representative and independent character will make these awards.

I am, Sir,
On behalf of the Electrical Sub-Committee,
JAMES SWINBURNE, Chairman.

1, Waterloo-place, Pall Mall, London, S.W.,
March 3, 1903.

JAPANESE SHIPBUILDING.

TO THE EDITOR OF ENGINEERING.

SIR,—Please permit us to advise you that there is an error in the notes on "Japanese Shipbuilding" which appeared in your issue of December 5 last.

You stated that "amalgamation reduced to four the number of shipyards in Japan," but this is a mistake. In fact, only our branch works (with one graving dock) at

DETAILS OF ENGINES OF THE RUSSIAN PROTECTED CRUISER "BOGATYR."

CONSTRUCTED BY THE STETTINER MASCHINENBAU ACTIEN-GESELLSCHAFT VULCAN, BREDOW, STETTIN.

(*For Description, see Page* 310.)

Fig. 30.

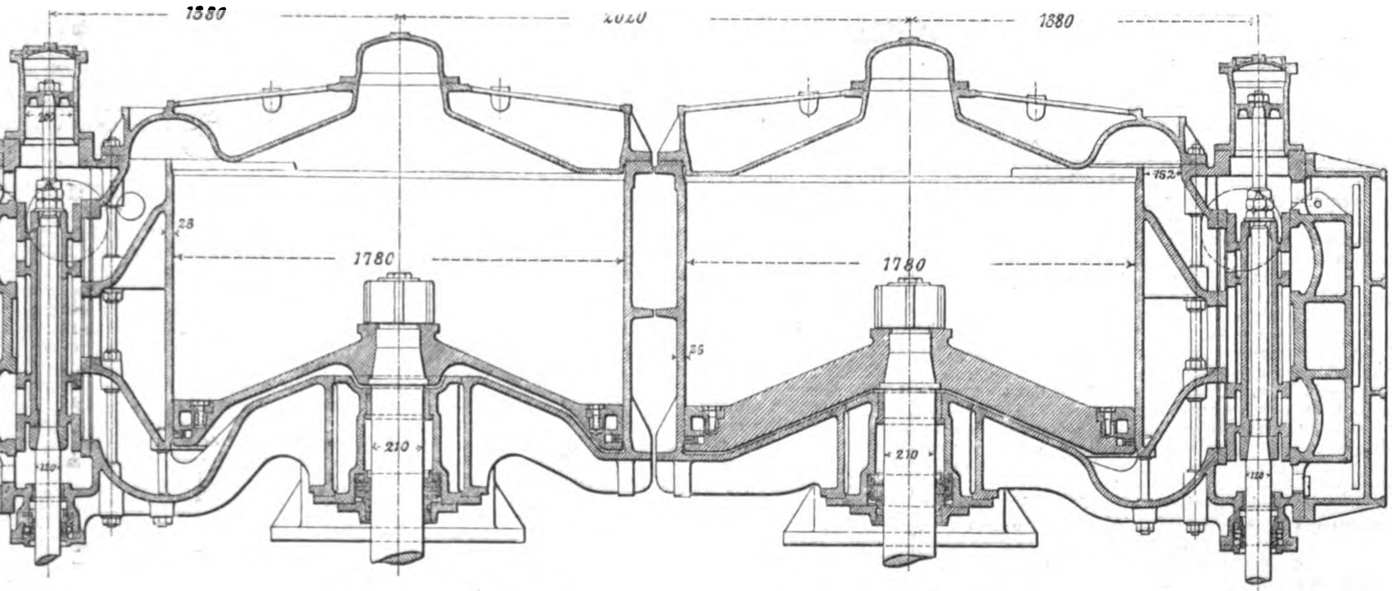
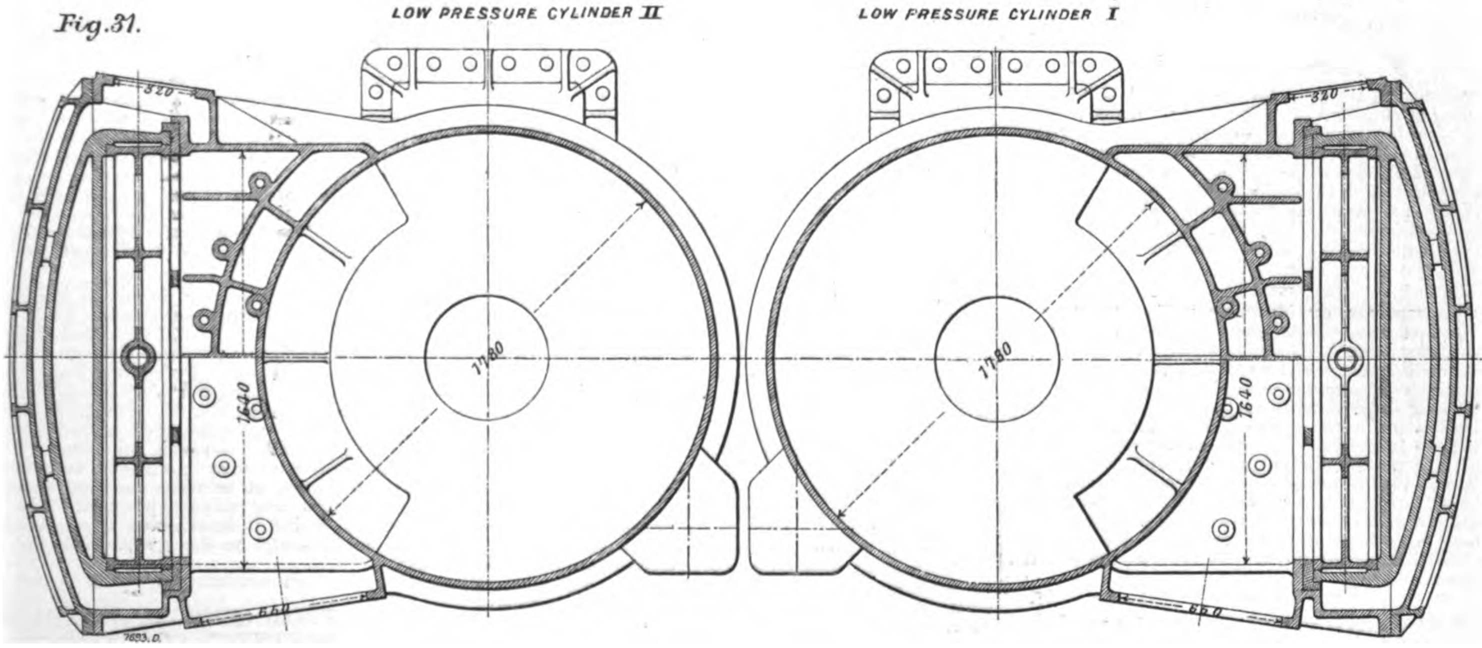


Fig. 31.



Uraga have been amalgamated with the Uraga Dock Company. We are in possession of shipbuilding berths and one dry dock, and are undertaking extensive works.

We take this opportunity to state that we are the pioneer private shipbuilding and dockyard in Japan.

Yours faithfully,
THE ISHIKAWAJIMA SHIPBUILDING AND ENGINEERING COMPANY, LIMITED, TOKIO.
Per T. INSHINOYA.

Tokio, January 22, 1903.

"UP-TO-DATE FIRE APPLIANCES."

TO THE EDITOR OF ENGINEERING.

SIR,—"Pro Patria," in taking up the cudgels for the British fire-appliance trade, has overlooked the main reason of the dissatisfaction so frequently expressed of late in the public press regarding our manufacturers—viz., their lack of initiative during the past decade. When the British fire-appliance maker has once made up his mind to put a certain class of appliance on the market, he not only holds his own opinion against all comers in design and make, but generally beats them in mechanical efficiency. But why should he take so long to make up his mind? Mentioning an instance, the horsed chemical first-aid engine has been in use in the United States for many a long year, and has been found a boon to all concerned. The Viennese Metropolitan Fire Brigade has over thirty of such large chemical engines, whilst in Germany the professional fire brigades have apparently been using them since 1890. Why must we needs wait to see the Yankee maker actually placing these appliances here, in order to bring about their manufacture in London some full ten years after they have been proved so useful in two other continents?

"Wake up, England!" said the Prince of Wales, after his return from the Colonies; verily here is a case in point where we should long ago have "woke up"—ten years, in effect—on this one important item of fire-brigade equipment.

Similar instances could be given regarding other appliances. Why should the French capital, and the provincial towns of Germany, also a number of American cities, introduce motor fire-engines quite a couple of years before English makers really start thinking of them? Why should they only seriously tackle the 80-ft. ladder question after the rest of the world has had the telescopic ladder in hand for a number of years, and the United States has actually imported them, in spite of the tariff question, from the Continent of Europe? Why do they not push the interchangeable coupling when the world's brigades—England's fire-service excepted—has been using them for a decade? Why has the smoke helmet been so neglected by the fire-appliance makers?

The introduction of all such appliances rests primarily with the makers in England, seeing that their influence among most of the fire chiefs of this country is of such a curious—we might say, exceptional—character, as to be able to practically control the nation's fire equipment. But, perhaps, the absence of healthy outside competition has made our fire-appliance makers apathetic, as is the case in several of our other trades. Having this wonderful influence, they prefer to keep to their old lines as far as possible and to limit their improvements to their old special lines—*i.e.*, the steamer, the manual, the hose-cart, and the hose-reel. They do not care for the expense of experimental work and new models until public opinion, the strenuous demand of some travelled fire-officer, or the public comments of such a man as Chief Parker, practically almost compel them to make a change. If our makers had only taken time by the forelock, the fire service generally in the country would have been in a somewhat advanced state of equipment. Their output would have been a greater one, and England's position as an exporter would not have been encroached upon.

There is, however, one pleasureable feature in "Pro Patria's" letter, and that is, the confirmation of the prospect of new vitality in at least one of our fire-appliance makers. New models were apparently completed last year, notably the motor steamer; other new modes, notably of the chemical automobile type, are in hand. Every Britisher will be pleased to hear of this, but nevertheless, those years of experience which have already been obtained elsewhere are lost to this country; for however cleverly initiated, a new model cannot reach that stage of perfection at once which large experience and lengthy trial alone can bring.

Thus, for the present at least, we must confess ourselves some years behind all the rest, and can only hope that the leeway will be made up as soon as possible.

I am, dear Sir, yours very truly,
March 3, 1903. "PRO BONO PUBLICO."

FOOD SUPPLY IN TIME OF WAR.

TO THE EDITOR OF ENGINEERING.

SIR,—I have read with much interest Mr. Wilson's letter, in your last issue, upon our "Food Supply in Time of War," and I quite agree with him in regarding this as one of the most serious problems of our time.

It is pretty certain that if we became involved in a war with one or more of the European powers, we should require all our fleet to guard our coast and fight the enemy: there would be none to spare to convoy grain ships across the ocean. The price of corn would rise in leaps and bounds, and in a few weeks would be quite beyond the purchasing power of the masses—without reckoning the thousands who would be thrown out of employment in consequence of the war; now, it is not in human nature to sit down and starve quietly, and we should have a repetition of the seige of Paris—fighting the enemy without and the revolutionist within.

The only alternative appears to be some such scheme as outlined by Mr. Wilson, but here again we are met by apparently insuperable difficulties; to begin with, Mr. Wilson thinks that if we kept a stock of six million quarters of grain, this would tide us over the most critica period of the year, from May until our own harvest, when we should have another six million quarters available for another four months. Yes; but suppose the war

k_n, C_n, e_n, being the proper values of these quantities for period n.

DETERMINATION OF k_n ON PARTICULAR ASSUMPTION.

We must now determine the values of k_n for the various periods of vibration, which may be taken as approximately correct for an actual ship, on the supposition that it acts somewhat like a thin rod.

The only observations for an actual ship, which I know, are those by Schlick, given in the Transactions of the Institution of Naval Architects for 1895. In the same volume will be found observations by Mallock from a plank so shaped that it may be considered nearly equivalent to a ship. I also use Schlick's figures, in the same paper, for a uniform rod.

The ratios of frequency are :—

TABLE IA.—*Relative Frequency of Vibrations.*

Line.	Number of Nodes.	2	3	4	5	6
a	Schlick, from uniform rod	9.10	24.99	49	81	121
	Ratio of numbers in line *a*	1	2.75	5.38	8.90	13.3
c	Mallock, from uniform rod	1	2.73			
d	Mallock, from plank equivalent to ship ..	1	2 +			
e	Schlick's figures, line *b*, except for 2 nodes, reduced as 2.75 to 2..	1	2	3.91	6.47	9.67
f	Strongly suggested by Yarrow's experiments	1	2	4	6	8

Lines *c* and *d* show that in passing from a straight rod to a ship the relative frequency for 2 and 3 nodes falls from 2.73 to 2. The change will not be quite the same for all ships, depending as it does on the distribution of stiffness and mass of ship and cargo, a change in loading making it somewhat different at different times for the same ship. A reduction, but not usually in exactly the same degree, would affect the numbers for 4, 5, and 6 nodes, in line *b*. If the reduction were in the same proportion, we would obtain line *e*. If line *b* held, the revolutions of the engine which gave synchronism of the first period with a two-nodal vibration would have to be increased considerably before the second period synchronised with a three-nodal, and the fourth period with a four-nodal vibration, and so on. On the other hand, a reduction of revolutions would make sixth-period synchronism with a four-nodal vibration. Again, if line *e* held, first, second, and fourth period would synchronise practically at the same time with two, three, and four-nodal vibrations respectively, while slight increase of revolutions would produce synchronism of sixth period with a five-nodal vibration.

Yarrow's experiments, referred to earlier in this appendix, strongly suggest line *f*. As the engine revolutions rose from 200 to 800 per minute, synchronism may have been successively established with vibrations having 3, 4, 5, and 6 nodes respectively, the frequencies of vibration at which synchronism held being in the proportion 1 : 2 : 3 : 4. It also indicates that possibly the whole set were nearly pure nodal vibrations.*

Macalpine and Flood's observations on the Circassia show first, second, and fourth period in turn becoming most prominent for very slight change in the revolutions, thus giving much the same law. Here it was the second period, however, which had two nodes; the first period had no node, and seems to have been only to a slight extent an elastic vibration.

I will suppose that the vibrations of first, second, fourth, and sixth period have two, three, four, and five nodes respectively, as in line *f*; though another assumption, while altering my figures a little, would in no way vitiate my argument. It should be recollected, however, that rarely in an actual ship will synchronism for the different periods occur at precisely the same revolutions. Indeed, this assumption not being fulfilled exactly, or even approximately, in many ships, is one reason why we have not always several different periods or vibration present at one time.

In the same papers by Schlick and Mallock, used in making Table IA, the positions of the nodes are given. From their figures I take h, making $h\,l$ the half length between the nodes nearest the centre of the ship. The results are tabulated below :—

TABLE IIA.—*Values of h and k.*

Period = n.	Number of Nodes.	Schlick, from Uniform Rod. h.	Schlick, from Uniform Rod. $\frac{2}{h}$	Schlick, from Fine-Lined Ship. h.	Schlick, from Fine-Lined Ship. $\frac{2}{h}$.	Mallock, from Plank, Equivalent to Ship. h.	Mallock, from Plank, Equivalent to Ship. $\frac{2}{h}$.	Values for Rod Increased in Proportion 7.25 to 9.5. k_n.
1st ..	2	.2758	7.25	.191 to .23 Mean .21	10.5 to 8.7 Mean 9.5	.176	11.4	9.5
2nd ..	3	.184	10.9	..	..	.147	13.6	14.3
4th ..	4	.1442	13.9	..	..	..	..	18.2
6th ..	5	.1115	17.9	..	..	..	..	23.5
8th ..	6	.091	22	..	..	..	..	28.8

We see that both for two and three nodal vibrations the nodes are nearer the centre of the ship than they would be for a straight rod. This will also be the case for greater numbers of nodes, and the values of k in the last column may be regarded as very roughly approximate for determining γ.

(*To be continued.*)

* Yarrow's words are:—"Some years since we had a boat in which severe vibration occurred at 200, 400, 600, and 800 revolutions per minute, but there was none at the intermediate speeds of 300, 500, and 700." They are taken from his 1892 paper read before the Institution of Naval Architects. It would have been extremely interesting to know if there was no vibration at 100 revolutions. If the above supposition regarding the number of nodes is correct, synchronism would then have been established with a two-nodal vibration. No doubt the inertia forces were then relatively feeble, and the engine may not have been placed so that it could produce vibration in this mode.

THE RUSSIAN FIRST-CLASS CRUISER "BOGATYR."

(*Concluded from page 310.*)

THE position of the surface condensers in relation to the main engines is shown by Fig. 33, page 380, the cooling surface of each condenser amounting to 1000 square metres (10,764 square feet). The shells of the condensers are of brass plates riveted, and the ends are made of bronze. The circulating water is supplied by centrifugal pumps, placed at the rear end of the engine-rooms, and each driven by a two-cylinder engine. This may also be used as a bilge pump to discharge any water from the engine-room overboard direct, without passing through the condenser.

The two-cylinder air pump, placed in the front portion of each engine-room, is of the Weir type (Fig. 32); it makes fifteen double strokes per minute when the engines are developing their maximum power. The pipe system is so arranged that either pump may be connected with either condenser; injury to one of the pumps would not, therefore, interfere with the working of both engines. The condensed water is delivered into a large feed-water tank, situated amidships in the engine compartment (Fig. 32). Oil-filters are fitted into both the ends of this feed-water tank. The two filters are connected by the main supply pipe for the feed-pumps, a special branch pipe leading from this common main into each of the six stokeholes. There are thus six pipes for the feed-water branching from the tank. By this arrangement the six feed-pumps have their independent supplies, and no trouble can arise from want of uniformity in the feed-water distribution.

Besides the main engines, the following auxiliary machines are erected in the engine compartment :

Near the forward bulkhead, on both sides (Fig. 32) is a one-cylinder steam pump of the Strube type; this pump deals with the bilge water, extinguishes fires, and works the sanitary arrangements. A similar pump, placed near the after bulkhead (Fig. 34), serves the same purpose and also for supplying bath water.

At the back of the engine-room there is, in addition, the potable water plant, with steam pump, filter, and evaporator, capable of supplying 136 tons of sanitary water and 30 tons of drinking water in 24 hours. A similar plant of the same capacity has been erected on the intermediate deck on the port side, above the aft boiler compartment.

Below the first-mentioned potable water plant is the auxiliary condensing plant, consisting of a condenser of the same construction as the chief condensers, and a pumping engine, which operates one air-pump and two circulating pumps for removing the condensed water and supplying the cold water. This auxiliary plant is able to condense the steam of all the auxiliary engines, and to return it to the boilers when the ship is at anchor in port. The two chief condensers are connected with this auxiliary system, and can thus themselves be worked as auxiliary condensers if that should prove desirable.

Near the front engine-room bulkhead, on both sides of the feed-water tank (Fig. 32) there are oil-filters, which separate the oil from the bilge water of the engine-room and render it again applicable.

The two fans which deliver fresh air into the engine-room through several systems of passages are fixed at the back of the engine-room, still under armour protection, and are driven by electric motors.

BOILER ARRANGEMENTS.

There are three boiler-rooms, as has already been mentioned, containing altogether sixteen water-tube boilers of the Normand type. Six are placed in each of the after and the middle compartments; the remaining four being in the front compartment. The stokeholes of the two former compartments are arranged longitudinally, those of the forward compartment athwart the ship. This arrangement had to be adopted in order to find room for the size of boilers decided upon. Each stokehole contains a feed-water heater system of the Normand type, and two single-cylinder Weir feed-pumps. Each of these pumps can keep three or two boilers fully supplied with water at their full efficiency. The arrangement of the feed-water tank has already been explained; the feed-water is drawn from the tank and forced through the heater into the boiler. The feed-water heater is supplied with the exhaust steam of the auxiliary engines, and, if necessary, with steam from the valve-casing of the low-pressure cylinder of the main engine. When the ship was being run at full power under forced draught during the trials, the feed-water temperature rose to between 100 and 103 deg. Cent. (212 deg. and 217.5 deg. Fahr.). This increased the efficiency of the whole boiler plant very materially.

Each stokehole is fitted with a hoist for the ashes; the steam winches operating the hoists being mounted on the upper deck. An amply sufficient supply of air under pressure is secured in the stokeholds by blowers; the after and middle compartments have each eight fans, while six have been put up in the forward compartment. The air supply is so ample to all portions of the grates that the pressure in the stokeholes need not be raised above 15 millimetres (0.59 in.). The forward boiler compartment also contains a pair of auxiliary steam pumps, one on either side. These pumps give drinking water and water for the baths.

BOILERS.

The construction of the sixteen Normand boilers is explained by the engravings, Figs. 35 to 43, page 381. The heating surfaces of the sixteen boilers totals 4714 square metres (nearly 50,800 square feet), and the grate area 91.6 square metres (986 square feet). The working steam pressure is 18 kilogrammes per square centimetre, equivalent to 256 lb. per square inch. Each boiler has one upper steam drum and two lower water drums, with two furnace doors. The boiler fittings are of the usual type; the feed-water regulation is very exact, and renders the strictly automatic feed absolutely reliable. Each boiler is connected to the auxiliary steam mains, and may thus serve separately or together for auxiliary duty in part. For this purpose dampers have been fitted to each boiler, by means of which all boilers, except the one or two in use, can be cut off from the flues and uptakes.

The steam generated in the boilers is sent to the engines through six systems of pipes; that is to say, there is on each side of the ship a separate system of steam mains leading from each of the six groups of boilers to the front bulkhead of the engine-room. At that spot there are, as shown on the section, Fig. 32, page 380, the cut-off valves for each pipe system. The three-pipe systems of both sides are joined, within the boiler-room, by a junction-pipe, which, however, can be shut out; they distribute the steam to the separators, whence it passes to the two high-pressure cylinders. Each of these cylinders can be again cut off from the steam mains by double valves. Every precaution has thus been adopted for insuring safe working. The auxiliary steam-pipe system is similarly joined to all the boilers and all the auxiliary engines, and there is a corresponding exhaust-pipe system which takes the

AUXILIARY MACHINERY OF THE RUSSIAN CRUISER "BOGATYR."

CONSTRUCTED BY THE STETTINER MASCHINENBAU ACTIEN-GESELLSCHAFT VULCAN, BREDOW, STETTIN.

Fig. 32. Section at Frame 45.

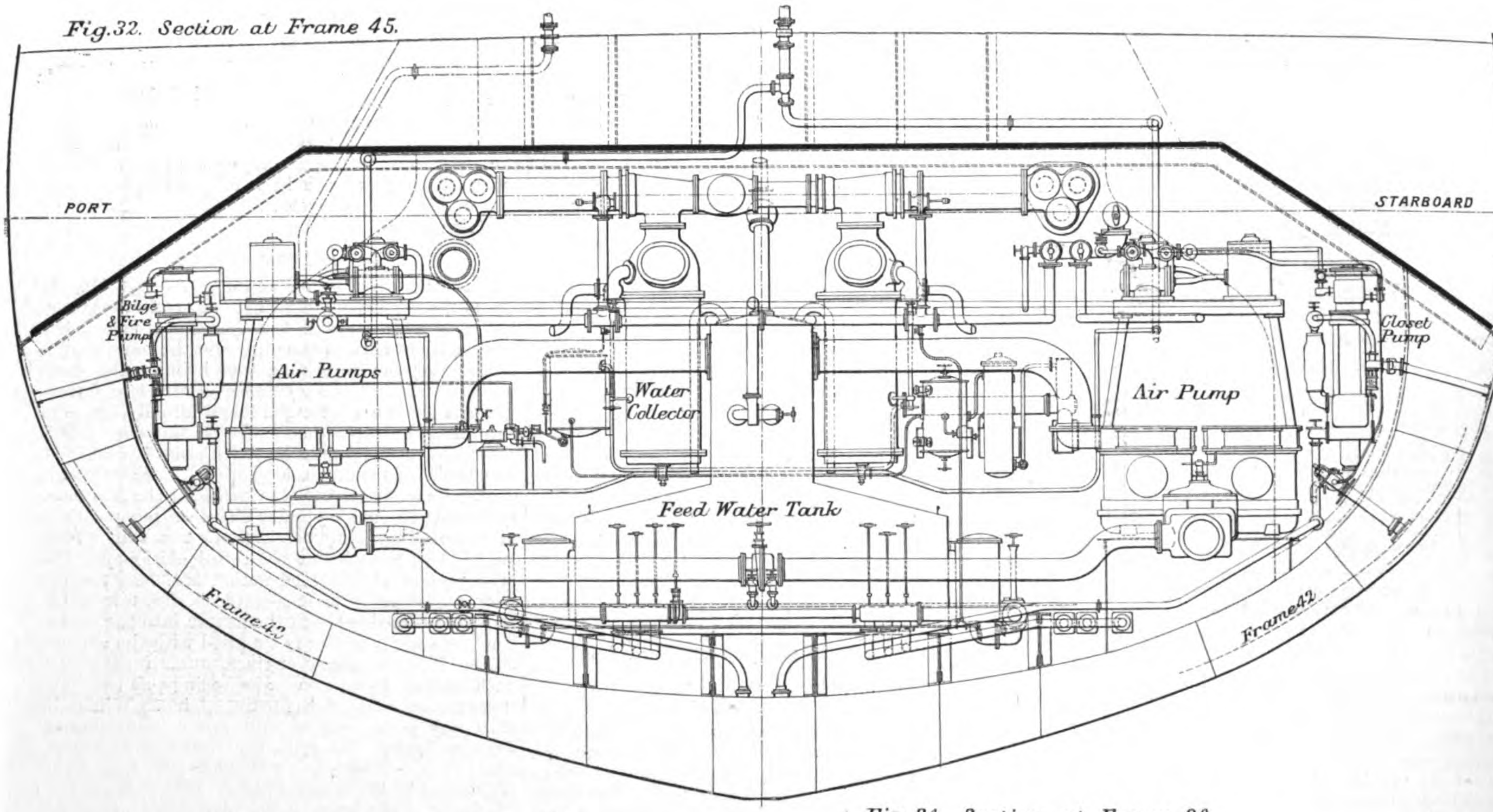
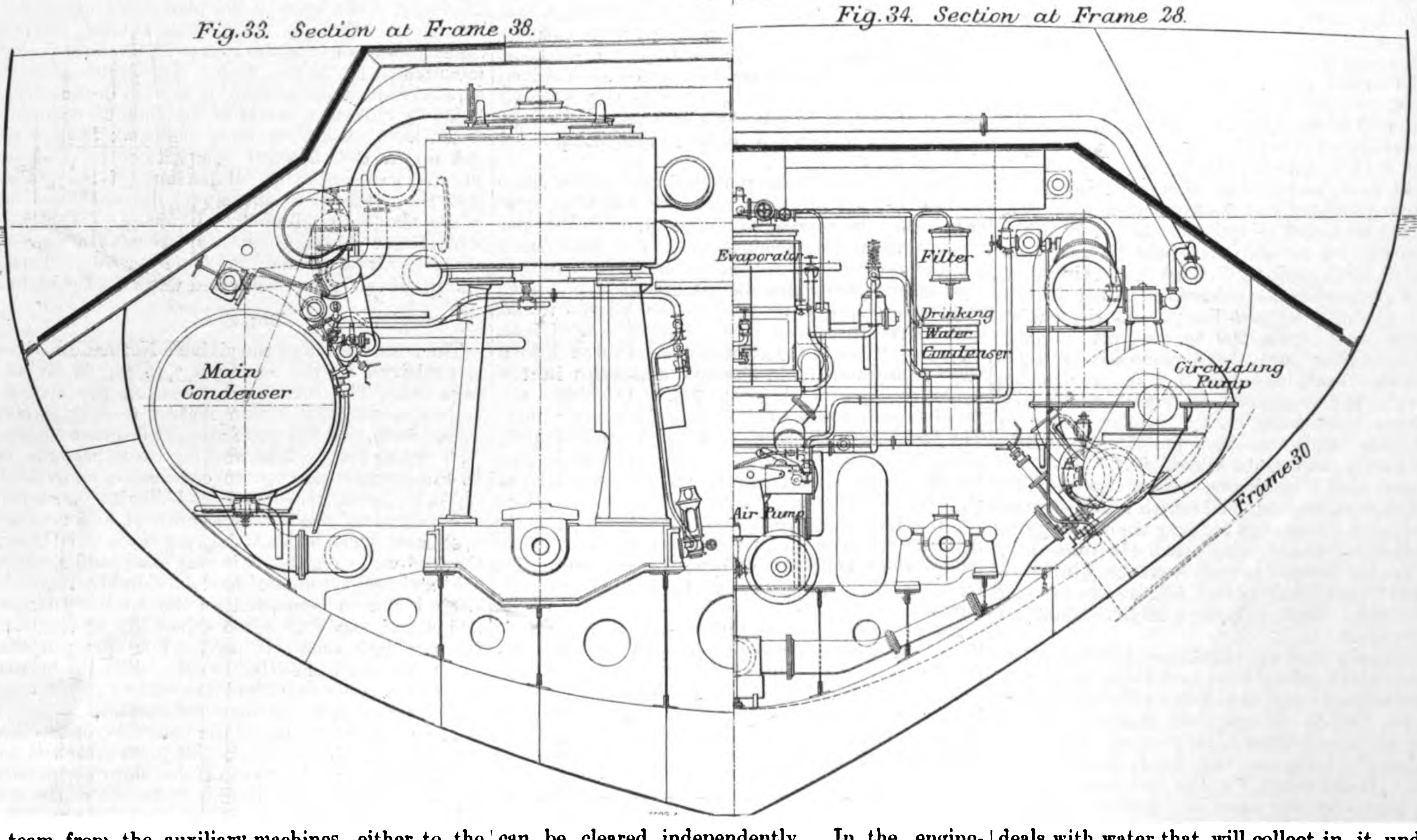


Fig. 33. Section at Frame 38.

Fig. 34. Section at Frame 28.



team from the auxiliary machines, either to the auxiliary condenser or to the feed-water heater, or to the atmosphere.

BILGE PUMPS IN THE ENGINE AND BOILER ROOMS.

The bilge water circulation forms a feature to which the Russian Navy devotes particular attention, and in the case of the Bogatyr it has been arranged on the Russian plan. There is in the Russian Navy no bilge main passing through all the compartments, as is the custom in other navies. Each compartment — and, above all, the engine and boiler rooms—has its own independent bilge plant, and can be cleared independently. In the engine-rooms of the Bogatyr this is effected by the two centrifugal pumps and the three bilge pumps already referred to. In each boiler compartment there is a pair of bilge turbines, one on each side, driven by electric motors mounted on the armoured deck. The dimensions of these turbines are such that each can empty within three-quarters of an hour the boiler compartment in which it is placed, even should the water level be up to the intermediate deck. This is not an estimate, but has been demonstrated by actual experiment. Each compartment is further provided with a steam bilge pump, which deals with water that will collect in it under ordinary conditions.

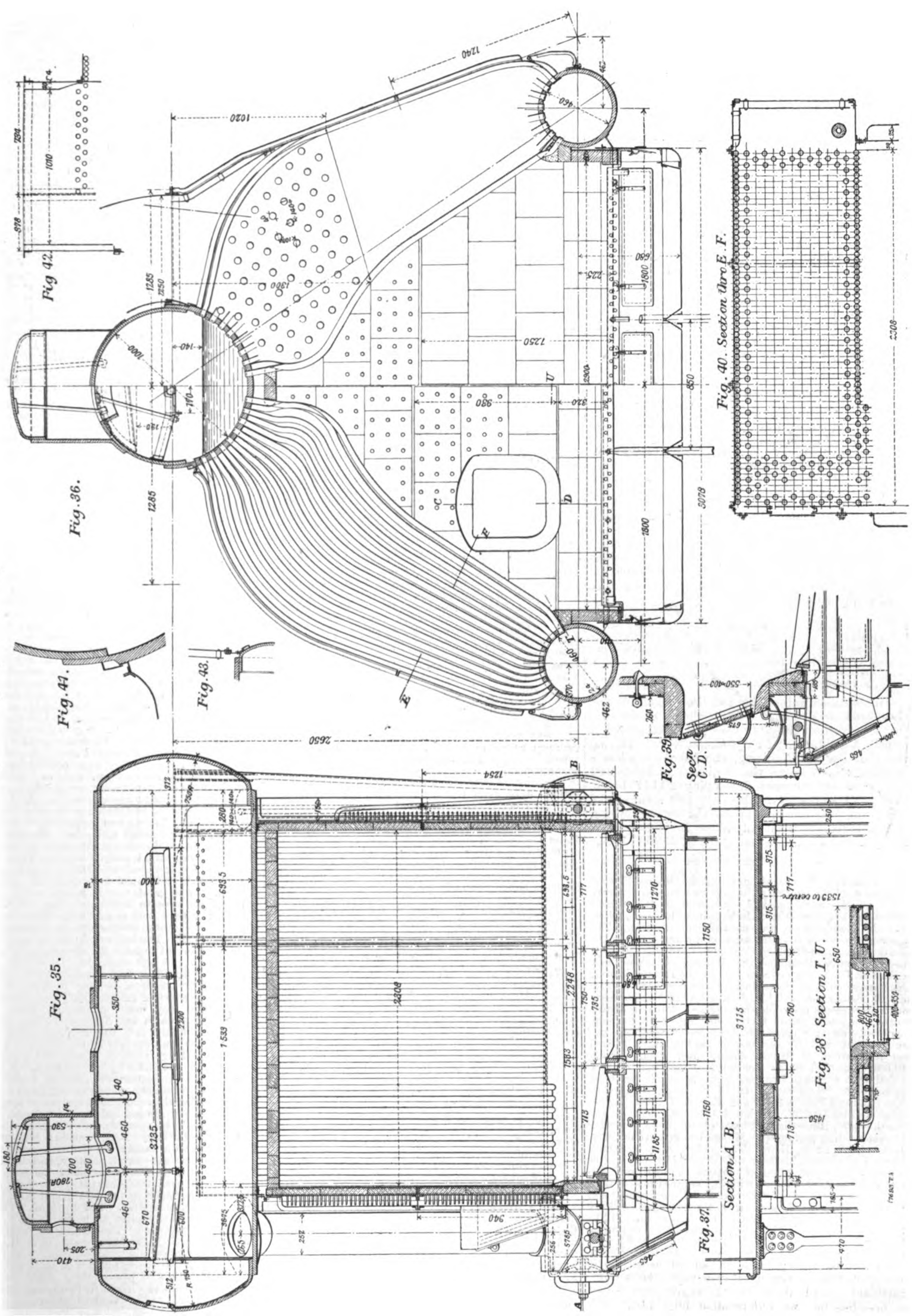
SPEED TRIALS.

In December, 1901, the Bogatyr steamed into the Baltic for her preliminary trials, which were eminently satisfactory. After her completion, the official trials took place on July 20, 22, and 23, 1902. Before starting each trial the ship was brought to her stipulated draught of 20 ft. 8 in. at the bow, and 20 ft. 9 in. at the stern, giving a mean of 20 ft. 8½ in. Under these normal conditions, the Bogatyr displaced 6750 tons. With this draught the ship first made her mile runs over the measured track of the German Navy at Neukrug, in the Bay

BOILERS (NORMAND TYPE) OF THE RUSSIAN PROTECTED CRUISER "BOGATYR."

CONSTRUCTED BY THE STETTINER MASCHINENBAU ACTIEN-GESELLSCHAFT VULCAN, BREDOW, STETTIN.

(For Description, see Page 379.)



of Danzig. The mile was traversed four times with the following results:

Number of Trial.	Speed.	Indicated Horse-Power.
	knots	
1	23.34	20,365
2	23.72	20,530
3	23.22	19,725
4	23.53	20,023
Mean of means of four runs ...	23.452	20,161
Mean air pressure in stokeholds ...	13 mm. (0.51 in.)	
Mean slip of propeller, about ...	12.5 per cent.	

The boilers having been cleaned, the first six hours forced-draught trial followed on July 22, between Danzig and the Island of Bornholm; and and on July 23 the second run was made under the same conditions between Bornholm and the port of Swinemunde at the mouth of the Oder. During the interval between these two runs, nothing was done beyond clearing slag from the grate bars of the boilers; any other operations at the engines or boilers would have been a violation of the terms of the contract.

The results of these two trials are summed up below:—

	First Run.	Second Run.
Mean air pressure in stokeholds	14 mm. (0.55 in.)	15.5 mm. (0.61 in.)
Indicated horse-power ...	20,196	20,343
Number of revolutions ...	150.85	151.6
Average speed	24.09 knots	24.21 knots
Coal consumption per indicated horse-power in kg.	0.646 kg.	0.655 kg.
Ditto, in lb.	1.42 lb.	1.44 lb.

The high-pressure cylinder worked with a cut-off of 62 per cent., the possible maximum being 73 per cent. Steam pressure was maintained with ease; there is thus something to spare both in the boilers and in the machinery. The subjoined Table demonstrates that the contract conditions were more than amply satisfied:

	Contract Requirements.	Mean Results Obtained.
Speed...	23 knots	24.15 knots
Air pressure... ...	52 mm. (2 in.)	15 mm. (0.59 in.)
Coal consumption per indicated horse-power per hour ...	0.91 kg. (2 lb.)	0.65 kg. (1.43 lb.

An additional interesting fact brought out during these trials was the marked superiority of the two-propeller cruiser Bogatyr over the three-propeller cruiser Askold, also of the Russian Navy. During the mile tests at Neukrug, the Askold reached a speed of 23.357 knots, the displacement being 5981 tons, and the engines developing 20,017 horse-power. The Bogatyr, with only two screws, and displacing 800 tons more than the three-propeller ship Askold, absorbed only about the same power, and yet attained the higher speed of 23.452 knots.

CONTRACTS.—We are informed that the General Electric Company, of Schenectady, have been awarded the contract for the entire control equipment of the electric trains for the New York Underground Railway, which will be made up on the multiple-unit system. The system here adopted is the same as is being fitted by the British Thomson-Houston Company, Limited, of Rugby, to the Great Northern and City Railway and other lines. —Messrs. C. A. Parsons and Co., of the Heaton Works, Newcastle-on-Tyne, have just received an order from Sir B. Samuelson and Co., Limited, of Middlesbrough, for a large steam turbo-blowing engine. The new engine will consist of a steam turbine driving an air turbine, and will run at a speed of about 3000 revolutions per minute. It will be capable of maintaining a normal air pressure of 12 lb. per square inch when blowing 16,000 cubic feet of air per minute, and will be provided with a steam bye-pass valve to enable the blast pressure to be increased to 15 lb. when required.—The Sandwell Park colliery and Earl of Dudley, Baggeridge Sinking (H. W. Hughes, F.G.S., engineer) in the South Staffordshire district, have placed their order for Corliss winding engines with Messrs. Fraser and Chalmers, Limited, of Erith, Kent. This order, it is especially interesting to note, has been placed in this country after a thorough investigation of current English and Continental practice. These winding engines are of 3000 horse-power each, will be duplicates of each other, and will be among the largest, if not the largest, colliery winding engines in the country. The duty of each will be 3000 tons per day of eight hours, from a depth of 600 yards. The coal per trip which will be wound will be 7½ tons, and the engines will eventually run condensing with 150 lb. initial steam pressure. Each will be a pair of tandem compound engines, with a 26-in. high-pressure cylinder and a 45-in. low-pressure cylinder by 66 in. stroke. The drum will be slightly conical at the start, and then cylindrical, and its diameter 17 ft.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—Last Thursday forenoon the pig-iron market was firm for Cleveland warrants, and hematite iron was steady, but only a small business of some 4000 tons was done. Cleveland changed hands up to 51s. 4d. per ton one month, and one lot of hematite iron was done at 60s. 10½d. 25 days. In the afternoon Cleveland was very strong, in sympathy with the rise in metals, copper having been done on Thursday in the London market up to 67*l*. April, and tin up to 141*l*. per ton cash. The turnover in Cleveland warrants was about 10,000 tons, the top price being 51s. 7½d. per ton cash and 51s. 10½d. one month. The settlement prices were: Scotch, 56s. 6d.; Cleveland, 51s.; Cumberland hematite iron, 60s. 9d. per ton. The market was again very firm on Friday forenoon in sympathy with the advance in the prices of other metals. Cleveland warrants were done up to 51s. 10d. cash, and at the close buyers were quoted 1d. above that figure. One lot of hematite iron changed hands at 61s. per ton cash, but Scotch iron was not in demand, and the turnover was about 10,000 tons. Prices eased off a little in the afternoon, Cleveland being done at 51s. 10d., but closing buyers ½d. per ton lower, or 1½d. under the forenoon quotation; there was a turnover of something like 10,000 tons. Very little change was shown by the settlement prices. A quiet business was transacted on Monday forenoon, the only thing reported being one lot of Cleveland iron which was done at 51s. 10s. one month. Cleveland was also done at 51s. 6½d. and 51s. 7½d. per ton for three months forward. In the afternoon there was an improvement in prices, as also in the volume of business transacted. Cleveland warrants changed hands up to 51s. 10d. per ton cash, and hematite iron was steady at 61s. cash. The quantity of iron which changed hands amounted to about 8000 tons; and the settlement prices were:—57s., 51s. 7½d., and 61s. per ton. A moderate amount of business was done on Tuesday, more especially in Cleveland iron, and prices were firm, the close showing a gain for the day of 1½d. per ton. The business done consisted of two lots of Cleveland warrants at 51s. 10½d. cash, and one lot of No. 3 Scotch at 54s. 6d. per ton cash. The price of Cleveland warrants was somewhat irregular in the afternoon, being done up to 52s. 0½d. per ton cash, and receding to 51s. 11½d., and closing ½d. below that figure. About 8000 tons were included in the afternoon business. One lot of hematite iron realised 61s. 3d. per ton cash; and the settlement prices were 57s., 51s. 10½d., and 61s. per ton. The market was strong this forenoon on reports from Germany. It seems that the exports from that country have been on such a large scale that there is a shortage for home consumption. Cleveland opened firm at 52s. cash. Hematite iron was dearer at 61s. 6d., and the turnover was about 12,000 tons. In the afternoon about 8000 tons of Cleveland changed hands. To-day's settlement prices for pig iron were:—57s., 52s. 3d., and 61s. 3d. The following are the market quotations for makers' No. 1 iron:—Clyde and Calder, 65s. per ton; Gartsherrie, 65s. 6d.; Summerlee, 68s. 6d.; Langloan, 70s. 6d.; Coltness, 71s. 6d.—all the foregoing shipped at Glasgow; Glengarnock (shipped at Ardrossan), 65s. 6d.; Shotts (shipped at Leith), 66s. 6d.; Carron (shipped at Grangemouth), 67s. 6d. per ton. A considerable effect has taken place during the week in consequence of the excited advances that have occurred in the prices of copper and tin and other metals. Transactions have been confined chiefly to Cleveland iron. Reports from America are very varied. Inquiries are certainly numerous, and of all sorts and sizes, but it is difficult to trace actual fresh business as the resultant. From Germany there are fairly good reports, but that country is now nearly independent of any outside supplies of raw products. There are reports of two big sales of a total of 7000 tons of Cumberland iron for the United States. Home trade reports retain their placid level of mediocrity, with makers inclined in some instances to shade quotations. The price of Cumberland iron has advanced to 61s. per ton. There are still 84 furnaces in blast, as compared with 62 at this time last year. The shipments for the year up till last Saturday amounted to 72,878 tons, against 59,446 tons at the same time last year.

Finished Iron and Steel.—Business in the Scotch steel trade is fairly active, and the prices may now be taken to be ruling firm at 5*l*. 17s. 6d. per ton for plates, and 5*l*. 10s. for angle bars. There have been a few orders placed at those prices, although not many, if any, large contracts have been made at the advanced rates. In view, however, of the advance in the price of pig iron, there is not much likelihood of any falling off in the price of finished material, the tendency being rather upwards. The steel works and malleable iron works in Scotland are all fairly well employed, and likely to be so for some time.

Sulphate of Ammonia.—The market for sulphate of ammonia is very firm at 12*l*. 15s. to 12*l*. 17s. 6d. per ton f.o.b. Leith, and sellers hold out for 13*l*. per ton. The shipments for the year to the last reckoning date show a decrease of 3883 tons, when compared with those for the corresponding period of last year. There is a prospect of prices of sulphate going up still further. Business was done at 13*l*. 5s. per ton.

West of Scotland Coal Trade.—The coal trade of the West of Scotland has not improved during the past week. Orders are not too plentiful for round coal, and prices are inclined to sag; but all kinds of small-sized fuel are in good demand, and values rule firm. House coal is in somewhat lessened request, but otherwise unchanged. Steam coal moves off moderately well at rather under last week's figure. Splint gives evidence of large outputs, against which the demand is scarcely equal; consequently buyers are in a comparatively favourable position when arranging for their requirements. Ell of the best quality has a good outlet at present, with prices steady, but the lower grades of this class are not so happily situated, and prices are shaded in some cases to induce sales. Treble and double nuts are in fairly good demand for home consumption and export, and prices show no further falling off meantime. First-class dross and single nuts and all manner of small stuffs have a very ready market, with prices fully maintained. Quotations f.o.b. Glasgow may be taken to-day as follows:—Steam coal, 9s. 6d. to 9s. 9d.; splint, 9s. 6d. to 10s.; and ell, 9s. to 9s. 9d. according to quality.

Steamers for the China Coasting Trade.—It is reported that Messrs. Scott and Co., Greenock, have contracted to build two screw steamers, each of 2000 tons, for the China Navigation Company, Limited, for the China coasting trade.

INSTITUTION OF CIVIL ENGINEERS.—On Wednesday evening, the annual dinner of the Institution of Civil Engineers took place, under the presidency of Mr. J. Clarke Hawkshaw, in the beautiful hall of Lincoln's Inn. There were a large number of guests, including the Right Hon. Lord Ashbourne, Lord Chancellor of Ireland, the Right Hon. Lord Selborne, First Lord of the Admiralty, Lord Monkswell, Lord Farrer, the Hon. Mr. Justice Channel, Lieut.-General Owen, Earl Cawdor, the Right Hon. Lord George Hamilton, and Sir George Kekewich. Unfortunately, the Right Hon. the Earl of Halsbury, Lord High Chancellor, the Right Hon. W. H. Long, and Mr. Arnold Forster were prevented at the last moment from attending. Covers were laid for 218 members and guests. After the loyal toasts, the toast of "Our National Defenders" was proposed by Lord George Hamilton. He referred to the debates which had been going on in Parliament in connection with the Army and the Navy, and said there was a great difference of opinion as to the number of regular troops required in this country. He congratulated the institution on the very earnest spirit of reform with regard to the Navy which was being shown by Lord Selborne. With regard to the Army, he did not hold out much hope of improvement. He said that the Army did not lend itself to reform, and no army had ever been radically reformed except under the pressure of great national disaster or collapse. Hitherto our army had avoided such contingencies; it had always managed to struggle through the difficulties which it had met. The Government were doing their best to attract ability to the Army, and to retain it, and were making a study how to amalgamate the volunteers with the regulars, so that they should both be available in time of war. He paid a tribute to Mr. Brodrick's great courage in attacking the problem. The toast was replied to by the Earl of Selborne, who spoke mainly in connection with the new scheme for the entrance of officers to the Navy. He said the critics had asserted that this scheme was a reflection on naval officers; this was a view that he repudiated most emphatically. The officers were beyond praise, and deserved well of the country; they had taken every opportunity of perfecting themselves, and all that the Admiralty were trying to do was to give them further facilities for this purpose. They wanted to make them perfect seamen, and perfect leaders of men. A great part of the duties which formerly fell upon officers had disappeared with the removal of masts and sails, and in future the Admiralty were desirous that officers should be not only perfect in gunnery and torpedo work, but should also be specialised engineers, and should be familiar with machinery —both steam, electric, and hydraulic—in the same way as they were now familiar with guns. They could no longer afford to divide the officers into sections, which he might liken to water-tight compartments. They had a large number of officers—about 1500—and they intended that they should all become acquainted with executive duties. In a great war it might easily happen that men might have to undertake other duties than those for which they had specialised. There was much to learn, but if they commenced early enough there was time for it all. The best naval opinion held the view that it was important to catch the officers young, and inoculate them with the sea character. Of course, early entry meant nomination instead of competition. Personally he preferred competition, because it saved the Admiralty from a very serious responsibility, but it was a responsibility that they must undertake. There had always been nomination in the Navy, and when they compared the naval officers and the military officers, the latter of whom entered entirely by competition, he would say, without making invidious comparisions, that the naval officers did not suffer by the contrast. It had been objected that nomination was not in harmony with the democratic character of our Government; but it must be remembered that under a system of competition the rich man's son always had the advantage, other things being equal, because his father could afford the best instruction for him. He had made a computation of the total cost to a father for the entrance of his son to the three services—naval, military, and civil. He found that before the father was quit of his responsibility, he would have paid 1600*l*. for entrance to the Civil Service, 1100*l*. for entrance to the Army, and 800*l*. to the Navy, under the new system. The toast of "The Houses of Parliament" was replied to by Earl Cawdor, while Lord Ashbourne proposed "The Institution," coupled with the name of Mr. J. Clarke Hawkshaw. In reply the President explained that certain technical colleges and universities were adding to the stringency of their examinations, so that students who passed them could be received as associate members without further examination. He also briefly referred to the Standardisation Committees, which were nearing the completion of their work.