of maintaining the engines and boilers in readiness for immediate service?

A letter was read from the chief engineer of the Oregon in this connection. The fires were spread thin, and the result was she used from 24 to 27 tons daily, much less than any similar ship. It may be said that your correspondent has had several opportunities of late to talk with officers of the fleet, and that the Oregon, within 15 minutes of the first signal of the advance of Admiral Cervera's fleet, was going ahead at full speed. Passed Assistant Engineer Walter McFarlane, Chief Assistant of Commodore Melville, presented the following account of the coal consumption:

| | Tons per Day. | Pounds per Square Foot Grate per Hour. |
|---|---|---|
| Indiana ... ... | 34.7 | 7.21 |
| Iowa ... ... ... | 35.16 | 5.2 |
| Massachusetts ... | 29.4 | 6.5 |
| Oregon ... ... ... | 24.91 | 4.35 |

As the Massachusetts, Iowa, and Oregon had spread fires, it showed that in addition to their great advantage as being ready for immediate use, they were economical.

### Excursions.

This closed the discussions, and there was a fine banquet at Delmonico's that evening. The next day the party started for Bethlehem, to visit by invitation the works of the Bethlehem Iron Company. On their arrival, the party were taken through the works in flat cars, and then were given the opportunity for personal inspection. This transportation by train was quite necessary, for the works are over a mile long. They stopped in the forge shop in front of the 5000-ton Whitworth press, and witnessed the forging of a 10-ton hollow ingot into a jacket for a 12-in. gun. The pumps used for the power can exert 2250 lb. pressure per square inch. Near by was a 1300-ton press, where the end of an ingot was being cut off. There was also in sight a four-throw crankshaft, a view of which is given in Fig. 87 (see page 823), designed by Mr. C. D. Mosher for the steam yacht Nada, building for Mr. C. R. Flint. The diameter of shaft and pins is 5 in., diameter of bores 3 in., 3½ in., and 4 in., length 9 ft. 5 in., and the following are the physical properties determined by testing specimens 2 in. long between measuring points. Tensile strength 95,240 lb.; elastic limit 56,020 lb., elongation 22.60 per cent.; contraction 47.57 per cent. The observation train was then hauled in front of the open-hearth furnaces, whose capacity is from 40 to 50 tons. The ingot-casting pit, some 20 ft. deep, was directly in front, and the ladle, capable of containing 15 tons, was at once filled by a stream of molten steel. The ladle was then run over the ingot moulds, which are 16 ft. long, and a 2-in. stream of steel was allowed to flow till they were filled; then the mould was run under the Whitworth press and 9000 tons pressure applied. The pressure is continued for six hours, at a reduction in length, of the ingot, of about 12 per cent. In order to prevent the escape of the metal from the mould, there is annular space around the plunger of about ¼ in., and as the pressure is applied gradually, this space fills with molten steel, which is allowed to chill, and thus the balance is held and there is no overflow. The observation train was then run through the machine shop, some 1400 ft. long. Each piece of work under construction was labelled, so that the members could readily see what it was; and it was noted that guns of various size, disappearing carriages, rifled mortars, and engine shafts of enormous proportions, were being finished here. Peace and war strangely combined, for the shafts were for industrial purposes for the most part. As a sample of the latter, the hollow shaft shown in Fig. 88 (see page 823) may be noted.

This is one of six similar fluid compressed open-hearth steel shafts, forged hollow on a mandril for the Edw. P. Allis Company, Milwaukee, Wis., for 7500 horse-power central station for the Metropolitan Street Railway Company, New York City. The following are the dimensions of the shaft:

| | |
|---|---|
| Diameter of flywheel fit... ... ... | 37 in. |
| ,, journals ... ... ... | 34 ,, |
| ,, crank fit ... ... ... | 30 ,, |
| ,, axial hole ... ... ... | 16 ,, |
| Length over all ... ... ... ... | 27 ft. 4 in. |
| Weight estimated ... ... ... | 70,000 |

Your correspondent also noted a new connecting-rod for the s.s. Paris, known through this little Spanish trouble as the Yale, and which, under the able command of Captain Watkins—who, like his ship, has returned to peaceful pursuits—gave such a good account of herself in the Cuban waters. The armour-plate department was next visited, where the 13,000-ton press was busy on a 15-in. plate. The original ingot, it was said, weighed 102,000 lb., while the finished plate would weigh about 67,000 lb. We also saw some curved plates constituting a portion of the after barbette of the Alabama; they consisted of seven 15-in. plates and four 10-in., 12 ft. high and 9 ft. 8 in. wide. Near by was a plate 8 in. by 10 in. being hardened for a safe deposit vault, which it would seem could defy any burglar's tools, including dynamite. The plate, at a high temperature, was placed over a large tank, and by means of a series of jets, water was applied to both surfaces. It was very interesting to watch the change of colour from an almost white to a cherry red, and then to black.

We saw one man in this establishment who seemed to fill the Irishman's idea of a bishop, when he said: "For a good lazy job, give me a bishop." This workman had charge of a saw which was cutting through a 15-in. plate. The saw was a circular disc about 4 ft. in diameter, and if matters

## TESTS OF 6¼-IN. KRUPP PROCESS ARMOUR-PLATE.

MANUFACTURED BY THE BETHLEHEM IRON COMPANY, BETHLEHEM, PA.

(*For Description, see Page* 825.)

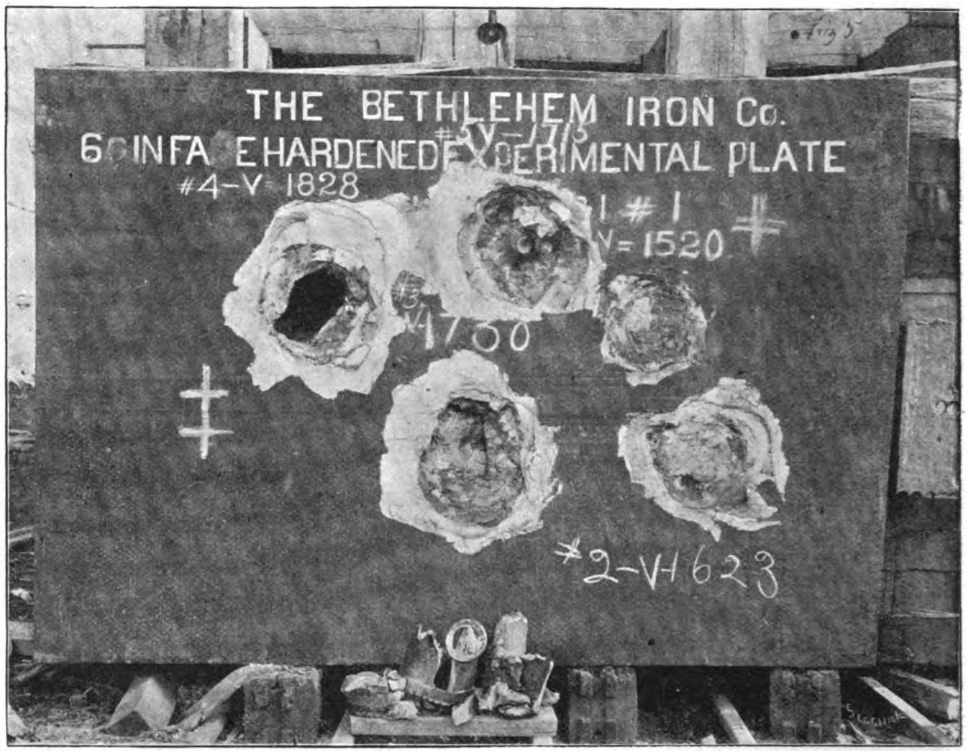


Fig. 89. Appearance of Plate After Fifth Round.

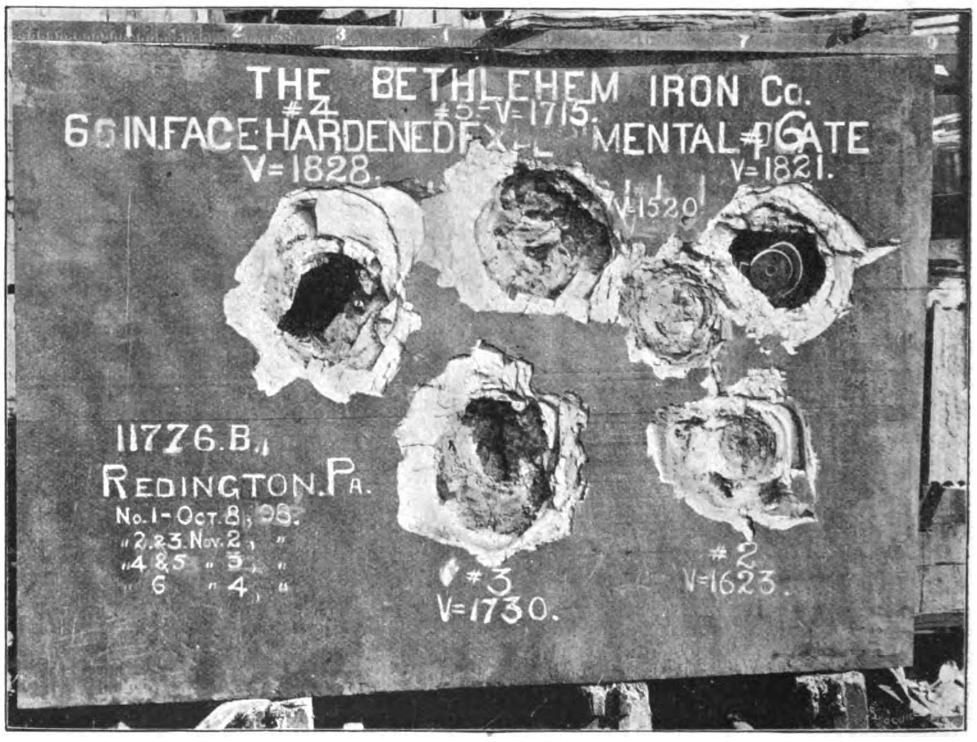


Fig. 90. Appearance of Plate After Sixth Round.

went well would complete the job in a week. The workman had to be on hand only, but the superintendent told your correspondent, if matters did not go well, the man might be kept very busy for a long time fixing up things. It looked lazy, but it was not. The writer suggested he might study Spanish in the interim, at which the superintendent scoffed. The tempering plant was next examined. There was not much to see, but the result was satisfactory. A crane lifted a jacket for a 12-in. gun, some 20 in. thick and 20 ft. long, from the gas blast-furnace, and lowered it into a cylindrical tank filled with oil, where it remains six hours. The jacket was at a high temperature, and the flame and smoke made a fine sight.

It was a subject of remark, throughout all this trip, how carefully it had been planned so as to bring the party in front of some apparatus just at the moment it was ready to be used. The writer has never seen a trip of this character conducted with less delay, and what many regarded as a happy accident was simply the successful result of carefully matured plans.

It had been a part of the original programme to take the party to the proving ground and show them some tests against the armour-plate, but it was absolutely impossible to crowd anything more into the time allotted, except, perhaps, a bountiful lunch, which was then "crowded" into the members, and not by any hydraulic press either, but rather by condensed grape-shot, if Moet and Chandon's product might be so classified. It was labelled "extra dry," and that described the condition of all the visitors, for it was fully 2 P.M., and they had been obliged to breakfast early, and had ridden some 80 miles and tramped a few more. The writer, however, had cultivated some of the managers of the works; and while he cannot present to the readers of ENGINEERING the story of the actual tests, he is enabled by the courtesy of these gentlemen to present the photographic results, and a brief account of them as follows:

REPORT OF 6¼-IN. KRUPP PROCESS ARMOUR-PLATE, 11,776 B1.

*Made by the Bethlehem Iron Company. Tested at Redington Proving Ground.*

Plate mounted on backing of 12 in. of oak, and 1⅜ in. soft steel skin plate, and attacked by 8-in. Navy rifle. Size of plate 108 in. by 74 in. by 6¼ in.

*First Round, Fired October* 8, 1898.—An 8-in. French Holtzer armour-piercing projectile, No. 190. Weight, 250½ lb.; struck the plate with a velocity of 1520 foot-seconds, developing an energy of 4017 foot-tons. Penetration, ¾ in. Point of impact 30 in. from top edge and 30½ in. from right-hand end of plate. Projectile was completely broken and thrown to rear. Plate and backing uninjured.

*Second Round, Fired November* 2, 1898.—Projectile 8-in. Midvale Holtzer No. W. 106, 1898 manufacture. Weight 252½ lb.; striking velocity, 1623½ foot-seconds; energy, 4619 foot-tons. Point of impact 23 in. from right end, 26 in. from bottom edge of plate, and 18½ in. from impact No. 1. Penetration, 2½ in. Point of shot fused to plate, and remainder broken and thrown to rear. No radial or other cracks. Slight spawling off of face of plate around shot hole. One backing bolt broken, and wood of backing splintered at right end of plate.

*Third Round, Fired November* 2, 1898.—Projectile, 8-in. Midvale Holtzer No. W. 1145, 1898 manufacture. Weight, 252 lb.; striking velocity, 1730 foot-seconds; energy, 5234 foot-tons. Point of impact 27 in. from bottom edge of plate, 27 in. from impact No. 1, and 29 in. from impact No. 2. Penetration, 6¼ in. No cracks whatever. Slight spawling off of face of plate around shot hole. Head of projectile fused to plate, and remainder broken and thrown to rear.

*Fourth Round, Fired November* 3, 1898.—Projectile, Midvale Holtzer, No. W. 1144, 1896 manufacture. Weight, 252½ lb.; striking velocity, 1828 foot-seconds; energy, 5847 foot-tons. Point of impact, 28 in. from top edge, 34 in. from left end, and 26 in. from impact No. 3. Projectile passed through plate and backing, the broken pieces lodging in sand-butt. No cracks in plate. Slight spawling off of face of plate around shot-hole.

*Fifth Round, Fired November* 3, 1898.—Projectile, Midvale Holtzer, No. W. 1146, 1898 manufacture. Weight, 252 lb.; striking velocity, 173 foot-seconds; energy, 5144 foot-tons. Point of impact, 21 in. from top end of plate, 26 in. from impact No. 4, 26 in. from impact No. 3, and 18 in. from impact No. 1. Penetration, 5 in. No cracks in plate. Slight spawling off of face of plate. Projectile broken and thrown to rear. Plate and backing uninjured. (See Fig. 89, page 824.)

*Sixth Round, Fired November* 4, 1898.—Projectile, Midvale Holtzer, No. W. 1268, 1898 manufacture. Weight, 252¼ lb.; striking velocity, 1821 foot-seconds; energy, 5807 foot-tons. Point of impact, 24 in. from top edge, 17 in. from right end of plate, and 14 in. from impact No. 1. Projectile penetrated, and broken pieces lodged in plate and backing. The skin plate bulged, but not cracked. Slight spawling off of face of plate around shot hole. No cracks in plate, although this shot was very close to the corner of the plate and to impact No. 1, and the backing supporting this portion of the plate had been badly splintered by previous shots (Fig. 90).

*Firing Test of Krupp Process Armour-Plate; October-November*, 1898.

| Round. | Gun. | Velocity. | Weight of Shot. | Energy. | Penetration of Actual Plate. | Factor above, De Marre Formula. |
|---|---|---|---|---|---|---|
| | in. | ft.-sec. | | ft.-tons | in. | |
| 1 | 8 | 1520 | 250½ | 4,017 | ¾ | 1.37 |
| 2 | 8 | 1623½ | 252½ | 4,619 | 2½ | 1.47 |
| 3 | 8 | 1730 | 252 | 5,234 | 6¼ | 1.56 |
| 4 | 8 | 1828 | 252½ | 5,847 | Perforated. | 1.65 |
| 5 | 8 | 1735 | 252 | 5,144 | 5 | 1.55 |
| 6 | 8 | 1821 | 252¼ | 5,807 | Projectile broken up and lodged in backing. Skin plate bulged but not open | 1.65 |
| Total energy | | .. | .. | 30,668 | | |

Last column of Table gives the factor obtained by dividing the actual velocity by velocity calculated by De Marre formula for perforating steel plate of equal thickness.

After the lunch was concluded, and thanks offered, the party returned to their cars and were landed in New York about 6 P.M.—well pleased with what they saw at Bethlehem, and delighted with the hospitality and courtesy of the Bethlehem Iron Company. The writer desires to express his special thanks to Mr. Robert P. Lindemann, the President, and to Mr. Robert Sayre, Junr., and to Mr. H. F. J. Porter, as it is through their efforts he was able to lay this full account before the readers of ENGINEERING.

## TUBE-MAKING MACHINERY.

ON page 826 we give two illustrations taken from photographs of the interior of the Alma Tube Works of Messrs. John Russell and Co., Limited, Walsall. It will be remembered that we described these works in connection with the visit paid to them last year at the Birmingham meeting of the Institution of Mechanical Engineers.* Fig. 1 is a general view of the mill train used in rolling down billets for solid-drawn tubes. As stated in our previous notice, the manufacture of solid-drawn tubes consists essentially of two main processes, rolling and drawing. The first is a hot process, and the latter a cold process. The tube-maker commences with steel billets of a size varying in accordance with the description of tube to be produced. As an average they may be taken as about 6 in. in diameter and 18 in. to 24 in. long. An axial hole is first bored. This hole will be from 1 in. to 1½ in. in diameter for Belleville boiler tubes. The billet is then heated in a furnace, and a mandril is forced through to enlarge the hole by means of a hydraulic press. The billet having been thus prepared, is again placed in a furnace, and then carried to the grooved rolls, which we now illustrate. As it is passed through, it is, at the same time, forced on to a mandril, the latter being kept in position in the grooves of the rolls by a long bar projecting out at the back of the rolls, and held by means of a rack or cross-bar. This rack is not shown in our illustration, which is a front view. It will, however, be understood that the rack lies parallel with the axis of the rolls, and is at a sufficient distance from them to allow space for the longest length of tube to be rolled. As the billet is worked it becomes longer at each pass. The rod supporting the mandril is naturally in compression, and each time the tube is forced over the mandril it encircles the rod, and therefore has to be stripped off for the next operation. For smaller diameter tubes the rod, naturally, has to be thinner, and will therefore not have sufficient section to act as a strut, or be stiff enough to stand the thrust without bending. For small diameter tubes, therefore, the mandril bar is placed in tension, the drag of the rolls tending to pull the mandril from the holding rack. The tube has, therefore, to be first threaded on the bar each pass, and is stripped in the process of rolling.

By the hot rolling process the cylindrical billet with thick sides is reduced to something more tube-like in appearance, and it is then cut to length according to the size of tube required by means of the circular saw shown in the foreground of the engraving. After this the tubes are cold-drawn on a chain draw-bench in the manner described in our previous notice before referred to, the tubes being annealed and pickled after every pass through the dies. For very light tubes, such as those used in cycle-making, the gauge is further reduced after the draw-bench operations are completed, by cold-rolling. This process is carried out by the machinery we illustrate in Fig. 2. It consists of a pair of taper rolls placed side by side with axes in the same horizontal plane. The taper on the rolls is in an opposite direction for each roll respectively to the other. The tube to be worked is forced on to a continuous mandril which fits the bore, and is then passed horizontally between the rolls. The varying peripheral speed of the two rolls respectively, owing to the changing diameter due to the taper, causes a stretching of the metal, and in this way tubes can be reduced as much as from 9 B.W.G. to 16 B.W.G., without materially increasing the diameter, the redundant metal being extended longitudinally, thus adding to the length.

It is hardly necessary to say that only the most perfect material can be treated in this way; and, indeed, the very finest description of mild steel is used for tube-making. We referred in our former article to the large number of experiments made at the Alma Works in order to find out the best composition of steel to stand the very exacting work that has to be done upon it. This is a most necessary point to be observed in making tubes for purposes where trustworthiness is an absolute necessity, as in water-tube boilers, cycle works, &c. Any steel will not do—not even any good steel—and it has been failure to appreciate just what was the proper grade that has led to a good many costly failures. The very best material may, however, be easily spoiled in the making, especially if due attention be not given to pickling and annealing. It is only by most careful attention that "reediness" can be avoided, and minute flaws scarcely to be detected except by a well-practised eye, will speedily develop into serious defects when placed in a boiler. The severe tests for steel tubes which we published in our former notice, already referred to, show how much importance is attached to these points.

The rolling mills illustrated in Fig. 1 were supplied by Messrs. Taylor and Farley, of West Bromwich; the taper rolls shown in Fig. 2 being made by Mr. Samuel Platt, of Wednesbury.

* See ENGINEERING, vol. lxiv., page 130.

BOMBAY, BARODA, AND CENTRAL INDIA RAILWAY.—The cost of locomotive power upon the Bombay, Baroda, and Central India Railway in the six months ending June 30 this year was 119,497*l*. The corresponding cost in the corresponding period of 1897 was 117,867*l*. The aggregate distance worked by engines in the first half of this year was 1,587,697 miles, as compared with 1,541,815 miles in the corresponding period of 1897. Indian coal was used more freely in the company's engines in the first half of this year, and the cost of the fuel consumed was reduced in consequence.

PUBLIC WORKS IN NEW ZEALAND.—The amount available for public works in New Zealand for the year ending March 31, 1898, was 1,192,035*l*. The expenditure for the year amounted to 865,543*l*., leaving a balance at the close of March, 1898, of 326,492*l*. It is proposed to supplement this amount by transfers from the Consolidated Fund to the amount of 425,000*l*.; 500,000*l*. being derived from loans, and 36,500*l*. realised from sinking funds. These will make a total of 1,287,992*l*. available for public works in 1898-9. Estimates of proposed expenditure for 1898-9 have been submitted to the New Zealand Parliament to the amount of 1,127,640*l*.

EUROPEAN RAILWAYS.—Some Tables have been prepared in Russia to contrast the railway systems of the United Kingdom, France, Germany, and Russia, the object being to show that Russia has made more progress in connection with railways than is, perhaps, generally supposed. The following are the figures:

| — | Russia. | Germany. | France. | United Kingdom. |
|---|---|---|---|---|
| Length, including light lines (miles) | 26,223 | 29,645 | 25,736 | 21,812 |
| Gross revenue in 1896 .. .. £ | 45,600,000 | 78,360,000 | 51,880,000 | 98,440,000 |
| Net revenue in 1896 .. .. £ | 19,120,000 | 34,800,000 | 24,280,000 | 40,600,000 |
| Cost of construction .. .. £ | 300,000,000 | 573,000,000 | 631,800,000 | 980,000,000 |
| Interest obtained per cent. | 6.37 | 6.07 | 3.84 | 4.14 |
| Number of locomotives in 1896 .. | 9260 | 16,156 | 10,111 | 18,958 |
| Number of passenger carriages in 1896 .. .. .. | 10,349 | 32,399 | 25,819 | 42,284 |
| Number of goods trucks in 1896 .. | 195,127 | 314,967 | 271,644 | 650,470 |