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THE ITALIAN CRUISER PIEMONTE.*

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THE Italian cruiser Piemonte has been constructed by the firm of Sir W. G. Armstrong, Mitchell & Co. This vessel is the latest of some dozen vessels of the protected cruiser class built by the same firm, including the Esmeralda, built in 1882-83, from the designs of Mr. George Rendel, and the Dogali, built in 1886, from the designs of Mr. White. Lord Armstrong, who has for several years past strongly advocated the construction of this class of war vessel, has enumerated as their chief features: "Great speed and nimbleness of movement combined with great offensive power," and "little or no side armor, but otherwise constructed to minimize the effect of projectiles;" and in designing the Piemonte I have sought to develop these features as much as possible, observing that the displacement was not to exceed 2,500 tons and the speed was not to fall short of 21 knots.

The principal dimensions, weights, etc., of the Piemonte are given herewith, and in Figs. 1, 2, and 3, the midship section, profile, and plans are shown.

Length, 303 feet; breadth, 38 feet; draught—fore, 14 feet; aft, 16 feet; displacement, 2,500 tons; I. H. P., 11,600; speed, 21½ knots. Armament—Six 6 inch rapid firing guns; six 12 cm. rapid firing guns; ten 6 pounder rapid firing guns; six 1 pounder rapid firing guns; four Maxims (10 mm.); three torpedo guns. Weights—Hull and fittings, 970 tons; protective material, 280 tons; equipment, 130 tons; machinery and spars, 720 tons; coals† (normal), 200 tons; armament, 200 tons; total, 2,500 tons. Protective deck—Thickness on slopes,

3 inches; thickness on slopes, horizontal parts, 1 inch; conning tower, 3 inches.

She is 300 feet long, 38 feet broad, and 15 feet mean draught, and her displacement is 2,500 tons. She has a protective deck with sloping sides from stem to stern, which is 1 inch thick along the middle and 3 inches

cated upon the plan of weather deck, Fig. 3. Four of the 6 pounder quick firing guns have right ahead fire; two of these are placed under the forecastle, and two upon the after end of the forecastle; and four of these guns have right aft fire, two being placed under the poop and two upon the fore end of the poop. The

Fig. 2—PROFILE

Fig. 3—PLAN OF WEATHER DECK.

Fig. 4—PROFILES OF WAVES AGAINST SIDE OF SHIP AT 20 KNOTS — AT 21 KNOTS

thick on the slopes. Her armament consists of six 6 inch quick firing guns, six 4¾ inch do., ten 6 pounder Hotchkiss guns, six 1 pounder do., four 10 mm. Maxim guns, and three torpedo tubes; and her speed is upward of 21 knots. Four of the 6 inch guns and the six 4¾ inch guns are carried upon the upper deck, the 6 inch guns being sponsoned out so as to enable the two foremost to fire right ahead and the two aftermost to fire right astern; one of the remaining 6 inch guns is placed on the forecastle, and the other on the poop. All of these guns have considerable arcs of training, as in di-

with the fire of any of the other guns. Four 6 inch guns, three 4¾ inch guns, five 6 pounder Hotchkiss guns, five 1 pounder Hotchkiss guns, and four 10 mm. guns can be brought to bear upon an enemy on either broadside; and three 6 inch guns, four 6 pounder Hotchkiss guns, two 1 pounder Hotchkiss guns, and two 10 mm. Maxim guns can be brought to bear upon an enemy either right ahead or right astern. The 6 inch and the 4¾ inch guns are provided with 4½ inch steel shields for protecting the gunners; and all of the other guns carry light shields for the same purpose.

* Read at the Thirtieth Session of the Institution of Naval Architects.
—The Engineer.
† Bunker space is provided in the ship for 600 tons of coal.

THE NEW ITALIAN CRUISER PIEMONTE,

The Piemonte is the first vessel armed with the new Elswick quick firing gun, all of the 6 inch and 4½ inch guns being of this pattern. Lord Armstrong, in speaking of this gun recently, said: "The advantage of being able to fire rapidly at critical moments must be obvious to all. In the first place, the increased rapidity of the fire of each gun is tantamount to increasing the number of guns, without necessitating a corresponding increase in the number of gunners or in the collective weight of the shields required to protect them. In the second place, we obtain the great advantage of being able to repeat a successful shot before the enemy can materially change his position, which would render necessary a fresh adjustment of the gun. These salient advantages have been fully realized in our new guns of 4½ inch and 6 inch caliber, with both of which a rapidity of fire has been attained hitherto considered impossible with guns of so heavy a nature. Great simplicity of design and strength of mechanism have been combined in the construction of these guns and their carriages; and with the improved descriptions of powder now coming into use, velocities have been obtained so great that the 4½ inch gun, weighing only 2 tons 1 cwt., is capable of piercing 10½ inches of wrought iron, while the 6 inch gun, weighing 5 tons 15 cwt., can pierce 15 inches of the same material, muzzle velocities being taken in each instance. These guns are mounted on specially designed shielded carriages, in which exceptional facilities in handling and aiming have been combined with great protection to the gunners, and in the numerous trials carried out the shooting has been characterized not only by rapidity, but by unusual accuracy. The comparative rates of fire of the present breech-loading service guns and of our new improved guns may be judged by the following instances: In some trials carried out last year with our 4½ inch gun by the Admiralty, ten rounds were actually fired in 47½ seconds, whereas an ordinary breech-loading gun of the same caliber, firing in competition, took 5 minutes and 7 seconds to fire the same number of rounds. Again, the great accuracy of the guns, combined with rapidity of fire, is illustrated by the fact that five rounds were fired a few weeks ago at Shoeburyness, in which at a distance of 1,300 yards a target of 6 feet square was hit five times running in 31 seconds."

Speaking of the Piemonte on the same occasion, Lord Armstrong said: "She will be capable of discharging against an adversary in a given time twice the weight of shot and shell that could be fired by the largest war vessel now afloat, not excluding the leviant battleships of five or six times her size, which could ill withstand the torrent of shell which the Piemonte could pour into the large unarmored portions of their structure."

The engines and boilers are wholly below the water line, and protected by the armor deck; so also, of course, are the magazines, steering gear, etc. The level of the armor deck throughout the length of the ship is shown on the profile, Fig. 2, the dotted line indicating the deck at middle, and the through line the deck at side. All apertures through the armor deck which would require to be opened in action are provided with cofferdams rising 4 ft. above water, and all openings are fitted with armor covers or armor bars. Both below and above the armor deck the ship is subdivided into a large number of water tight compartments. Each set of engines is in a separate compartment, and each pair of boilers is in a separate compartment.

There is a series of water tight flats forming an inner bottom throughout the ship, except in wake of the boiler compartments and the crank pits in the engine rooms. There are coal bunkers along the side throughout the machinery compartment, and the inner skin is continued on forward and aft as sides of the magazines, etc. Above the armor deck the side bunkers extend to the upper deck; and dwarf bulkheads are introduced between the main transverse bulkheads so as to divide the bunkers into spaces varying from 10 ft. to 12 ft. long.

Before and abaft the machinery spaces there are deck flats from 2 ft. to 3 ft. above the water line, the spaces between these and the armor deck forming a raft body, which can be packed with patent fuel, coal and stores as desired. On the midship section, Fig. 1, is indicated the level of the coal above the armor deck when the normal supply of 200 tons is carried. Besides the coal on the armor deck, a quantity is stowed in the cross bunkers, so that the ship may be in readiness for steaming at speed. Patent fuel is shown on the slopes of the deck up to the level of the top of the armor deck. Ordinary coal may be carried here, but patent fuel has advantages which are, I think, worth securing, at least to this limited extent, when it is possible to do so. The advantages are these: patent fuel may be stowed so as practically to exclude all water, however much the side may be riddled in action, except in so far as it is blown out or otherwise removed; it is less liable to be blown out than coal by shell fire and is much less liable to be washed out by the action of the sea through large openings made in the side; and it forms an excellent shoveling flat, down to which coal may be removed without risking materially loss of buoyancy and stability in action.

With the full supply of coal, the top of the armor deck is 6 in. below the water line; but part of this full supply may consist of patent fuel or coal in sacks stowed upon the armor deck to a depth of say 2 ft., thus forming a continuation of the raft body forward and aft; and this fuel need not be disturbed until, by the consumption of the coal from elsewhere, the ship is lightened, and the deck armor is raised above the water. If at the deep draught, with the assistance of the cofferdams, large volumes of water can be prevented from getting below—which is not likely to be difficult, seeing that any water finding its way to holes in the cofferdams will have but little head—and supposing the armor deck to remain intact, the buoyancy and stability of the ship may be regarded as to a very considerable extent assured even against modern shell fire.

The two sections, Figs. 5 and 6, show the belt protection which might have been given to the Piemonte without increasing the displacement; Fig. 5 on the supposition that the weight of the patent fuel is put into armor, and consequently the normal supply of fuel reduced by 100 tons; and Fig. 6 on the supposition that 200 tons of coal are carried as at present. The protection afforded in the case of Fig. 6 arrangement is

much less than that afforded in the case of Fig. 5, but the ship provided with Fig. 6 arrangement would always have as her normal supply of coal the same quantity as the Piemonte has for ordinary sea-going purposes in peace time; while the ship provided with Fig. 5 arrangement would only have as her normal supply the quantity of coal which the Piemonte would be free to burn without touching the fuel which might aid her materially in action.

We will compare the protection afforded by the Fig. 5 belt arrangement with that afforded by the arrangement adopted in the Piemonte, shown in section on the midship section, Fig. 1. In each of these cases the horizontal deck is of the same thickness, and the width

FIG. 1.—MIDSHIP SECTION.

of the belt is the same as the width measured vertically of the sloping side of the Piemonte's protective deck. The total thickness of the vertical armor attainable, supposing the plating behind the armor and an equivalent to the wood backing to be added as armor, is 10½ in. Giving the patent fuel a similar value in the case of the sloping armor arrangement of the Piemonte, i. e., supposing its weight to be put into armor, the corresponding thickness of the sloping armor arrived at is 6 in.; this divided by the sine of the slope gives 14 in. as the thickness of the sloping armor, measured horizontally. Thus the advantage is with the sloping armor to the extent of 3½ in. But, besides this advantage in absolute thickness, vertical armor is much less effective in resisting projectiles than sloping armor of the same horizontal thickness. The patent fuel also has great advantages over an equivalent thickness of armor in resisting shell fire and especially shell charged with high explosives, as the resistance takes place over a greater distance, giving the shell time to explode, and the armor has only therefore to resist the broken pieces of the shell.

The arrangement with sloping armor has the disadvantage that light shell, which would be kept out by the vertical armor, will probably blow out some of the patent fuel, and do other damage to the ship's structure; but as the 6 in. quick firing gun can now penetrate 15 in. of wrought iron, this risk should, I think, be run for the sake of securing the additional protection afforded by the sloping armor. A shell from a 6 in. gun could be fired through the side with vertical armor, section Fig. 5, but the chances are very remote that it could be fired through the side of the Piemonte so as to penetrate the sloping armor, and especially if charged with high explosives. Moreover,

FIG. 5.

FIG. 6.

against the disadvantage above referred to must be set the fact that the target presented by the comparatively thin horizontal deck, when the ship heels, is very much larger in the case of the ship with vertical armor than in the case of the ship with the sloping armor. The question of cost also is very much in favor of the sloping deck armor. Apart, therefore, from the advantage of being able to carry some 100 tons more coal in peace time, and of having this quantity in reserve to be used in an emergency in war time, the advantage appears clearly on the side of the sloping deck arrangement adopted in the Piemonte.

The relative advantages of vertical and sloping armor have been on more than one occasion lengthily discussed by this Institution, but the importance of the

question must be my excuse for making the above comparison.

The machinery of the Piemonte has been constructed by Messrs. Humphrys, Tennant & Co., Deptford, and consists of two sets of vertical triple expansion engines. Each set has two low-pressure cylinders, and therefore acts on four cranks. The cylinders are of the following dimensions: high pressure, 36 inches; intermediate, 55 inches; low pressure, each 60 inches, and the stroke is 27 inches. Steam is generated in four double-ended boilers, adapted for a working pressure of 155 lb. Forced draught can be supplied by eight fans, but the stokeholds are arranged so that they can be worked with or without forced draught. Distilling apparatus of ample power has been provided for making fresh water for the boilers; and auxiliary condensers are also fitted in each engine room. An auxiliary boiler stands on the protective deck amidships, capable of supplying steam to any of the auxiliary engines throughout the ship.

The steam trials of the ship are only in course of being made. I had hoped that these would have been completed in time for me to have given curves of performance, but the continuous bad weather on the northeast coast during the last few weeks has prevented this. At a preliminary trial made on March 28th, some slight defects occurred in connection with the lubrication, which necessitated some adjustments. When these defects were overcome toward the close of the day, a series of runs were made on the measured mile, without the use of the fans, with open stokeholds, and with forced draught. There was very little wind on the occasion, so that much interest does not attach to the steaming without the use of the fans. Two runs, however, without the use of the fans showed that the ship could steam about 19½ knots under these circumstances. Four runs made with a moderate pressure of air in the stokeholds, never exceeding ¼ in. of water, gave a mean speed of 20.168 knots with an indicated horse-power of 7,760. With an air pressure of ½ in. of water, the limit fixed by the Admiralty for continuous steaming at sea, a speed of 20.3 knots could with ease be obtained with about 8,000 indicated horse-power. With closed stokeholds and forced draught a power of 11,600 horses was realized, but the trials under these conditions were not completed. The mean of two runs, however, when upward of 11,000 indicated horse power was realized, gave a speed of over 21 knots.

As I have stated, 21 knots was the speed aimed at in the design, and is also the speed which is guaranteed by my firm to the Italian government.

Whatever speed may ultimately be obtained in this vessel with forced draught, the fact that with natural draught, when the wind is favorable, or with a moderate pressure in the stokeholds, she can steam continuously in fair weather at from 20¼ to 20½ knots, has been fully established. This I regard as of very much greater importance than the high performance which will probably be attained with forced draught. Forced draught with high pressure in the stokeholds, and anything above 2 in. should, I think, be regarded as high, can only be reckoned upon for a spurt of three or four hours, and after such a spurt you will usually find that your boilers require some overhauling. At 20¼ knots the Admiralty displacement constant of the Piemonte is 190, which shows that very little work is uselessly wasted in the formation of waves. On Fig. 4 is shown the profiles of waves along the side of the vessel, at 20 and 21 knots speed, the full line indicating at 20 knots and the dotted line at 21 knots; and I have here some photographs, some of them taken from the foremost upper top, which show that the wave disturbance was remarkably small. So small was it when the ship was going upward of 21 knots, that her high speed could scarcely be realized. This was due partially to the entire absence of anything like excessive vibration. The vibration was measured by means of a seismometer, very ingeniously contrived by Mr. A. Mallock, and was shown never to have exceeded 0.12 of an inch, horizontally or vertically, at the extreme after end of the vessel, while the amplitude of the mean of the vibrations was less than half of this. With her full coal supply of 600 tons, the vessel will be enabled to steam the considerable distance of 1,950 knots at full speed with natural draught, and she will be able to maintain a cruising speed of 10 to 12 knots for 55 days, during which time she could cover a distance of about 13,500 knots. As will be seen from the profile, the after deadwood is cut away and a large balance rudder is provided, immediately in front of which also the deadwood is removed. These features will, I anticipate, give the vessel good maneuvering power, and from the trial already made there is no doubt that this has been secured.

We give an illustration from the *Engineer* of the Piemonte steaming at about 19 knots, taken from an instantaneous photograph.

[Continued from SUPPLEMENT, No. 699, page 11163.]

PLANT AND MATERIAL OF THE PANAMA CANAL*

By WILLIAM PLUMB WILLIAMS, Jun. Am. Soc. C. E.

ROCK DRILLS.—A large consignment of the Ingersoll type of rock drills was sent down to the "Societe de Travaux Publics" for use at Bas Obispo and at Emperador. These drills were in use only a few days, on account of insufficient number of skilled foremen to instruct the native labor in using them. Consequently the whole plant was abandoned. I did not see any machine drills in operation in crossing over the whole line, and the most modern plant which has accomplished such a wonderful work upon our New York aqueduct has been side-tracked at Panama for reasons dependent upon labor.

The French machine drills have proved a cumbersome appliance for all styles of work and uneven ground. A platform car, mounted on four wheels, supports a horizontal boiler of fifteen horse power. An upright frame supports four drills three feet apart, and these drills are raised and lowered by a ratchet and pinion attachment in the frame. A circular motion is communicated to each drill by a shaft from the main engine fitted with a beveled wheel. The drill is operated by a circular movement, being a borer rather than an up-and-down stroke. The contact of drill,

* A paper read before the American Society of Civil Engineers, July 2, 1888. From the *Transactions* of the Society.