whilst there would be a total saving of 51,000 tons of steel as compared with a similar number of steel ships of equal carrying capacity. Moreover, this steel is worked in the form of reinforcement rods and is not dependent upon the plate rolling mills for its production. This is the more important, as at the present moment it is largely the limited output of the rolling mills which adds to the difficulty of procuring an adequate amount of shipbuilding steel.

We came to the conclusion that the most economical as well as the most efficient rod for ship construction was that known as the spiral bond bar. This is an ordinary mild steel bar, which subsequent to being rolled is stressed by being twisted in such a manner that the elastic limit is raised about 35 per cent., the twist in the bar giving it at the same time a continuous mechanical bond with the concrete in which it is imbedded. With this high elastic limit smaller sections may be employed than would be possible with any ordinary mild steel bar, which means a reduction in weight of steel used. As the continuous mechanical bond justifies shorter overlapping of bars at junctions, the weight of steel is again reduced. A further advantage of the special twisting treatment lies in the fact that steel of very low tensile strength may be thus treated, and release for other important work the higher quality steel.

The following is a table of actual tests of a spiral bond (1⅜ in. diameter) before and after twisting:—

Original Size. Diameter.	Area.	Contraction of Area. Diam.	Contraction of Area. Area.	Contraction of Area. Per Cent.	Elongation in 8 in. Inches.	Elongation in 8 in. Per Cent.	Ultimate Stress. Actual Tons.	Ultimate Stress. Tons per sq. in.	Elastic Limit. Actual Tons.	Elastic Limit. Tons per sq. in.
Before twisting, 1.375 in.	1.39	.88	.568	59.2	10.40	30.0	37.4	26.9	24.5	17.62
After twisting, 1.375 in.	1.39	.89	.581	58.2	9.68	21.0	41.3	29.7	33.2	23.86

See stress-strain diagram, Fig. 2.

Although the structure of these vessels, both in relation to the shell and frames, is purely reinforced concrete throughout, the possibility of working the shell of ferro-concrete vessels in conjunction with ordinary frame bars or built-up frames has not been lost sight of, although the problems attendant on such a departure from a purely monolithic structure present difficulties. It is conceivable that a vessel might be satisfactorily constructed in which the ordinary steel frame is used in conjunction with the present system of reinforced concrete hull, and in the United States they appear to have adopted some such method. With our present knowledge there would appear to be in this connection an element of danger unless a system is used, blending together the parts in such a way as to leave no possible chance of disruption. The experience gained by American builders in this respect may help to solve this difficulty, as the principle, if successful, appears to be well worthy of adoption. It may indeed be essential in ferro-concrete ships of large tonnage. Such a system, too, would overcome some of the difficulties in connection with the fitting of various details, which, at present, it is necessary to arrange for before the concrete portion is commenced. A further advantage, and probably the principal one, is that without having to introduce a much greater proportion of skilled labor, the system would result in a decreased weight of hull.

Hull Fittings and Their Connection

Many problems have arisen regarding fittings and their connection and relation to the ship, which in ordinary steel construction are simple, but which, in the case of ferro-concrete construction, offer difficulties which have had to be carefully examined and overcome. Amongst these are the openings in the ship's bottom, stuffing boxes, the passage of pipes through bulkheads, the connection of fittings to the bulkheads, and the connection of stanchions, fairleads, bollards, etc., to the deck. Added to these are important problems, such as the connection to the hull of the rudder post, stern post, and the stern tube.

Lines and Tank Trials

It is obvious, in view of the fact that the whole of the vessel's hull has to be cast in moulds or shutters, that the simpler and straighter the lines of the vessel the more cheaply and easily the shuttering can be constructed, and the more rapidly the work can be proceeded with. For this reason, when designing the lines, a simple midship section was adopted having a perfectly straight side and bottom with only a very small curvature at the bilge. This section was retained in a parallel middle body for half the length of the vessel amidships, and the waterlines forward rounded into an easy entrance, still retaining, however, the straight-line sections. In rounding in the waterlines aft the straight-line sections were retained as far as possible and then run aft to the propeller and faired in with a minimum of curvature.

Propelling Machinery and Boilers

With respect to the propelling machinery, the considerations which have to be taken into account as to suitability of type are practically the same in ferro-concrete as in steel ships; but the method of efficiently connecting the machinery to the hull of the ship, the arrangement of the stern tubes, the special attachment to the shell of sea connections, etc., require more consideration in the former case, and great care has to be taken to ensure reliability in this respect.

In the present six boats building to this design the adoption of machinery has been largely governed by what it has been possible to obtain under existing circumstances.

In three of the vessels we are fitting compound surface condensing single-screw engines of approximately 350-400 horsepower with cylinders 17-in. and 34-in. diameter, 24-in. stroke, working at about 100 revolutions per minute.

The boiler installation consists of two cylindrical boilers 9 ft. 6 in. diameter by 9 ft. long, working at a pressure of about 130 lbs.

In the remaining three we intend fitting triple expansion engines of about 500 I.H.P., which will somewhat reduce our deadweight capacity but give an appreciable increase of speed.

Two boilers were decided upon, so that in the case of a breakdown of one there would be sufficient boiler-power in the ship to drive the vessel at a reasonable speed. When in port one of the boilers will be of sufficient power to work all necessary auxiliary machinery, including that for loading or discharging. Incidentally, there are other advantages in having two small boilers, such as the possibility of their transport by rail instead of by sea from the place of manufacture to wherever the machinery is

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