THE DESIGN AND PROPULSION OF FAST DOUBLE-ENDED SCREW VESSELS.*

Some Considerations with Reference to the Sydney Passenger Vessels "Dee Why" and "Curl Curl."

By E. H. MITCHELL.

The vessels are for service in Sydney Harbour, running between the Circular Quay, in the heart of the city of Sydney, and Manly. which is a large residential suburb about seven miles down the harbour, and near the Heads at the harbour entrance. There are so many lines of ferry traffic converging at the Circular Quay and crossing the main route of sea-going traffic that if turning were allowed, considerable danger to the latter would follow. The ferry traffic is a very large one, most of the ferry vessels being confined to the comparatively smooth water of the harbour, but the particular service for which these vessels are intended involves not only a longer journey, but encountering much rougher weather. This service is carried out by the Port Jackson & Manly Steamship Company, to whose order the new vessels have been built by Napier & Miller, of Old Kilpatrick, near Glasgow. The special requirements were as follows: Length not to exceed 220 ft.; speed, 17 knots going in either direction; passenger capacity, about 2,000; draught not to exceed 12 ft. 6 in.; the vessels to be built of heavy scantling, with two enclosed passenger decks, and to be capable of standing fairly heavy weather, which is frequently met with near the Heads. A single screw at each end directly coupled to the main engines was preferred, acting on the "push-pull" principle, which is the usual arrangement in the existing vessels in Sydney Harbour; but if the desired result could not be obtained with this, the owners were prepared to consider alternative proposals, including a twin-screw arrangement. Owing to the fine ends of the vessels necessary for the speed and for good sea-going qualities, it was, however, difficult properly to protect the screws in a twin-screw arrangement. It was essential that the boilers should be entirely under the main deck with as small casings as possible, so as to interfere as little as possible with the embarking and disembarking of the large number of passengers.

To get the best results, it is generally found beneficial to have the bow and stern sections of a vessel of different form, the forward end having more or less U sections, and the after-end V sections with a fuller water-line. In the double-ended vessel both ends must be the same. The loss from this cause is probably very small, but it is an item which has to be taken into serious account in connection with the stability, as the usual comparatively full water-line aft has to be replaced by one of the same fineness as that required for the fore-end, with a considerable reduction of the metacentric height. In the ordinary vessel the driving face of the propeller is usually flat; the back round. When a similar propeller is fitted at each end of a vessel, and so as to be able to travel in either direction, the driving face at one end must be the rounded surface giving an excessive pitch at the leading edge, and too little at the trailing edge. This must result in a loss of efficiency of quite an appreciable amount. An attempt may be made to reduce this by making the blades of symmetrical section rounded on both back and face, but to a smaller extent. The effect of that, however, is to make both the screws less efficient in either direction, instead of confining the inefficiency to the one rounded on the driving face. Mr. Baker, of the William Froude National Tank, has supplied the author with information from which this loss may be estimated. The information is given in an appendix to the paper. If the screw is working at the bow instead of at the stern, there will be no wake, and the gain from the wake factor will disappear. On the other hand, the thrust deduction factor will still remain owing to the screw race impinging on the vessel and increasing the resistance. It looks, therefore, from this reasoning as if the efficiency might be reduced owing to this cause in inverse proportion to the wake factor, resulting in a loss of about 15 per cent.

Summing up these losses we get, due to the thrust deduction and no corresponding gain from a wake factor, a possible loss of about 15 per cent., and due to the curvature of the working face of one of the screws a possible loss also of about 15 per cent. If the propulsive efficiency of a stern-screw arrangement were 50 per cent. accepting the above figures of loss the corresponding efficiency of a bow screw would then be 35 per cent., and the combined efficiency of bow and stern screws 42½ per cent. On this basis, the power required for a bow and stern screw for the same speed would be about 17½ per cent. more than that required for an efficient stern-screw arrangement, a result which agrees fairly well with the American estimate of 19 per cent.

When the order for the vessels was placed, tank experiments were carried out at the William Froude National Tank, both with the naked hull and with both bow and stern screws working in place; and after adopting modifications suggested by the superintendent of the tank, results were obtained which were fully up to expectations, an overall propulsive efficiency of about 42½ per cent. being obtained. Two types of screws were tried. One type with the usual flat driving face and round back, and another with the curvature divided between the two faces. With the first type, the stern screw took about two-thirds of the power, but with the second type, the power was fairly evenly divided between the two screws. The first type proved, however, to be rather the more efficient.

In a vessel of this type, there is always a possibility of improving the results by transmitting all, or practically all, the power to the after screw, either by fitting a clutch or by fitting electric drive, and these results show to what extent an improvement would have been possible in this particular case. The fitting of a clutch is in many ways undesirable, and taking into account the resistance caused by the idly rotating bow screw as it is pushed through the water the gain would have been very small. In the early stages of the design the fitting of electric drive to these vessels was seriously considered, in view of this system having been fitted to so many of the American ferry boats; but the conditions were not quite the same, and in view of the small gain in efficiency which these experiments show would have resulted, the large increase in cost would certainly not have been justified.

While on the subject of the increased power necessary for double-ended vessels for the same speed, it is desirable to look at the problem from another point of view. Assuming for the moment that the increased power was as much as 19 per cent. (an amount which should certainly not be exceeded) for the same power, the ordinary or stern-propelled vessel would obtain about 6 per cent. more speed, or, say, a service speed of 15·9 knots, compared with 15 knots for the double-ended vessels. On a run of seven statute miles the time for the first vessel would be about 23 minutes, for the second vessel 24·3 minutes. A difference of 1·3 minutes. On the other hand, the ordinary vessel would have to turn round either at the commencement or at the end of the trip, or make a half-turn at each end: whereas this would not be necessary in the case of the double-ended vessel, which would go direct from point to point. The time lost in turning can very easily occupy three to four minutes, and with piers, as they are necessarily arranged in Sydney Harbour, it would probably take more time, so that considering the matter from a broad point of view the double-ended vessel is really the more efficient, and this would be much more apparent in the case of a shorter run.

The drawings on page 392 show the general arrangement of the vessels, the leading particulars of which are as follow:—

Length on L.W.L.	220 ft.
Breadth moulded	35 ft. 11 in.
Depth moulded to main deck	15 ft. 6 in.
Draught, extreme	12 ft. 6 in.
Gross tonnage	799.

The vessels are classed with Lloyd's 100 A1 with freeboard, and have the Board of Trade Steam 4 and 5 Certificates. The bulkheads extend to the main deck, which is of steel over the engines and boilers, sheathed with teak. The general arrangement of the vessels may be readily followed from the plan.

The main engines, which have been supplied by D. & W. Henderson & Co. Ltd., are of the four-crank triple-expansion Yarrow-

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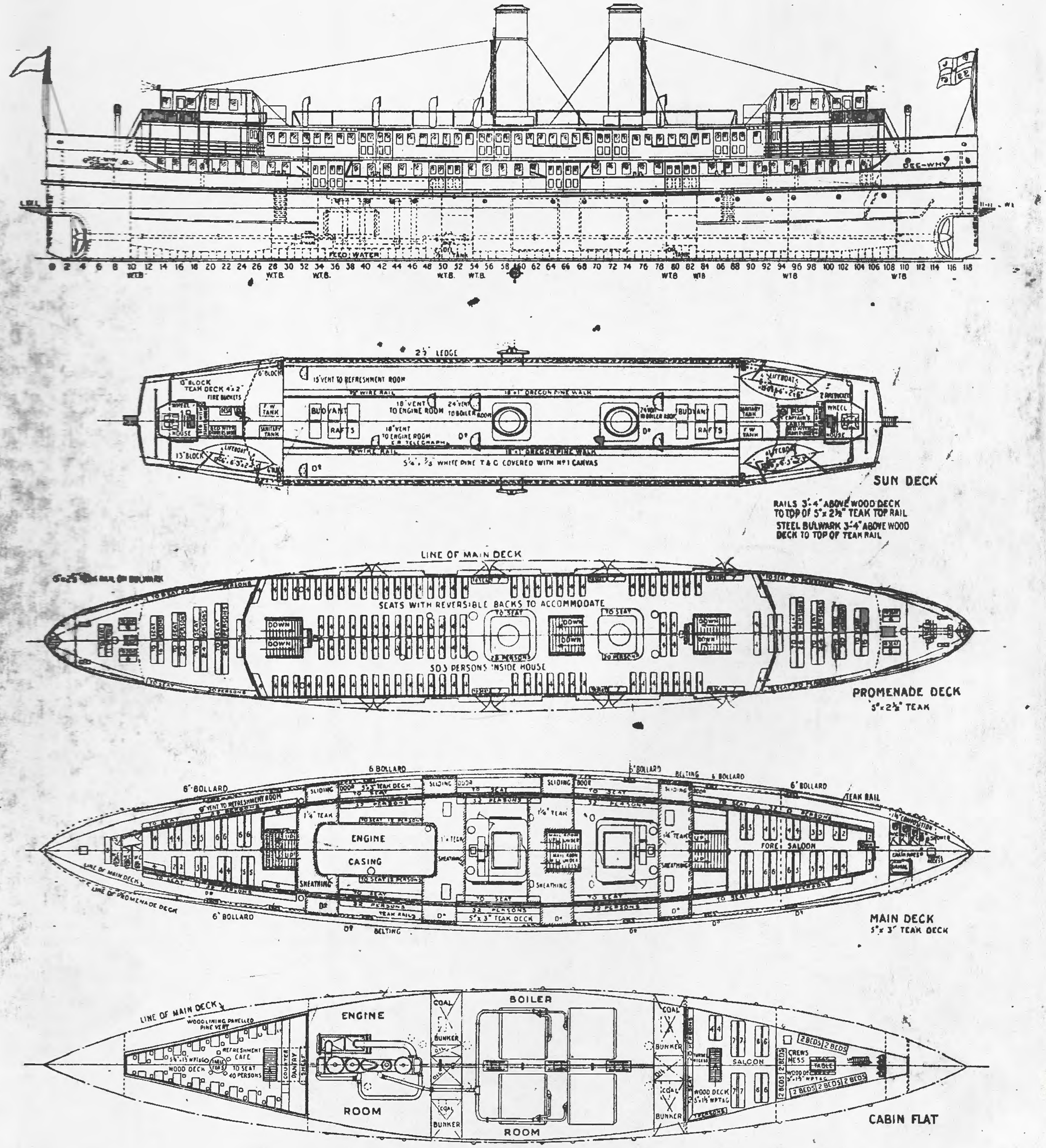

General Arrangement of the Double-ended Ferries "Dee Why" and "Curl Curl."

Schlick & Tweedy balanced type. To suit the peculiar system of propulsion, the valve gear is arranged to give the same power ahead and astern at the designed speed of 160 r.p.m. There are two Michell thrust blocks, one at each end of the engine, and the propellers are bronze. The shafting is of bright ingot steel. The air pump is an independent unit of G. & J. Weir's dual type, the feed pumps being also Weir's make. The circulating pump is of the centrifugal type by Matthew Paul & Co. The remaining pumps are of the duplex type. The reversing engine is of the steam and hydraulic type by Brown Bros., of Edinburgh. The steam generating installation consists of four single-ended Scotch boilers, 12 ft. diameter by 11 ft. 6 in. long, built to Lloyd's and Board of Trade requirements for 185 lb. per sq. in. working pressure, and fitted with Howden's system of forced draught, there being a steam-driven fan to each pair of boilers. The boilers are suited for both coal and oil, the oil-fuel plant being on the Wallsend-Howden system. Steam flue blowers of the Parry type are fitted to each combustion chamber.