the same length of river subject to the same variations of depth of water, first by paddles and then by screws, the result would be the same. Any vessel passing through the water makes two waves, visible to the eye only under exceptional conditions, which he would refer to later.

In the open sea these two waves, called waves of oscillation, were not observable at all, but they existed, one being pushed forward by the fore end of the ship, and its counterpart being towed by the stern. Now you cannot create one half of a wave without the other; therefore a wave pushed forward by the bow whose crest was at or about the stem was in turn pushing out ahead of the vessel its other half. The same thing went on aft, the wave whose crest was at or about the stern post was towing its other half. But it did not end there: those waves repeated themselves again and again, one series out ahead, the other trailing astern. One authority said at 12 knots they could be traced definitely sixty times the vessel's length.

He didn't want to confound these waves of displacement, as they would call them, with the white seas that curled off a vessel's bow and followed behind her stern, and were, of course, apparent to any eye; they were merely the little crests, so to speak, of the two big ones he was talking about.

Now in deep water these waves had complete freedom of movement, but as shallow water was approached they rapidly changed from waves of oscillation to waves of translation, and performed almost the same transformation as did a swell when it changed into a comber on the beach. They were manifest in the case of a vessel by piling up short and steep, and often breaking.

So far as he knew this phenomenon applied to all vessels, and varied only with the displacement of the ship, the speed of the ship, and the draft of water, and was quite independent of the method of propulsion: paddle, screw, or towed.

In the process of steepening, as described, a corresponding deep trough was produced, into which the vessel sank, and while the shallows lasted it was actually drawing more water than when at rest, because her fine ends were more immersed, and her main body less immersed, and she sank till her total weight was balanced by the displacement in its new form.

This applied in a general way with moderate speed ships of the commercial class; but such extraordinary things sometimes happened that one was dubious about laying down laws, for we had indisputable figures for the following apparent paradox:—

Full speed in 8 fathoms, 22.8 knots.
Full speed in 2½ fathoms, 24.1 knots.
Half speed in 8 fathoms, 18.3 knots.
Half speed in 2½ fathoms, 13.1 knots.

But to look for a solution of such a matter was quite beyond his scope to-night.

An optical illustration of what he had been describing could be obtained by riding on the front of an electric tram where a long straight road was ahead, and the wave generated in the wire by the contact and upward push of the pole would be seen to run ahead as far as the eye could detect it; or another way: watch how the wire was affected by an approaching tram, and the same thing happened as does in the waves made by a steamer.

Now the question of the water being affected a long way up the river, 16 miles was mentioned. That was so, and was partly explained already; but go one step further, and imagine that the tributary was a canal without fall, whose section just coincided with the midship section of a steamer. The steamer being moved ahead would push all the water forward, which being incompressible, would rise and rise till it overflowed, and the water would be affected just as many miles as one imagined that canal to be in length. In such an extreme case the ship simply became the ram of a pump; and put in that form, it was clear at once what happens.

One point in the paper was of peculiar interest—that of changing over the auxiliary exhausts from condenser to L.P. valve casing, with a gain of 10 per cent. H.P.

MR. CHALMERS, in reply, said that he felt indebted for the attentive hearing they had given him, and was gratified if in any way he had been able to add interest to the subject of the paper.

He would like also to acknowledge the credit due to Mr. McNamara for his careful oversight of the printing, and to the printer for the exceptionally good results with the sketches and records attached thereto.

In reply to Mr. Kidd: The water tube boiler had effectually done away with the anxiety in regard to variation of temperature in raising steam, and was very responsive to call. The air pressure varied from 5 to 7 sixteenths of an inch, the temperature of the escaping gases from 600-700 deg. On the 10th inst. two tests were taken with a Leskole CO_2 tester, and gave 15 per cent. for the port boiler, 13.5 for the starboard, and one from the auxiliary gave 12.4 per cent. The system of firing was quick and light: two full shovels to each door, the fires about 8in. thick, and a round of 9 fires in less than six minutes, and the quantity per square foot of grate from 16 to 18 lbs., and from 1.7 to 1.8 lbs. per I.H.P. But this was somewhat misleading, as the diagrams only showed the power driving the ship, and no credit was got for the power necessary for the auxiliaries, which should make a considerable reduction were any means available for arriving at the power used for these purposes.

In reference to the closed exhaust, this subject had received much attention in "Engineering" of late. The gain was accounted for in this way: The special feeds (two Caruthers duplex) took steam at 225 lbs., and could exhaust to either the casing or the condenser, but steam at that pressure with an 8in. or 9in. stroke, was a long step, and in taking diagrams under both conditions, showed a very material difference in the power developed in the main engines; the closed exhaust would also decrease the power of the pump, but from experiment they were found sufficient with a back pressure of from 10 to 13 lbs. This steam was then taken to the heaters, which were made for live steam, and so the openings or ports were rather small for the lower steam; but even so, the feed was sent on at 170 degrees with the closed exhaust system, the surplus steam to the casing; the other auxiliaries, the electric light engine, the fan, and two sets of air and circulating pumps, all exhausted under these conditions. The effect of this upon the boilers was that the L.P. cylinders of the light engine and the air and circulators were always under pressure, and so the tendency to draw the oil in was very largely reduced.

Mr. Sinclair indulged in a quiet thrust over the cost of the coal, but coal at under 9/-, important in its way, was less so than at, say, double that figure. The displacement of the "Hunter" at ordinary loads is from 1850 to 2000 tons.

The opening under the fore and aft divisional bulkhead in the trimming tank is equal to 3in., for its whole length, the opening above being the depth of the beams, $5\frac{1}{2}$in. To get the anti-rolling effect, the water was reduced about 3 feet, making 12 feet in the tank, with a bunker, and a light cargo 12 feet, but vanishing to a point with a heavy cargo.

Mr. Reeks thought the suggestion that the water in the river had been favourable to the retention of the paddle wheel was founded on a misconception. With the development of the wave theory he added value to the discussion; but the author ventured to think that there was something in the statement that the navigable depth of the river restricted the depth of vessel employed. Take the two vessels more particularly under notice, the "Newcastle" and the "Hunter."

The first was a very fine-lined ship, originally designed to go $16\frac{1}{2}$ knots. She had a keel of 5in. or 6in. in depth, and a good rise of floor, and, as already stated, at 11 feet draught the bottom edge of her floats were 5 feet from the surface of the water. It had been mentioned that she exceeded the capacity of the river, although on one occasion the river was successfully navigated, and on that occasion Mr. Reeks was present.

A specification drawn up by himself read thus: "The object of these alterations is to lessen her draught by 1ft. 3in." To do this, it was proposed to give her a plate keel and lessen the rise of floor. Granting that this would have been a successful proposition, it would make the depth of the hull under the bottom edge of the wheel 4ft. 9in., or a total draught of 9ft. 9in. But why not carry this further, and by additional displacement raise the bottom of the hull 2 feet more? This would then leave a depth of 2ft. 9in. under the wheel, or a total of 7ft. 9in.

draught without affecting the efficiency of the wheel; whereas in the case of the "Hunter," she was at her minimum draught at 10ft. 6in., having a plate keel and less rise of floor; a fuller form, .604, with a 40ft. beam.

This might be carrying the question to an extremity, but applied to the river navigation only. The "Newcastle" had 60 miles of sea water to cover as her main business, and this had a material effect upon her design, business, and this had a material effect upon her designs, and hence a compromise was effected, but to the detriment of her river service.
