Mr. A. Christie said he had listened with very great pleasure to the author's excellent Paper on Double-ended Screw Steamers. The Paper was well written, and the claims made for improvements were so modestly put forward that no fault could be found on that score. He was of the same opinion as the author that double-ended screw boats would supersede both paddle and single screw boats for our harbour service, especially where the runs were short; not because the method of propelling was better or more economical, but simply on account of their handiness. The only double-ended boat he had any actual experience with was one named the "John Beaumont," built for the North British Railway Company in 1876 for their Queensferry service. This vessel was 125 ft. long x 25 ft. beam, having a long, flat floor and comparatively bluff ends, as it was necessary to make her "full" on account of the weight to be carried on a shallow draft. However, she steamed fairly well, but was very difficult to manage in the shallow water and strong tides at North Queensferry, and after being "stove in" once or twice she was converted into a paddle steamer, and ran the service until the opening of the Forth bridge. It was a remarkable thing that this boat was all right in deep water, but in passing over the shallows the engines ran faster, but the vessel herself "slowed down." She was also slow in going astern.

Since then, until about six years ago, when, in conjunction with Mr. G. A. Key, he prepared a design in response to an advertisement by the Balmain Ferry Co. for competitive plans, he had never troubled himself about double-ended screw steamers, being fully engaged with a different class of vessels. But one could not live long in Sydney without being impressed with the enormous ferry service employed in the harbour, and to endeavour to think out which would be the best class of boats for carrying on this great and increasing traffic in the future. As before stated, he believed that double-ended screw boats would find most favour.

The author stated "that screws at each end, keyed to the same shaft and driven direct, was an economical method of propulsion," but he (the speaker) considered this at variance with facts, and this could be demonstrated if we considered the action of a single screw in propelling a ship, and then compared it with the action of a screw at both ends. But perhaps it would be better to commence with a vessel being towed or propelled by sails, because then there was nothing to disturb the water except the vessel herself. The power exerted through the tow rope or by the sails was expended in overcoming the frictional resistance of the wetted surface of the ship, of the wave-making at bow and eddy-making at the stern. But when a vessel was propelled by a screw an additional force or resistance came into play, termed the "augment of resistance," due to the action of the propeller diminishing the pressure under the stern. To some of you who were not engaged in marine work this might not be very intelligible and therefore required a little explanation. When a vessel was being towed, the water was parted by the bow, flowed along the sides and under the vessel, fell in under the stern, and so restored the equilibrium of pressure at both ends. But when the propeller was at work it threw a certain amount of this water behind the ship, and thereby reduced the pressure there; the consequence was that there was a greater pressure at one end of the ship than there was at the other. The difference between the two was termed the "augment of resistance." If, for instance, we took an ordinary dock gate having the water at the same level on both sides, then the gate would be in perfect equilibrium. But if we started a powerful propeller to work on one side, then a certain amount of water would be thrown back, which would be equivalent to lowering the head of water on that side. That reduction of pressure was termed the augment of resistance. If, now, we added another propeller to the other side of the dock gate, but instead of throwing the water away from the gate it delivered the water on to it, then,

as a consequence, we would increase the pressure there and so make the augment of resistance still greater. And this was exactly what was done in a double-ended screw steamer.

The late Dr. Froude demonstrated that in ordinary vessels the augment of resistance was about 40 per cent. of the ship's resistance, a very serious loss indeed, but how much more serious must it be when we increased this by the forward screw in a double-ended steamer causing an increased pressure on the bow. It was self-evident that in fine vessels this augment of resistance must be, and was, less than in bluff lined vessels, so that in designing double-ended screw boats he thought it would be found advantageous to keep the ends as fine as possible, especially under water, even at the expense of making the midship section fuller. Dr. Froude also proved by experiment that if the screw was placed from a third to a quarter of the extreme breadth of the ship clear from the stern the augment of resistance was only one-fifth of that ordinarily produced. Now it seemed to him (the speaker) that in the "Lady Manning" the screws were so placed that they, to a certain extent, fulfilled the above conditions. The screws were a good distance away from the hull under water, at or near the water line—he did not think it mattered so much. Suppose, for argument, that her augment of resistance was reduced from 40 per cent. to 20 per cent., and further suppose that under ordinary conditions her speed would be 11 knots, then under the reduced resistance her speed would be increased to $11\frac{3}{4}$ knots, a very considerable increase indeed for the same expenditure of power. But it might be that if the ends of an ordinary straight keel boats were fine enough we might get the same result; but having no proper data it simply rested now as a matter of opinion. If, for instance, we compared the two latest additions to our harbour fleet, viz., the "Lady Manning" and the "Waringa," we found that they were about the same length, beam, depth, draft and power, the "Lady Manning" being built, as Mr. Reeks had described in his Paper, with the keel

turned up from end to end, whereas the "Waringa" was built with an ordinary straight keel. He understood that the "Lady Manning" was the faster of the two by about half a knot, so that at first blush one would be apt to think that the extra speed was due to the peculiar form of the hull; but when we considered that the "Waringa" had a displacement at least 25 per cent. greater than the "Lady Manning," this opinion must be somewhat modified, as it must not be forgotten that the extra weight of the "Waringa" told against her in two ways—1st, the extra weight to be propelled, and 2nd, that the vessel had to be made "fuller" to carry this extra weight on the same draft. Then one would naturally ask how much, if any, of the extra speed in the "Lady Manning" was due to her peculiar form, and how much was due to her lightness? And was it not possible that if the "Waringa" had had the same displacement, and, consequently, finer lines, would she not have been her equal in speed? A little care and trouble in making the trials of the "Lady Manning" and "Waringa" such as was taken with the "Captain Cook," would probably have settled the question as to which was the better type of boat, but as this had not been done, and there was nothing to show that one boat was really superior to the other, we were left free to form our own conclusions and enjoy our own opinions.

Mr. Cruickshank had so fully described how the trials of the "Captain Cook" were conducted and the diagrams made up that he (the speaker) need not say anything on that subject, but if there was any one member who did not fully understand the diagrams, he would only be too pleased to explain how they are constructed. He was thoroughly of opinion regarding trial trips that, if well conducted, good information was gained, but, as ordinarily conducted, a vast amount of valuable information was lost.

Mr. Norman Selfe considered that the author had contributed a most acceptable paper to the Association, and it was to be hoped that the "lines" of the "Lady Manning," together

with those of the "Waringa" (with which North Shore steamer she has been contrasted by Mr. Cruickshank) would be printed with the paper in the proceedings. Mr. Reeks had received a much kinder reception than was accorded to the writer of a paper on a similar subject in these rooms six years ago, when the working of vessels with a screw at each end was much less understood than it was now. During the discussion on that former paper, Mr. Cruickshank made a statement that the introduction of these "double screws" to Australia was due to Mr. Wildridge and Captain Bremner, and for six years he (the speaker) had not contradicted that statement, believing that the real facts were pretty generally known. But Mr. Cruickshank had, however, just repeated that statement, and was evidently labouring under some great misapprehension in merely connecting him (the speaker) with the design of the engines of the "Wallaby;" and as it was highly important that the printed records of this Association, in matters that have an historic interest, should be absolutely correct, he would read a letter which he had turned out that morning. The letter was dated May 9th, 1878, addressed to him by the secretary of the North Shore Ferry Company, and was as follows:—"Norman Selfe, Esq. Dear Sir,—I have the pleasure, by instruction of my directors, to inform you that your design of a double-screw passenger and horse boat, motto "North Shore," has been awarded the advertised premium, and I enclose you a cheque, &c., &c.—ALFRED BURGESS, Secretary." No comment was necessary; and members who did not previously know how it was the "Wallaby" came to be built would now understand to whom the credit belonged sixteen years ago for introducing this type of ferry boats. No doubt Captain Bremner, as one of the Directors of the North Shore Company, afterwards gave the order to Mr. W. Dunn to build the "Wallaby," and also instructed him (the speaker) to prepare plans for the machinery and get her completed; and it was a fact that until the matter was placed in his (the speaker's) hands to carry through

to a successful completion, such trifling matters as draught of water, immersion of the screws, weight of hull and machinery, (and other such unimportant points, in many people's opinion) were never thought of at all. Mr. Dunn fortunately had a very good conception of the form to give such a boat (although she was much fuller and heavier than was necessary); and the singular fact was that after fourteen years' experience we found, according to Mr. Cruickshank's tables, that the "Kangaroo," recently designed throughout by Messrs. Wildridge and Sinclair, with every advantage that was absent in the "Wallaby," did not show the slightest improvement upon her.

In the case of the "Lady Mary" and "Lady Manning," the author had the advantage of being both the naval architect and the business contractor combined in one person; and although we most of us hold strong views about such combinations, it gave Mr. Reeks a great opportunity, which he boldly availed himself of. It was something to fly in the face of ignorance and prejudice, such as for many years kept back the improvement of our ferry steamers. Mr. Reeks in these later days had had to deal with men of more liberal views and more knowledge. And the Directors of the Balmain New Ferry Company were to be congratulated, as well as the designer, for the addition to the harbour fleet of such a vessel as the "Lady Manning," if only for the opportunity which it afforded for comparison with other types of double-ended screw boats.

When he (the speaker) first took to the improvement of the harbour steamers (over twenty years ago) the screw ferry-boat did not exist at all; and the best paddle-boats were narrow-pointed boxes, with flat floors and sharp bilges, very deficient in stability. Their sponsons extended only about half-way from the paddle beams towards the ends, which were quite sharp on deck. The steam chests showed on deck, with only a short casing; in some instances there were three or four short separate casings for the cranks

and steam chests, letting all the heat out among the passengers; the wheel chains passed down through inside the paddle-boxes and around a multiplicity of sheaves before they got to the rudders. In the "Quondong," designed over twenty years ago, he first introduced the sponson all round clear of the vessel and elliptical on plan, in the way now universal in our ferry-boats, and for the first time led the rudder stocks up through the upper deck. This latter innovation, however, was so great that the proprietor had them promptly sawn off. When the "Wallaby" was put in his hands the rudder stocks were short, but he scarfed iron stocks on to them and put large half-wheels above with wire cables direct to the wheel chains; and this first vessel so fitted was such a success that the system is now universal in the harbour—even the old "Quondong" was altered back. Persons now who looked upon these things as a matter of course had little idea of the difficulties there were to get such improvements introduced, unless a competent designer was given full charge—in the way he had, say, with the torpedo boats, and Mr. Reeks had with the Balmain boats.

Besides the features just mentioned, he was the first to introduce the tandem compound to both the paddle and screw harbour steamers, and the ordinary compound to launches, the "Bell Bird's" engines being illustrated in *Engineering* before any English firm had similar engines shown in such journals (and are also shown in a large work, "Modern Marine Engineering"). The one casing to enclose crank and steam chest and carry all the heat above was another innovation. In the "Quondong" and "Wallaby," for the lines of which he (the speaker) was alone responsible, the first step was made from the pointed box towards the full scow ends which the author showed in the "Manning." Mr. Reeks would remember that before he tendered for the "Lady Mary" he was shown a plan of a boat nearly as much a scow as the "Lady Manning" which he (the speaker) had prepared for the New Balmain Company before the Directors took the construc-

tion of the "Lady Napier" into their own hands. It was well known, but he would take this opportunity of making all the members acquainted with the fact that the Directors of that Company, and not he (the speaker), were responsible for whatever excellencies or defects there may be in the "Lady Napier."

With regard to progressive trials, he hoped the North Shore Company and the New Balmain Company would be able to spare these boats for a series of trials, and he would suggest that the revolutions be taken of the screw running loose when driven by the other screw only, both at the bow and stern. It would probably be a great improvement to drive the two screws with separate engines, and perhaps some modification of Rankin and Blackmore's system would suit.

He hoped we should have more papers like the one under discussion, and again congratulated the author on his boldness and enterprise in departing so far from established ideas and types.

Mr. Reeks, in reply, said that he must thank Mr. Cruickshank for what was in reality an addition to his (the speaker's) paper, as distinguished from a discussion on it. It was most gratifying to find that Mr. Cruickshank's experience and his own agreed on all points but one, viz., the question of economy of the double-ended screw system; but in reference to this matter he wished to point out that it was economical as compared with other double-ended boats, and not as against those propelled by a single screw.

As to those English shipbuilders and engineers so well up in modern practice Mr. Cruickshank's imagination had put before us, notebook in hand, and asking conventional questions, we should, he (the speaker) thought, give them just a little slack, and then in a casual way mention that we were followers of the deeply-condemned Scott Russell and Colton Archer, and that as our calculations were based on their data, because we found that "Kirk's Analysis," "Seaton's Co-efficients," and

"Froude's Tables" left too much to guesswork and trial, they might then, he opined, go home and say, "We have been to the bush, and find men producing successful boats on the very system we all say is wrong. Perhaps there is something in poor old Scott Russell after all; let us look him up."

He quite agreed that "progressive trials" should be made every time they were of enormous importance; but what use was it, if we knew the power required to drive one hull, when the next might differ in some small detail, and so completely upset all calculations. He considered an analysis—and a very careful one, too—of the hull, the curve of geometrical progression, the percentages off or on, the ·5 co-efficient, the perfect balancing of body to body, allowing for the different lengths of each, as being the only possible way of measuring the resistance a proposed boat would meet with, must be known before it was possible to say what power would be required to overcome that resistance. But he must not go on in this strain—it was a subject quite apart from double-ended screw boats, and applied to all and sundry that swim and move upon the waters. It might some day be his privilege to enlarge upon this subject, when, with Mr. Cruickshank's kind assistance—which he felt sure would not be denied—an interesting paper might be the result.

Mr. Christie was also his creditor—and for which he (the speaker) tendered his thanks—for the additional light thrown on the subject. The illustration given of the dock gate and propellers was good, and conveyed an idea that almost certainly could not be better understood. He thought surely Mr. Christie must be in error in saying that the "Waringa" was 25 per cent. greater displacement than the "Lady Manning." From what he (the speaker) knew of the former's specification, he considered 10 per cent. would be the outside excess. He believed the "Waringa" carried some ballast, but how much he could not say; but anyway, in high-floored and deep boats such as these, ballast was altogether unnecessary. It was true

that no progressive trials of the two boats had been made in the proper sense of the term, but he felt sure that, in the interests of science, the Directors of both the Balmain New Ferry Company and the North Shore Ferry Company would allow the use of their boats for that purpose; and he hoped shortly to take part in a thorough examination of the boats' respective performances, when, together with those with whom he might be associated, he should be only too happy to lay before this Association the results obtained. The work would would be a labour of love, and, he trusted, prove valuable and instructive to many.

Mr. Selfe's remarks, though largely of a personal character, were doubtless valuable; but for his (the speaker's) own part, when treating of a matter of such wide significance as that of our harbour traffic, individuality might well be dropped. We all wanted to do our little share in the direction of improvement, and that improvement, or those improvements, once established, it mattered little which of us was directly responsible.