to the Committee that was appointed for the very conscientious and careful way in which the experiments were carried out, and also our obligation to the Ferry Company that provided the boat. He considered that the evidence which was now available, through those trials, was calculated to be of the very greatest service in designing boats of the future for ferry service. He had had the opportunity of seeing ferry service in nine different countries, but he had never seen as good a service of boats for the special requirements as we have in Sydney Harbour. That was his firm conviction. There were larger ones in San Francisco and in other parts of America, and they were great, clumsy, unwieldy things in many instances, but they were coming round to more of our stamp. He would like to say that when he came here over fifty years ago there were few such things as ferry boats, and the watermen were still a great factor in the land ("on the water"). Well, you could see the land on the bottom right across to Balmain in those days. It would surprise many here present to know that a steam ferry boat, "The Pet," was built at Broadstairs-street and carried on a dray down to the east end of Darling-street to the water. Two able-bodied men could have carried her engine easily, as it was a side lever engine, the levers about three feet long, paddle wheels about 4ft. 6in. in diameter, and 25 to 30 revolutions a minute. It took about twenty minutes to steam from the Gas Works to the wharf where Jubilee Dock now is. The ferry service has, however, been improving all the time, and in his opinion will go on improving, although I may consider myself now wiped out. I have, however, got the drawings to show where and how the great evolutions came in. Up to the year 1872 the boats were of very simple construction, and as for many of the double-ended boats, they were considered most dangerous vessels to carry and land passengers. The old boats had flat floors and square bilges with sharp ends, and were merely pointed boxes, hardly ever on an even keel. When the New Balmain Company was formed (not the present Company, but a previous one which never ran), they came to him to design a boat; this was the "Quondong," which was sold to Mr. Perdriau, and ran for several years afterwards on the Balmain Ferry, and which, so far as he knew, was the first steamer to have two sterns instead of two bows, and continuous sponsons all round, and the rudder stocks carried up through the upper deck. It was a great innovation—the wheel worked the tiller lines all on the upper deck instead of under the sponson. He had brought the model of the "Wallaby" to show that, after all, she was not such a barge. The model was made by Mr. William Dunn, who only had his rough sketch for which he got the premium. He was not responsible for the lines. He fitted the boat up; that was to say, designed all the machinery, and everything but the bare hull he was responsible for. The boat was made with disconnected propellers to provide against accident damaging the bow one, and if we had had as much enterprise in those days, no doubt a great many interesting experiments could have been carried out with the two screws. As to the results of the recent trials, he was entirely at one with Mr. Christie and Mr. Sinclair. At the same time he fully appreciated Mr. Reeks' enterprise and the Company's enterprise in trying the experiments with only one screw, because if nobody tried such experiments we would not get information for future guidance. Mr. Christie and Mr. Sinclair had not mentioned that with the screw ahead-towing, the vibration of the hull was very great indeed. That could possibly be altered by using another form of screw, but at present the vibration is very bad when the boat is going full speed. But perhaps she doesn't require to run full speed when towing. It is not so bad, however, as the working of the hull was in the old "Governor-General"; there, through vibration, it was said, the heads of the saloon passengers used to be seen bobbing up and down behind the bales of hay carried on deck by the steerage people in the bow. Of course, everything came to those who waited, and we got in Mr. Reeks a man that could wait, and he believed we should yet see some boats that would not have any vibration in them. A little thing saved in first cost would not be justified if it led to loss in handling and control, because it stood to reason that with a right-handed bow screw alone going ahead the bow must be thrown off to the right, whereas with two screws—one at each end—the boat would go straight and a little to the right sideways. If one of the screws was made reversible like those in the oil launches, so that one screw could be made left while the other was right, the boat could then really get a stroke sideways. And for that one reason we might get some one to develop hydraulic propulsion that can make a steamer go sideways as well as end on.

Mr. J. Shirra said that our thanks were due to the author for the detailed information he had given us on the design and success of his single-screw double-ended steamers, and we might readily admit some of his claims in favour of them, but some of these were open to argument. On p. 107 he mentioned six points in their favour; of these, the 3rd, reduced consumption of coal, was hardly tenable, and the 5th, equal average speed both ways of going, with a little better speed one way, was apt to mislead, for the somewhat better speed was not with the pulling propeller, but with the pushing one, and the approach to equality each way was attained by making the propeller blade section less efficient as a pusher to favour it as a puller, but the trials have shewn that the deficiency of bow screw was still very material.

It was evident that these boats did not need to turn at a crowded wharf like the Circular Quay, but this time lost in turning was immaterial to most steamships, as unless there was no falling off in speed with the screw pulling, it was soon negatived by loss of time on the run. With a ferry service and short runs, it was no doubt a clear gain, but the Author purposed to fit cargo steamers, presumably for ocean voyages, thus; and the gain in efficiency would need to be very marked to compensate for the obvious disadvantages of the position of the screw. We had had many instances of steamers getting their bows stove in by collision with other vessels, rocks, or icebergs, which yet reached their desired haven in safety—they would have had a poor chance if fitted with bow screws.

The idea of a bow screw was not altogether a novel one. The novelty was in a practical man putting the idea to this practical use, in a double-ended boat, and the author was worthy of credit for the measure of success he had attained. The first record of a bow screw he (the speaker) could find was in a letter to "Engineering," in 1876, by Hayes of Stony Stratford, apropos of Howden's double-ended screw tugs, referred to by the author as having been tried on the Clyde. Hayes stated that in 1868 he made a trial of a bow screw on a canal tug 70ft. long and 7ft. beam, which, when tried tug-of-war fashion against a precisely similar boat with a screw at the stern, walked away with it, but the unprotected screw for canal traffic, and the conservatism of the canal people, prevented the idea being taken up, though the boat made several experimental trips on the canal system between Liverpool and London.

In 1873, Robert Griffiths, who did so much good work with screw propellers, tried models of double-ended double-screw boats, and read papers on them before the Institute of Naval Architects and the United Service Institution; the gunboat "Bruiser" was put at his disposal by the Admiralty in 1875 for full size trials, but he did not know if they were carried out. Griffiths showed that the great defect of the aft propeller was the want of a free flow of water to it, and proposed to form tunnels in the fore end and stern of the hull to allow the streams from the bow and to the stern propellers to flow under the hull. The superiority of Hayes' bow screw canal tug was no doubt due to the free flow to the propeller compared with the restricted supply to its rival's; restricted by the bluff run of the canal barge, and by the limited depth and cross section of the canal channel. But in a fine shaped passenger steamer in deep water, this disadvantage would be minimised, and the victory of the bow screw doubtful.

For to offset the advantage of a free feed of water to the bow screw, we had the increased frictional resistance of the wash along the sides and bottom of the hull. In well-formed hulls at high speed this skin friction was about 90 per cent. of the whole resistance, and varied nearly as the square of the speed, so if the sternward current from a bow screw screw goes 7 knots through the water while the ship was going 11 knots ahead,—that is, if the wash from the screw had a sternward speed in relation to the ship of 18 knots, or there was a slip at 11 knots of 38 per cent. as seemed to be nearly true of the "Lady Northcote" when pulling, the frictional resistance would apparently be increased as 18 squared was to 11 squared, 324 to 121, or more than 2½ times what it was when the screw was aft and the hull going at the same speed. As the bow screw received its water freely, and the induced sternward current set up ahead of it when moving at speed was not disturbed, the resistance to rotation was less, and the engines made more revolutions and developed more power, but the extra skin friction more than used it up, and the indicated thrust was much more when pulling than when pushing at the same speed. The indicator diagrams and curves of indicated thrust show this clearly. So that if we take equal speeds each way, the power, and therefore coal consumption, were much higher pulling than pushing. The possibility of getting this increased power out of the engine was due to diminishing the resistance to the propeller's rotation, but the extra power was not profitably utilised.

The extra resistance caused by the extra skin friction was not so great indeed as the above crude application of the rule that it increased as the speed squared implied, because the corresponding increased resistance and extra skin friction caused by a stern propeller had been neglected. The "Augment of Resistance" due to the sternward current that fed a stern propeller has been said to be owing to the diminished water pressure on the aft part of the hull caused by the water streaming aft, but this could hardly be the whole cause. In a badly formed hull we often had seen a wave heaped up at the stern which gave a higher stational pressure than at the bow, but this difference was not of much moment. The real Augment of Resistance was nearly wholly the extra skin friction on the run of the vessel due to the induced current set up to feed the screw. Nothing was done "per saltum" in hydraulics, water would not be compelled to instantaneously assume a higher velocity—the eddying and commotion that accompanied the motion of the propeller on first starting showed this, but very soon the action subsided into a steady cycle, a current was set up ahead of the screw, which flowed aft to feed it, and if we required the best results the screw blade was made with increasing pitch to accelerate the water as gradually as possible. But this sternward current had a less velocity before than after passing the propeller, and hence while increasing the skin friction and so causing augment of resistance, it did so much less than if it ran along the hull with the velocity of discharge from the screw. Also it affected only the after body practically, while the wash from the bow propeller affected the whole immersed surface. In a double-screw double-ended boat we had a similar disadvantage.

With a screw at each end on the same shaft, if the torque on either end of the shaft was measured by some of our modern electrical methods, getting the actual angle of twist as was done in getting the brake horse power of marine turbines, we should likely find that the forward screw absorbed most of the engine power; but if each screw was driven by independent engines, the aft screw, acting on water already projected astern, would find less resistance and would run away faster than the bow one, although when running alone it would run slower than the bow screw running alone. He was not aware of any case where a double-ended screw had been so driven, but in the paddle steamer "Bessemer," a double-ended Channel steamer 350 feet long, of which great things were expected thirty-one years ago, there were two sets of independent engines of 2000 I.H.P. each, driving independent pairs of paddle wheels, 106 feet apart centre to centre, disposed thus because the midship part of the hull was taken up with a swinging saloon. The aft paddles thus worked in the wash of the forward ones, and went about 30 revolutions to the forward ones' 25, per minute, while the forward ones did nearly all the work, as proved by the fact that the forward shaft bearings always gave trouble by heating. The "Bessemer" was a failure, but had the wheels been coupled up like the drivers of a four-coupled locomotive, she would have been a greater failure still.

The propellers in our double-screw boats were thus coupled up when on one shaft, and if speed was all we wanted, would fail in comparative efficiency. But the great advantage of the two propellers was that we had a better grip of the water when starting or stopping than we would have with one, unless that one was of much larger diameter than often it was possible to make it. In our down-harbour boats, the depth of water was sufficient for large propellers, and a single one, either aft or forward, could be made to give us this quick acceleration; for light draft boats, or where small propellers were necessary, as in turbine steamers, we obtained the capacity by increasing the number. The problem with our ferry steamers was much the same as our locomotive and electric traction engineers had, to get quick acceleration. The single driving axle locomotive had had a long and honourable career in Great Britain, and dies hard. The single driver "Duke of Connaught" took a moderately heavy train from Bristol to Paddington two years ago at about 72 miles per hour, doing the 119 miles in just under 100 minutes, but no one would therefore think such an engine good for heavy suburban traffic. We required four-coupled and six-coupled engines for this, and small wheels to get good adhesion and high tractive power. The weight of water a propeller acted on per revolution corresponded to the adhesion of a locomotive,—if one propeller could not get hold of enough, two were put on. The coupled locomotive was less efficient as a mere speed machine than the single one, there was more work lost by friction, unbalanced coupling rods, and so on,—but it was needed for rapid acceleration when stoppages were frequent. So also the double-screws on our light draft ferry steamers were needed. Railway engineers were familiar with curves plotted to show the velocity and acceleration of trains. He did not know if such curves had ever been plotted for steamers, the great difficulty with them was to get the instantaneous velocity; our trials "on the mile" were often vitiated by forgetting that a boat wanted some distance of run to gather her full way, and should run half a mile or so at full speed before she passed the first post. A cable tramcar, with a reckless gripman, might get up to 10 knots from rest in three seconds, to the great discomfort of the passengers, but few steamers would do it in less than three minutes, except perhaps high-powered motor launches.

The thrust of the propeller varied as the mean pressure on the engine pistons, but it was not safe to put the full pressure on these when starting until the stream line currents had been fairly set up to supply the propeller with water—if the engines were opened out too quickly, as might be done when a sudden order "full speed astern" was given, they raced dangerously; that was, "cavitation" ensued, the screw lost its hold of the water, just as a locomotive wheel slipped on the rail when started too quickly; but there was no sand box on a steamer.

The time saved by being able to get close to a wharf while at full speed and to check the speed quickly by putting the engines astern, as well as attaining speed up quickly when leaving, would well compensate for a lower speed on a short run, and here the double-screw showed to advantage, and if its propellers were of a fair size, the bow screw also. The rounded back of an