Discussion.

Mr. WALTER REEKS said he had great pleasure, on behalf of the Association, in proposing a vote of thanks to the lecturer for his excellent paper. Mr. Harricks had, to a large extent, discussed his own paper, and he (Mr. Reeks) was afraid that one or two points he intended to make had already been touched upon by Mr. Harricks in his paper, which, though short, was full of meat, many a paper occupying a whole evening having had in it less food for thought.

Referring to the "Aerotug" (Fig. 1), he knew that these extreme light draft tunnel stern screw boats turned out by Thornycroft and others, and sometimes called "canoes," looked very like square boxes, and the one depicted did not appear to be such as to give its propelling power a chance, but likely enough, for special purposes, this form of propulsion might yet be quite successful. the diagram (Fig. 3) was quite instructive, and showed clearly at a glance what usually occupied some paragraphs of matter, requiring care to follow, and while the geared turbine showed up conspicuously well in steam consumption, it would appear even in a better light had the other powers been reduced from I.H.P. to S.H.P., the ratio being, in reciprocating engines, usually .85 to 1. He entirely agreed with Mr. Harricks that, seeing the British Empire was poor in oil and rich in coal, our duty to ourselves was to do all possible to use the latter economically. It would be better to use the latent wealth we had than to buy oil from other people, and, on the figures shown that evening, with plenty of others to support them, the geared turbine so far would appear to be our best friend. It might be of interest to state that the owners were considering geared turbines for a double-ended screw ferry steamer about to be built for local service, the choice between them and reciprocating engines depending largely on the reply they got from the builders, Parsons.

Taking table II., by which it would seem that steam had no hope with oil, and just altering the figures to our local conditions with coal at 14/- and oil at least 95/-, and even more, the fuel bill became £1425, as against £600; total cost per month £1535, as against £700 odd, and the cost of conveying 1 ton became a little over 4/1, as against 2/-, putting the boot on the other leg entirely. Of course, they looked at these things from their own point of view, and things obtaining under present conditions. Mr. Harricks had, since he (Mr. Reeks) had compiled his notes on the uncorrected proof, introduced a reference to the San Francisco oil ferry steamer "Bridgit," and he was sorry that Mr. Harricks did not say something more about it; if, when he replied, he could give a little further information on the subject, more particulalry as to the reversing of the engines, he (Mr. Reeks) thought the members would be obliged.

Mr. WILLIAM SINCLAIR said he had great pleasure in seconding Mr. Reeks' motion for a vote of thanks to Mr. Harricks. After reading the paper, and then seeing it elaborated at the meeting, one was struck with the fact that ship owners had a remarkable number of types to select from for a ship nowadays. In addition to the types of propelling machinery shown in Mr. Harricks' tables, there was another development, an example of which was recently in Sydney Harbour, viz., the super-heated steam engine using the "Schmidt" superheater. Another arrangement, as used in the Orient boats, was the provision of a sort of central station for working the auxiliary engines. Mr. Harricks had commented on the fact that independent pumping sets led to greater fuel consumption, and they were all fairly alive to this feature. In the

Table I. exhibited, showing the different kinds of marine installations, practically in every steamer, with the exception of the "Admiral von Tirpitz" (which, likely enough, had water-tube boilers), all the boilers appeared to be of the Scotch type, which seemed to have survived all others. There were a lot of things which the men who had the handling of ships were always desirous of keeping in the front, one of which was absolute reliability, and this had a great deal of effect in keeping down what might be called "freak" designs—unusual designs in modern steamers. The point that had occurred to him was that modern engines, compared to those of some years ago, would outlast the ship. He did not know whether ship owners expected ships to be like Oliver Wendell Holmes' one horse shay—the whole thing finishing up simultaneously—but he was convinced that one would probably never hear of an instance where, when a ship was put out of commission, the engines would be worn out.

Commander G. H. Bromwich said he was afraid he could only discuss the paper read by Mr. Harricks from the naval side, as far as it applied to warships. He (the speaker) could not quite agree with one thing that Mr. Harricks said with regard to the reciprocating engine, viz., that he thought it might be admitted that no other could be compared with it so far as being independent of the "shore gang" in case of breakdown at sea. Referring to the engine from a naval point of view (where reliability was the first point to be considered in choosing propelling power), he (the speaker) held rather different views, because right through his twenty-five years' experience of service steam trials, which occurred at least once a quarter, they had in men-of-war been a perfect bugbear. Every ounce of power had to be got out of the machinery, and even with contractors' trials, it was with the greatest difficulty that they had been able to get the specified power and rate of speed that had been contracted to be built. He might mention one case—the "Good Hope" and the "Glasgow." He had made the first trip in the "Glasgow," which, about 2 years afterwards, took the late Mr. Joseph Chamberlain out to the Cape, and which was the last ship in which the contractors were allowed to readjust their bearings for each trial. In the case of warships, before the "Good Hope" they made entirely different adjustments to their bearings, and they used to have highly qualified men simply sitting and watching every bearing right through the trial, so, naturally, when the ships were turned over, with more or less scratch crews of stokers, who were really fairly well trained men in the navy, they were not to be compared to the mechanics who had built the ship, and until the men got trained to the running of the ship it had taken every ounce out of every man in the ship to get the trials through. The introduction of the turbine drive, combined with the use of oil fuel, had fulfilled these requirements more satisfactorily than had the reciprocating engines and coal fuel.

The other point he was going to touch upon was with regard to the electrical drive. He was hoping that, eventually, it would become efficient and reliable, which was what was wanted for naval ships. He anticipated that, amongst the advantages to be claimed for electrical drive for warships would be:—

(a) That it lent itself admirably to sub-division into water-tight compartments;
(b) the turbine revolved in one direction only, which was a great advantage;
(c) the breaking down of one turbine would not affect the ship except at a high speed;
(d) the turbine was less likely to be damaged from priming;

(e) the manoeuvring qualities were, he believed, far superior to any other method in the following respects:—

(1) Big heavy throttles were dispensed with;

(2) governing was very easy;

(3) speed could be maintained constant and accurately without any effort on the part of the personnel;

(4) full power in astern direction.

(f) the engine room watch would be about half that with turbine drive;

(g) only one set of auxiliaries would be used at a time.

If electrical transmission could be brought to a reliable and efficient state it would possess tremendous advantages. One would have to wait for the trials of the American battleship "California" in order to see how she got on.

There was one other point about warships which he would like to mention. Economy he put down third, in the relative order of importance. Reliability came first; the manoeuvring qualities second; and economy third—economy not being so much a question of money as of fuel and men.

Although not exactly apropos of the subject under discussion, he thought it might interest those present to know what the staff was in a battleship like the "Princess Royal," which was his first battleship, in which he was a junior officer. There were about 150 in the staff. and the speed of the "Princess Royal" was about three times that of the old "Bellerophon," and the total staff was 541. Any reduction in men in the engine room department was a tremendous advantage in war time, because there were fewer to lose, and fewer to organise. In the

"Princess Royal" the staff included four engineer officers commissioned, four warrant officers, 39 engine room artificers, eight mechanicians, eight chief stokers, forty-eight senior petty officers, seventy-eight leading stokers and three hundred and fifty-two stokers.

MR. TOURNEY-HINDE said he also had very much pleasure in supporting the motion before the meeting, and he rose simply to call attention to what appeared to him to be an omission in the reference, in Mr. Harricks' paper, to the electrical transmission in the American super-dreadnought "California," where he said:—

> "It can hardly be said that this form of transmission has yet quite emerged from the experimental stage, and it is difficult to see how this system, which requires two stages of transmission, each a unit in itself, can compete successfully with the simple transmission by a pair of gear wheels now being so largely adopted in the Parsons' geared turbine sets. Indeed, it seems that even the comparatively inefficient hydraulic transmission of Fottinger design, which is claimed an overall efficiency of 92 to 94 per cent., would compare favorably in economy, whereas the latter has a tremendous advantage in permitting of reversal of propellers without reversing the prime mover."

He did not think that Mr. Harricks meant that electrical transmission did not permit of the same facility of reversal. There was no necessity to reverse electric machinery (which was the prime mover) for the purpose of reversing the propeller.

MR. W. H. GRIEVE said he was sorry he had arrived at the meeting only in time to hear the conclusion of Mr. Harricks' paper. He did not know what had been added to it by Mr. Harricks, but he (Mr. Grieve) had read the uncorrected proof of the paper with great interest.

As Mr. Harricks stated, the advancement in marine propulsion, both in new types and also H.P., had been very startling within recent years. Mr. Harricks mentioned that many large steamship owners had not as yet adopted the steam turbine. In the great majority of such cases the reason was quite clear. The speed of the boats would not be higher than about 15 knots, which is unsuitable for the direct coupled turbine—in other words, the loss due to the compromise in coupling together an ideal high speed motor to the propeller, which, for economical design, must revolve at a comparatively slow speed, being much too great, and in many cases shipping companies had probably benefitted in adhering to the reciprocating engine.

The great disadvantage of direct coupling turbines and propellers inherently unsuitable for direct coupling no longer existed since the introduction of Parsons' creep cut helical gears, and almost every important Steamship Co. had now adopted the geared turbine principle.

A local example of the disadvantage of direct coupling on a ship of moderate speed was the Union Co.'s "Maheno." This vessel had now been converted to the geared principle with highly satisfactory results, and he understood that a saving of about 25 per cent. in fuel consumption had been effected. This Company had recently ordered further boats with geared turbine propulsion, as also had Huddart, Parker & Co.

The British navy had very largely adopted the principle, and battleships were now under consideration having a total horse power of 100,000 distributed to four propellers, 25,000 H.P. each, entirely by the creep cut helical gearing. The total power at work, or under construction with this system of speed reduction was 1¼ million H.P.

In connection with Mr. Harricks' remarks in his concluding paragraph, wherein he stated that "oil fuel is essential to success, whether for internal or external combustion"—everyone who had had the pleasure—and it was a pleasure, of being in an oil using stokehold admitted the ease with which steam was raised, and the perfect control the firemen had over the fire; and for certain purposes (he, Mr. Grieve, referred more particularly to naval work) oil fuel did appear essential—that was, of course, if the enemy or other fleets were so supplied.

A very common impression which the daily press fastened in the lay mind was that coal for steaming purposes was rapidly being replaced by oil fuel, which, of course, was utterly impossible for the simple reason that the supply of oil fuel was not available for anything but a very small percentage of the total fuel required. The world's total output of coal per annum was something in the vicinity of 1,100,000,000 metric tons. The world's total output of oil was, approximately, 40,000,000 metric tons. In other words, the total oil output was only about 4 per cent. of the total coal output.

The Hon. Sir Charles Parsons, in his presidential address before the North East Coast Institute in 1912, gave some interesting figures he had received from Mr. Dugald Clerk on this subject, which read as follows:—

> "The motive power of the world would require about 51.5 million tons of oil, while the whole oil raised is only 45.5 million tons, and the portion available for engine fuel, after allowing for petrol for motor cars, lamp oil, and lubricating oil, is only about 10 million tons. At best, oil could only be used for 20 per cent. of the world's motive power, and it is improbable that it could do so much because the price would rise far beyond 50/- per ton, which appears to be the price at which competition with coal is possible."

He mentioned this matter, as he thought the common and erroneous impression abroad that oil could replace coal should be corrected, and that our almost total reliance upon coal still held to-day as it did before the advent of oil fuel.

The scant information as yet received about the electrical marine gearing was most interesting, but, like Mr. Harricks, he failed to see how this system, or the hydraulic transmission gearing, could possibly compete in efficiency with a purely mechanical gearing with an efficiency of over 98 per cent. The only advantage of such systems was that the direction of the turbines need not be reversed, and so the power was always ready for application; but the reversal of large electrical rotaries took an appreciable time. All things considered, the loss in efficiency would greatly outweigh any advantages such electrical or hydraulic systems might possess, compared to the geared turbines.

Mr. McEwin said he was sorry not to have heard the whole of Mr. Harricks' paper, but he had been able to study it before coming to the meeting, and he thanked Mr. Harricks very much for the matter he had brought before them, the greater part of which was, he thought, absolutely new to the majority of members present. He might, perhaps, make one or two remarks with regard to the price of oil. Oil was far too valuable a product in this part of the world to be used for the purpose of boiler fuel. As an engine fuel it was to some extent an impracticable proposition. The price quoted for oil in England was 50/- a ton; it could be landed here at 100/- a ton. There was a duty of 10/- a ton on oil intended for fuel purposes, but on the same oil used for other purposes there was another £3 a ton to be added. Oil was not likely to be a practical proposition for use as boiler fuel. Having regard to the many other purposes for which oil was used, if a great demand was encouraged for it the supply would hardly be equal to the demand. While on the subject of oil, a very important point in the paper had reference to the lubrication of the Diesel type of engine. Lubrication with that type of engine was known to be a very difficult matter, but it was possible that some lubricant might be discovered other than oil which would ultimately get over the difficulty. A very serious problem was before engineers in that respect, and one which would require a good deal of research work. The number of lubricating-oil experts was very limited. He himself was not one by a long way, and he was sure he could not name more than two at most. In talking of lubricating oils, the term was sometimes used in quite a misleading sense. Many people claimed that if there was a good deal of "body" it was suitable for the purpose, but many oils contained compositions which had no lubricating value whatever.

With regard to boilers, he thought it was a strange anomaly that the Scotch Boiler had held its position in marine engineering as it had done. He thought it might be freely admitted that, in many respects, it was one of the worst contrivances which could be used for the purpose to which it was put. The Water-tube Boiler, in theory at any rate, was a most efficient contrivance, and were it more efficient in practical use, from a mechanical point of view, the Scotch Boiler would probably disappear very quickly. As far as the subject of marine propulsion itself was concerned, he had a great deal of confidence in the future as far as the price of oil in this part of the world was concerned, as we were living on a continent containing large oil fields.

THE AUTHOR'S REPLY.

Mr. Harricks said, in reply to Mr. Reeks' remarks about the poor shape of the Aerotug, that he had no doubt Mr. Reeks was quite right, but the outstanding necessity of the craft in question was that it should have the least possible draft, and, seeing that the maximum draft of the vessel was only 9 inches, and that it operated in particularly shallow and narrow streams, he felt rather doubtful whether there was much justification for more careful design on orthodox lines. Mr. Reeks referred to Fig. 3, which gave the relative efficiencies of reciprocating engine installations as compared with geared turbines, and suggested that it would have been more useful if the I.H.P. figures had been converted to S.H.P., but it would be noticed on referring to the diagram that a direct comparison was available between a combination installation and a geared turbine, and, as it was generally accepted that no more efficient installation in which reciprocating engines formed the major part existed than the combination set, a relative comparison could be made with the figures given for the I.H.P. of the quadruple, triple, and two-cylinder sets, etc.

The ratio of S.H.P. to I.H.P. in reciprocating engines is in the region of the figure quoted by Mr. Reeks, viz., .85 to 1.

The author was interested to hear there was a possibility of a local ferry company adopting geared turbines in one of their new boats, and although he had no doubt that an economical installation could be obtained, it was to be remembered that the efficiency of turbine installations did not become very marked until powers of about 500 H.P. or more were being considered. Mr. Reeks' comments on the comparison between Diesel engines and steam engines, as given in Table 2, serve to emphasise the fact which the author laid stress upon, viz., that with the present price of oil in Australia, the Diesel ship was practically an economic impossibility. The author was sorry that he could not give Mr. Reeks much more information about the Diesel engine ferry steamer "Bridgit," in San Francisco, but he understood that the boat was a double-ended screw vessel, with a single 500 H.P. Diesel reversible engine. Although at first sight it would appear that on account of the large proportion of its time a ferry steamer would be standing, that an internal combustion engine would have a great advantage, on the other hand there was the disadvantage that, on account of the vessel making short and frequent runs, stopping, starting, and reversing, formed a very important portion of her operations, and particularly with regard to reversing was this an objection with the reversible Diesel engine.

Mr. William Sinclair remarked that what struck him particularly about the paper was that ship owners had a remarkable number of types of marine propulsion to select from nowadays, and the author could only say that it was the strong impression this fact had had on the author's mind that had led him to prepare his notes. Mr. Sinclair had also drawn attention to the fact that in nearly every installation shown in Table 1 the Scotch type of boiler had been adopted. This was a striking fact, but had not been referred to by the author, as it was really outside the scope of his notes. It was, nevertheless, a remarkable fact, and must make those who decry this type of boiler ponder very seriously. The author did not propose to enter into a discussion as to the merits of any particular type of boiler, but could only say that, with the vast amount of experience available as to the best type of boiler to adopt for marine purposes, it was very evident that the old Scotch type must hold some tremendous advantages to enable it to secure pride of place in the majority of our most modern and largest commercial ships.

In reply to Commander Bromwich, who said that he could only discuss the paper from the naval side, the author had no doubt that a man of Commander Bromwich's experience could add very much of interest to the discussion, by giving members some of his experiences; he had evidently noticed that the author had purposely avoided reference to naval practice. The conditions that applied in the respective fields of naval and commercial practice were so different that it would be almost impossible for the author to attempt to make any useful comparisons. Commander Bromwich's experience with reciprocating engines, as compared with turbines in warships, brought this point out clearly, and one can only point to the vast number of commercial ships, ranging up to 70,000 H.P., and to realise that these vessels were daily tramping every quarter of the globe with the utmost reliability and maintaining guaranteed speeds and economies, to fully appreciate the fact that reciprocating engines were, to say the least of it, absolutely as reliable as any other type, and more so than most others that could be mentioned. The author also said that reciprocating engines for so many years had shown how seldom breakdowns had been so serious as to render it impossible for the ship's staff to effect sufficient repairs to enable the vessel to make a port. One can easily recall reports of damage to cylinders or moving parts of compound engines, and it had been possible for the ship's staff to re-arrange the remaining parts so as to enable the machinery to be worked, and develop sufficient power to render the ship safe. On the other hand, although probably it is not likely, imagine that a turbine should strip her blades—in this case, of course, any repairs would be out of the question. It is not the author's intention to endeavour to try and prove that the reciprocating engine is the superior from every point of view, but he must adhere to his opinion that, for reliability and independence of the shore gang, the reciprocating engine held first place.

The author had so far departed from his intention to not refer to the naval side of the question when he stated that, for naval purposes, oil had to be considered as practically a necessity. Commander Bromwich expressed his admiration for the electrical drive, and he gave a most interesting set of reasons why such a form of propulsion would be of benefit in men-'o-war. If we considered these, it would be evident that the electrical drive would lend itself in many respects, but, as remarked before, a comparison between naval and commercial ships was, in many respects, impossible, and this was another instance when Commander Bromwich said economy would be placed third on the list in the relative order of importance, for warships. One at once realized that, for commercial purposes, although reliability must hold pride of place in any vessel, economy must follow very closely in the order of importance. One had only to compare the staff of a war ship, as given by Commander Bromwich, with that of a commercial ship of approximately the same H.P., to at once see that it would be impossible for commercial ship-owners to employ ships requiring such extensive staffs.

Again, one must reiterate the fact that the conditions differed too greatly to allow one to make a fair comparison. Whereas we have the utmost pride and confidence in the machinery installations of our war-ships, it can perhaps be safely said that they are never called upon to develop their full power for such long runs as are commercial vessels. When we think of the recent remarkable bursts of speed shown by our naval vessels, we can appreciate the fact that their machinery installations must have been in a very high state of efficiency, but it is seldom during their existence that they would be called upon to maintain such speeds. We know that in commercial work, a ship such as one of our ordinary Australian mail boats, had to regularly run over 100,000 miles per annum, and in order to maintain a strict time table between many ports en route, her speed could not be reduced appreciably.

Mr. Tournay-Hinde had drawn attention to an obvious error in the author's notes. Of course, one of the important advantages of the electrical drive was the facility for reversing the propellers and their motors, without reversing the turbines or prime movers.

In reply to Mr. Grieve, the author would say that he was sorry that he could not support with actual instances his remarks with regard to the retention of reciprocating engines by certain ship-owners, but when the author was recently on the Clyde, he remembered being told by several engineers that for passenger vessels up to 17-18 knots speed, a number of ship-owners had adhered to the reciprocating engine in preference to the turbine. The author was not prepared to say whether this was the right or the wrong course to adopt; personally, he was inclined towards the belief that the turbine would be the better installation for such a speed, but it served to show that the difference in economy was not perhaps very marked for speeds that were not very much higher than the ordinary cargo steamer, and for which the reciprocating engine or geared turbine was most suitable.

Mr. Grieve's remarks with regard to the Australian steamer, the "Maheno," had provided members with actual figures as to the efficiency of the geared turbine, and as the author had pointed out in his notes, he could not see what could prevent most extensive adoption of this type of marine propulsion for almost all classes of vessels in the future. Mr. Grieve had referred very fully, and had given some interesting figures with regard to coal and oil for marine engineering purposes, but it would be noticed that the author had specifically mentioned that oil fuel was considered practically a necessity for naval purposes only at present. In remarking that oil fuel was essential to success, whether for internal or external combustion, he was referring to the future, and it would be readily understood that in making a statement of this kind, he was looking forward perhaps a long way, to a time when research had shown us a more economical way of using coal fuel than was at present known. The author knew full well that at the present time coal was the primary fuel, and it might remain so for many years, but one cannot shut one's eyes to the tremendous thermal economy and general convenience to be obtained with oil for internal combustion, and which would lead investigators onward with the desire to make its adoption general. The author was careful in his notes to refer particularly to the fact that, until the distillation of oil from coal was practicable, and this course seemed to hold the greatest promise for the future, the oil supply in sight would not be sufficient to keep the world's power going for many years. If it was possible to add to the supply of natural oil by obtaining, by distillation, oil from coal, and, of course, this process would require to be so economical as to leave a good margin of value over coal as a primary fuel, we could at once have a combined force of greater capacity of power than is available from coal and oil together. The simplicity and convenience that follows in the train of internal combustion are obvious.