Discussion.

MR. BRAGG said: It is very kind of the President to give me the chance of moving a vote of thanks to Mr. Grieve for one of the most interesting papers we have ever had before the Association. We are the more indebted to him because he has gone through the same work twice in one week. I had the pleasure of listening to the same paper last Friday night, and I may say that I have appreciated it more to-night than on the first occasion. One of the first things which strike me while listening to a paper of this kind is the enormous size of the parts of the machinery of these turbines, and we cannot fail to appreciate the brain power which is capable of thinking out and inventing such gigantic machines. Beyond that there are also machine tools necessary for turning out the work. When we think of turbines of such size and power, of the aeroplanes, of wireless telegraphy, and of the other numerous developments we ourselves have seen, I think we may fairly expect the historian of the future, when he comes to write the history of our times, will be justified in saying, as a great historian once remarked, "There were giants in those days."

I would like to criticise the paper, if I could, but I am afraid I am not in a position to do so. I will, therefore, only ask questions. One question I would like Mr. Grieve to answer is, whether there is any difficulty in combination turbines, whether one wheel is driven by one pinion, in getting the speeds of the two turbines to exactly coincide? He also mentioned a case where a chain drive had been discarded, and I would like to know the reason for that. It is very efficient as a rule, but he could hardly get up to an efficiency of 98 per cent.

I have much pleasure in proposing a vote of thanks to Mr. Grieve.

MR. SHIRRA said: Gentlemen, I have much pleasure in seconding the motion proposed by the Vice-President. I was much interested in the paper, and I think the slides were very good and clear. Indeed, they showed everything as it should be shown. In the case of the chain-drive, it struck me that it was driven by the first shaft. With a high speed turbine revolving at 1500 revolutions per minute, one would think it would throw the chain off. An old engineer brought up on old-fashioned engines can appreciate that. We engineers were rather frightened at the number of revolutions. However, we have now got beyond many times that, and things seem to go all right. In the "Vespasian" Mr. Grieve said that with the same number of revolutions in both cases, the power was increased 20 per cent. when using the turbines. Now, I would like to know whether the propeller was the same? If not, I do not see how this could be. I should also like to know whether this system of geared turbines has ever been applied to motor-boats? We have motor-cars running at over 1,000 revolutions per minute, but that speed is not suitable for launches. I think that a motor-launch running at about 150 revolutions would be a success. With geared turbines you have to allow for a certain amount of friction, but in a direct-coupled engine the thrust-block is merely a guide-block, and takes very little of the thrust. In a geared turbine we have an ordinary thrust-block which causes a fair percentage of loss of power in friction—possibly 5 per cent. Still, the efficiency of the geared turbine seems to overcome that disadvantage, and I have no doubt they will be much commoner in future years. I may say that we have had geared turbines on the Watson's Bay Ferry boats for some years past.

I have listened with great interest to the lecturer, and I have much pleasure in seconding the vote of thanks.

MR. BAYLISS said: Gentlemen, I should like to support the vote of thanks to Mr. Grieve, and at the same time I would like to give my opinion on the subject of the chain-drive, and I will ask Mr. Grieve if he will act as arbitrator in the matter. I believe that the record in high speed chain-drive claimed by the Westinghouse Co. is something like 600 h.p. Now the point I wish to raise is that raised by Mr. Shirra, who said that the chain-drive shown on the slide was running at about 1500 revolutions a minute. In regard to Mr. Shirra's remarks concerning the gearing in motor-boats, it is quite a common affair. Last year it was reported that at Monaco they were running their engines at 4,500 revolutions, and the propellers at 2,500. It is true some were called "musical boxes," and created a great noise. With regard to the question of gear, I should like to ask Mr. Grieve if the creep motion has been used for other gearing than the spiral gear on the turbines mentioned, because a silencing gear seems to present a lot of problems which motor engineers have not been able to overcome to their satisfaction.

THE PRESIDENT said: I have listened with much interest first to Mr. Grieve's paper, and then to the remarks by the gentlemen who followed.

It may be of interest to mention that I have looked into this question of geared turbines for use in our local ferry service. The question was put to me of producing light, fast, small steamers to carry on the day service with half the number of boats, using those laid by during the business trips night and morning, or peak loads.

It figured out that, allowing for reasonable delays, a speed of 15 knots was essential, and 15½ desirable.

Having a good deal of data of reciprocating engines, I saw almost at once that for such small vessels the weight of machinery would be so closely chased up by the dis-

placement necessary to carry it, that much greater expense would be involved than the saving in other ways warranted, so I turned to geared turbines, and the best data as to their performances available; needless to say, all examples published were of far greater power than I had in mind, but by deduction, got approximately at the space and position of an installation of that kind, with a view to leaving items, such as centre line of shafting, size of aperture, diameter of propeller, type and position of boilers, alone, otherwise retaining the general design of hull which suits the work.

It is obvious that, in ferry steamers, many of which are limited to draft of water, particularly those that run up the rivers, one must keep the centre line of shaft as low as possible. This at first appeared to seriously limit the ratio of the speeds between turbine and propeller, and would, I think, obtain but for the fact that in the mill plants the reduction is done in two steps; and that being so, the problem becomes easy, for on this basis I found the conditions could be filled entirely.

I got to the length of setting this out, and had every intention of submitting my plans to Messrs. Parsons, through their Sydney representative, for confirmation or correction of my figures, when a change in the company's policy stopped it; but I have every reason to believe that the question will be revived later, and gone into more fully. Meantime, I may say that the little study I devoted to the subject was a very fascinating one.

This scheme involved two sets of turbines for equal running both ways, but each so small as to cost and weigh all told very much less than reciprocating engines of equal power. And just here comes the point on which I should like Mr. Grieve to enlighten me. It has been stated, apparently seriously, that the stresses set up

particularly in the go-astern turbines when commencing manoeuvring, and until well hot, are very great; in fact, dangerous—is that so? and, if so, does he see any difficulty in keeping the idle turbines in a case such as I have mentioned warm enough during the running in one direction to eliminate that danger when taking the way off the boat at the end of the trip, and starting up for the return journey?

If that is not a real trouble, then there is nothing to prevent our ferry boats, of which we in Sydney are rather proud, being fitted with geared turbine machinery —very much to the pecuniary advantage of the companies who run them.

It has been said by a very eminent engineer that nothing which is within the imagination of the normal mind is impossible; and it has often occurred to me when looking at pictures of these beautifully finished gears—and it has been confirmed by the pictures I have seen this evening on the screen—relative to the diameter of these geared wheels, that the teeth seem to be ridiculously small, approaching almost to frictional gear, which appears to be a confirmation of the remarks of that eminent engineer to the effect that nothing which is capable of imagination is impossible.

I know of a case where a De Laval turbine lighting plant was fitted into a small boat, which was under the control of what is known as a "⅝" engineer, and he came to the conclusion that in connection with the driving-shaft, which is, as you know, turned out to a very small diameter between the bearings, there must have been a mistake somewhere; he had another made parallel—about ⅝in.—with the result that there was a horrible noise, which lasted only a few seconds; but from that on, the lighting of the boat was quite practicable, though

dull. In due course—some six months afterwards—this driving pinion was sent to Sydney—I have it in my office this moment, and if I had thought of it I would have brought it along—to find out from the agents of the De Laval Co. why the lights had been so dull since the alteration was made in the plant. It is bored up till the spaces between the teeth practically amount to nothing—to put it in a few words, during those six months that De Laval turbine ran as a friction machine. That confirms the opinion I have had for some years past that the time will come when these plants will be run by friction gear. If that idea is entirely mad, I shall be glad if Mr. Grieve will say so in plain words. He may say it would be all right in 10 h.p. plants, but of no possible use in larger engines.

I had intended raising the very same question which Mr. Shirra raised, and I cannot quite understand the statement which has been made in connection with the experience of the "Vespasian," that 20 per cent. more h.p. was developed by the same propeller, revolving at the same number of revolutions. If Mr. Grieve can throw some light on that statement, I shall be very pleased.

I have very great pleasure in conveying to Mr. Grieve the vote of thanks, proposed by Mr. Bragg, seconded by Mr. Shirra, and supported by Mr. Bayliss, for his exceedingly interesting and intelligent paper.

Mr. Grieve, responding to the vote of thanks, said: Mr. President and Gentlemen,—I thank you very much for the reception given to my paper. Mr. Bragg raised the question of two-pinion wheels driving one wheel. You must remember that the two turbines are in tandem, and there is no difficulty at all in distributing the power in each. The pinions are designed with an enormous

factor of safety, and even if one turbine were quite disabled and the other had to do its work, there would be no trouble.

With regard to the chain-drive in the Dunlop Rolling Mill Plants, that was simply driving a small rotary oil-pump. It merely lifts the oil from the bottom of the gear casing, and lets it flow onto the mesh point of the teeth. That is a two-stage double helico-reduction scheme, the revolutions being only about 70, which they could not get in one stage, and the chain-drive is from the first reduction—not direct from the turbine.

In reply to Mr. Shirra's remarks concerning the increased efficiency of the converted "Vespasian"; The propeller, as pointed out in my paper, was the original propeller as driven by the triple expansion engines. I am afraid I did not express myself correctly. What I should have stated was that there was a gain of about 20 per cent. in steam consumption in favour of the geared turbine propelling plant compared to the reciprocating machinery when revolving at the same speed. This saving means that with the same boiler plant about 20 per cent. increased power was procured by a slight increase in the speed of the propeller. In other words, the 20 per cent. saving is the cause, the 20 per cent. increased power at increased propeller speed is the effect.

This double helical gear has not yet been applied to oil engines.

Perhaps members are not aware of the exceedingly ingenious innovation of Mitchell, of Melbourne—I refer to his thrust-block. Messrs. Parsons have adopted it as their standard in all their turbines, not only for thrust in ships, but for turbine balancing purposes also—that is, they have adopted it for keeping the turbine in one fixed position while running. It possesses the self-lubricating

property of a cylindrical bearing. The coefficient of friction being from about 0.001 to 0.002. It is extremely simple, and well worthy of a paper before this Association.

With reference to the chain-drive gear, to which I have already referred, I do not think we will ever see it adopted for transmitting large powers. The efficiency is, relatively speaking, very low, and they are extremely noisy. The double helical gear possesses so many advantages for the transmission of large powers that any other type of gear is not likely to be adopted for marine work.

I listened with great interest to Mr. Reeks, and I would remind him that turbine cylinders retain their heat for a great length of time. It is not a question of minutes, but of hours and days; so that there would be no difficulty at all as regarding quick starting, after a trip, due to unequal expansion of the cylinders. Mr. Reeks also referred to the smallness of the teeth; but, needless to say, the smaller the teeth, the smoother the running; and in the double helical gear you get much better running still. The example given of the ferry steamer fitted with the De Laval engine, shows the importance of efficient lubrication—I mean that a double helical reduction for these powers would be impossible without the most efficient lubrication. As a matter of fact, the gears can hardly be in contact, for they are designed with such a large factor of safety that a film of oil is practically always between engaging teeth.

A pure friction drive would be quite impossible for such powers.