29TH JUNE, 1911.

DISCUSSION.

Mr. Shirra said that a paper was read by a member of the Institute of Mechanical Engineers on this subject a few years ago, and a great deal was said about a certain engine installed at Harrowgate. It was erected some eight or ten years ago, and if we could hear how that plant was working to-day we would get some very valuable information. We got some information about it some years back, but we would like to hear further. There is a lot to learn about Diesel engines, and there is no doubt they are coming to the front. The British Admiralty is adopting them and using them for certain purposes, such as refrigerators, that is when there is no steam on the boilers and so on. There is no doubt they must be of great benefit or they would not be used. A great deal of the paper was devoted to investigating the comparative economy of oil and coal, which is to a certain extent a question of economics rather than of engineering, although it is a very practical thing for engineers to know what oil is going to cost; we seem to want information from the Chamber of Commerce or some similar body as to what price oil can be supplied at. The question that concerns us is not what oil can be supplied at in England, but what it can be supplied at in Australia. There was a good deal of feeling expressed in depreciating the steam engine. He is quite prepared to accept the Diesel engine if it is a better one than the steam engine, but at the same time the steam engine of to-day is a very different thing to what it was 100 years ago, and a steam engine will be a very different thing in 100 years to what it is to-day. It seems to be a very roundabout way to get steam by boiling water in a separate vessel and afterwards sending it as steam into the engine. If we could save the complication it would save a good deal of loss, and it would be a splendid thing if we could eliminate the boiler and use the fuel direct in the cylinder. In the Diesel engine the oil is heated in the cylinder itself, and it is quite a legitimate development in the experiments of the engineers of the last century. Probably the engines of the future will be somewhat on the lines of the Humphrey oil engine pump.

It is quite possible that the engine of the future will have comparatively little mechanism in it. There is a great deal of food for thought in that idea, and if we consider the real cause of the propulsion of ships, we would not trouble so much about the mechanism, but would try and get a direct action. This certainly has hardly anything to do with the Diesel engine, but we are always seeking for information that will, as in the Diesel engine, dispense wth some complication. If we could learn something about the Harrowgate engine referred to earlier, the author would help us.

Mr. G. N. Tregarthen said that in glancing through the reports of the tests that were given, he was rather surprised to find one which gave undoubted superiority to the steam engine. He referred to the figures given in connection with the Wakefield and District Light Railway.

Here the cost per unit for the steam engine is given as .384d. This is correct, but the author has omitted the figure for an oil engine, which, worked out, comes to .443d. per unit.

Had the Diesel engine been a steam engine, the 18 per cent. load factor might have been put forward in explanation, but he understood that low load factors are considered to be the oil engine's strong point.

There are one or two other items in this same report upon which he could not help remarking. For instance, the repairs to steam plant are set down at £321; surely an extraordinary amount. Then again, it is charged with £110 for repairs to building, while the Diesel engine gets off with only 18s. 1d. If these two amounts are deducted from the steam plant total, as of course they should be, then the cost per unit will be still more satisfactory from the steam engineer's point of view.

The question of fuel seems, at the present moment, to be the greatest obstacle to the introduction of these engines, both as regards price and certainty of supply.

In regard to the guaranteeing of a demand for 5,000 tons of oil, it certainly seems to him that the Diesel Company would be serving their own interests were they to do so.

It would appear to him that the small powered gas

engine has too great a hold to be readily ousted by a rival somewhat complicated in mechanical design; whilst, for larger powers, the experience of many purchasers of large producer gas engines, who have found that with these engines they have bought lawsuits, will prove a serious obstacle to the Diesel engine in this, its legitimate field.

There are one or two questions he should like to ask. Is the Diesel engine made in two cycle types or only four ? In a paper read before the Institute of Naval Architects about two months ago, he noticed it was stated that the new engines being made for the Hamburg-American Line would be two-cycle. What form of packing would be used for rods in that case, with the very high temperatures and pressures? He should like to know what jointing is used for the cylinder heads, which he observed in the drawings are made with covers. Do they have copper gaskets, or what method is adopted?

Mr. W. F. Findlay said that he would like to ask one question; that is, with regard to the effect of the high-pressures and high temperature on the fuel. Do these cause carbonization on the cylinder head? He understood that the engine starts by the heat of the compression. He would like to know if he is right in that belief.

Mr. Walter Reeks observed that in looking at the matter from a business point of view, the thing that interested him most was of course a question of cost. Mr. Shirra said that from an engineering point of view that was not very important. It is a vital question. Some of his clients started out with a fixed determination to adopt, not necessarily Diesel engines, but oil engines rather than steam engines for small vessels up to say 500 or 600 horse power. He had put in a good deal of time in ascertaining the comparative costs, and although the first cost is very important, the running cost was more important still. After spending weeks in the aggregate and many days at a time, he found that the first cost, as applied to Diesel engines, was absolutely prohibitive. He may have been misinformed. He had had several chats with Mr. Deane since, who, as is known, is not directly interested in the sale of Diesel engines, but looks at the question from purely an engineering point of view. He tells him that there were many cases where the

first cost of the Diesel engine had compared very favorably indeed, and in many cases had even been in favor of the Diesel engine compared with the steam engine. Some people called him an experimenter. That may be. He certainly liked to be up-to-date. If it could be shown that such engines could be used in fair competition with steam, he was ready for them. All he could hope was that Mr. Deane in his reply would be able to satisfy them reasonably at any rate, that the figures he gave us at our last meeting were correct. He had no doubt that in big installations, such as for a tramway power scheme, they were; but he wanted to know if Diesel engines could be brought into competition with steam for about the horse-power he had mentioned. There are many cases of coasting vessels where space, draught and weight are of the first importance. They might very easily outweigh the difference, compared with the steam engine, either in regard to first or running cost. He was sure Mr. Deane would give them all the information he could on that very important point.

The President said that when recently considering a power installation for a very big workshop in Sydney, he made a close comparison of the cost of operation of a Diesel plant and a suction gas plant. He was surprised in getting tenders for the plant to find that the tender for the Diesel engine was generally lower in first cost than that for the suction plant. The building space required was less, there was no producer room required, and in all these charges the Diesel engine came out on top. When it came, however, to cost of operation, notwithstanding its undoubted superiority, and higher thermal efficiency than gas or any other prime mover, the high cost of fuel brought the annual cost of working the Diesel plant slightly above that of suction gas. This estimate was based on the present rates for fuel ruling in Sydney, that is for oil fuel, and the comparison is therefore not a fair one. The present rate for oil fuel is anything from 80s. to 100s. per ton, whereas at home it is 37s. to 40s. Notwithstanding the fact that the fuel charges for suction gas amount to £100 a year, and for the Diesel plant £300 a year, still with depreciation and running charges the suction plant came out at £2,100 and the Diesel plant at £2,120, which speaks volumes for the efficiency of Diesel machinery. There was no doubt in his

mind about the satisfactory running of these machines. Their compressing pressures are abnormally high. One would anticipate difficulties with packing the glands, etc., but that does not occur in practice. He was connected with a firm running the only Diesel engine in New South Wales. The plant starts at 8 o'clock in the morning. The attendant comes in and starts the engine at five minutes to 8, and it had given absolute satisfaction with one exception, and that is the difficulty in obtaining fuel. There was no doubt in his mind that if that difficulty could be got over the Diesel engine had a very great future before it. It is very easily run. The man who is engaged to watch its operation can engage in a multiplicity of operations. No feeding of fuel is required, and the running of the governor is very good. The examples selected by Mr. Deane in his paper, showing the relative uses of steam and Diesel plants, are very unfortunate. Possibly Mr Deane will be able to give us some information on that. In West Australia he was associated with two Diesel plants, and there we had perfectly satisfactory running. There was no depreciation, the wear and tear were not by any means excessive, the engines maintained their compression, and we only had the one difficulty, the supply of fuel. If it can be arranged that we can get fuel here, there can be no doubt in his mind as to the successful installation of Diesel plant, particularly for electric power, owing to their exceedingly steady running.

THE AUTHOR'S REPLY.

In replying to the discussion, Mr. Deane said that with regard to Mr. Shirra's remarks he thought he had made it clear at the end of the paper that he was greatly indebted to the author of a former paper. That was the first paper written in English on the Diesel engine, and described the machine much better than he could. Mr. Shirra mentioned the Harrogate engine. That is running to-day, and when he left Home he understood that the authorities there were thinking of putting another one down. He thought that that remark with regard to putting other engines down applies to practically all the installations that have been carried out with Diesels, with the few exceptions where fuel is practically unobtainable.

Mr. Tregarthen brought up the question of the Wakefield costs. The reason that these were particularly put in will be partly explained by the footnote at the bottom of the tests. Although the Diesel engine costs came out somewhat higher than those of the steam costs, it will be noted that coal, good Yorkshire slack, was obtained at the Powerhouse bunkers at Wakefield at a rate of 5/3 per ton of 21 cwts. That comes out at about 4/10 per ton. The average cost of the oil fuel from January to March was 69/6 per ton. It certainly dropped to 61/10 per ton. There is a difference of something like 13½ times in prime cost of the fuel in the first case, and 12 times in the latter case. That is not a bad showing, considering the difference in the fuel costs. The cost at that time for oil was abnormally high. As stated in the paper, oil can be obtained at Home as low as 33/- a ton, and the particular lot he was speaking of was shipped from Borneo and Sumatra, carried round the Cape, which is about 3½ times the distance to here. He thought one might reasonably go into the question of the cost of oil. Unfortunately the demand in Australia for crude oil is extremely small, and anybody who thinks the question over will remember that transport of oil is a costly matter. The Shell Transport Company's ships cost £66 a day to run. If a 5000-ton ship is to bring a load of only 1000 tons, it is palpable that the cost of transport is going to be five times as much as it would be on 5000 tons. Roughly speaking, a 1000 ton tank would cost £4,000. That also makes a material difference in the cost. About 250 tons a year in Sydney and about 1,000 or 1,500 tons a year in Melbourne is the present sale—Broken Hill takes nearly 3,000 tons a year for concentration purposes. Prices are better in Adelaide than they are here. That gives an indication of what can be done with regard to the reduction of the prime cost of oil if the demand grows. Oil has to be transported practically 3½ times the distance, and yet is sold at Home for 33/- a ton, if the demand arises in Australia there is not the slightest doubt that it can be sold at 33/- a ton here. At the present time it undoubtedly prejudices the development of the Diesel engine. That is still a point that can be got over, especially when freight comes into the question. The average man has not been

able to get coal at under 15/- a ton. Looking at the ratio at Wakefield, and knowing that the Diesel plant has been beaten slightly—very slightly indeed—with a difference in cost of oil to coal of 13 to 1, what price can we go to with oil to compete with coal at 15/- a ton? The firm he represents has several Diesel stations in South Africa. There they find that ten to one can be taken as a safe ratio for Fuel Cost comparison, because in South Africa the labour costs are pretty high. Labour costs are extremely high here; in fact, somewhat higher than in South Africa. At Home the labour costs are lower. It could not be taken as the ratio for prime cost there, which would be certainly not higher than 8 to 1. Here he is convinced they can go to at least 10 to 1. The actual figures given by Mr. Julius corroborates that statement.

Another point raised by Mr. Tregarthen was whether two-cycle engines were being made? They are being made very successfully.

Mr. Tregarthen: I meant double acting.

Mr. Deane: The Augsburg-Nurnburg people, who have had a pretty big experience of Diesel engines, together with Messrs. Bloom and Voss, are making not a double acting engine, but a two-cycle engine with super-imposed cylinders. That is the type of engine being adopted for the boats of the North German Lloyd. Each engine developed 1500 h.p. The packing gland is practically the same type as that developed by the Augsburg-Nurnburg people. The United States Metallic packing is used. That will give an indication of the type of packing. It may be said that in practically all the big gas engines at Home they are used. After all, the difference in pressures between the gas engine and the Diesel is not very great. The lowest compression pressure of the gas engine is about 130 lbs., but the maximum pressure reached in explosion will go up as high as 380 or 400 lbs. In the most successful vertical running gas engine the explosion goes up materially higher than that. So that the experience gained on the big gas engines is simply being extended to the Diesel as regards the question of gland packings for rods, etc. The method of jointing is to have an absolute metal-to-metal face. One or two firms, he believed, use very fine copper gauze with a black-lead mix-

ture. The black-lead is to enable the packing to be removed easily. The ordinary two-cycle engine does not need packing unless it has super-imposed cylinders or is double acting.

Mr. Findlay raised the question as to whether the high temperature did not produce carbonisation. The high temperature stops carbonisation. In starting it is only necessary to give the engine sufficient compression once to give the fly-wheel sufficient momentum to carry it over one or two compressions, after which the fuel is ejected at the point of compression, enabling it to be started right away. That was the main reason for giving the card. In that particular card there were only two strokes for working under air conditions. Then the machine was evidently switched over on to the fuel condition. That was given to show how easily the starting could take place.

Mr. Reeks raised the point of the first cost for the marine engines. He had not had much to do with the marine side of the question. He knew that under present conditions engines can be supplied in Australia at approximately £10 per h.p. To that must be added the shafting, propeller and auxiliary gear. It could be done, roughly speaking, at the outside for about 20 per cent. higher than the first cost for steam. But the question of first cost is a secondary one when it is realised that from a bunker point of view the Diesel engine only requires about 30 per cent. of the space coal does. Then again, the engine itself only takes up a small space, and there is a saving there of 40 per cent. or 60 per cent. These are such important factors that they probably quite outweigh the question of first cost. The weights are a very difficult problem at the present time, but he believes that at about 90 revolutions a h.p. could be developed with a weight of engine of about 500 or 600 lbs. But it is, of course, materially higher with naval vessels, because there is a big difference in the number of propeller revolutions. One particular case was very interesting. A naval vessel propeller was to run at 180 revolutions, with an electric transmission gear in between the propeller and engine which was to run at 450 revolutions. The actual weight came out at 18½ h.p. per ton. That quite beats anything that can be done with steam engines under the same condition of propeller revolutions. Even with a turbine-

electric proposition better figures could not be obtained, even if as good. With regard to the running cost from the marine point of view, the comparison has to be taken from the cost of fuel in both cases. The average cost of fuel, according to the figures given before the Marine Engineers' Institute in Sydney, was about 30/- per ton for Welsh coal. The majority of steamship lines preferred to use Welsh coal at that price. That is, the lines running from Home, at any rate. On that basis one could certainly with marine cases go to 90/-, and probably 108/-, a ton for oil. Mr. Julius brought up the question of fuel costs, and gave his experience on actual maintenance costs. He should like to know the exact consumption. He came across a most interesting case to-day of a vertical suction gas engine. The Engineer has got his installation very well equipped. He is driving electric machinery, and has got a Watt meter on, and he weighs his fuel out every day. He told me that he is using charcoal, but has to use 2 to 2¼ lbs. per kilowatt hour. The Diesel engine would compare more than favourably with that. The figures were given to me quite candidly this afternoon. It is certainly a wide margin, because many gas engine firms give figures of approximately from 1 to 1¼ lbs. per brake h.p. developed, but he had never seen it done in a running job apart from an elaborately got-up test. There is a great difference between specialised tests and actual running costs. As Mr. Julius very well pointed out, the whole question as to where the Diesel can be adopted under what might be called the abnormally high fuel costs is a matter of considering carefully the capital charges, depreciation, maintenance and labour costs. From these points of view, although an extremely great admirer of steam engines—because they are probably the most beautiful sets of machinery that could possibly be designed, the elaboration that has to be maintained to get anything like real economy means a tremendously heavy capital outlay and maintenance cost. The number of links in the chain which need to be watched in the steam plant is another great factor in favour of the Diesel plant. With the single unit as a prime mover, like the Diesel, there are practically only about four points that a man has to look at to keep up the machine's efficiency.