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OIL ENGINES FOR MARINE PURPOSES

BY

MR. F. M. TIMPSON (MEMBER),

READ ON

Monday, December 3rd, 1906.

CHAIRMAN, MR. W. C. ROBERTS, R.N.R.

ADJOURNED DISCUSSION

Monday, January 7th, 1907.

CHAIRMAN, MR. W. LAWRIE

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PRESIDENT : THE RIGHT HON. LORD PIRRIE.

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December 3, 1906.

PREFACE.

AT the meeting of the Institute held here this evening a paper on " Oil Engines for Marine Purposes " was read by Mr. F. M. Timpson (member), which opens up a subject of growing interest.

The discussion was adjourned till Monday, January 7, and as there are several very important points touched upon not only in the paper but in the discussion which took place this evening, it is desired that members who have had experience of this class of engine, or who can give expression to opinions on the suggestions made by the author in regard to auxiliary machinery, should do so either in speech or in writing, in order that the value of the paper may be enhanced by the contributions to the discussion.

JAS. ADAMSON,
Hon. Secretary.

Oil Engines for Marine Purposes.

By MR. F. M. TIMPSON.

Read Monday, December 3rd, 1906.

Chairman: Mr. W. C. ROBERTS, R.N.R.

The value of Paraffin Oil Engines seems to be fully appreciated for land purposes, judging from the number employed in all classes of work, and they can be found giving every satisfaction even in the hands of practically unskilled labour, the only skilled supervision being the periodical visit of the Insurance Inspector. This would seem to prove that the difficulties in running are not complicated and should cause no anxiety to the Marine Engineer of the day, but rather lessen same, as well designed oil engines have fewer working parts than those worked by steam, and if treated with care require but little attention. For some years past, motors obtaining power from low flash oils such as naphtha and petrol have been fitted as a general rule for the propulsion of pleasure boats, fishing craft, etc., in the United States and some Continental countries and more recently in Great Britain. The service given by these motors has been as a rule satisfactory, but the dangers of explosion and fire from using these highly explosive spirits, coupled with the cost, has rather retarded much progress for use in every day commercial work. Still a lot of valuable experience has been gained and will, no doubt, prove of great service in the construction of engines to use the heavier and higher flash oils, and as there now seems a growing demand for engines using paraffin, makers are giving the matter attention, and we have a number of firms offering marine paraffin motors. Many of these are limited to power, and very few can give over 50 or 60 B.H.P., while others are unable to go over 10 or 20 B.H.P. At the present these do not seriously tackle a very important commercial demand which exists in the fishing industry, and with a view to this a firm with whom I am associated put in hand this year a large drifter with a three-cylinder oil engine of 250 B.H.P. which is, I believe, the largest oil engine yet made in this country. The engine in question was designed to have simplicity in working, and although not yet fully completed in respect to sea trials, has proved a

thorough success as an oil engine. The engine is of the Central Valve Type and Peck's patented design, having one valve on each cylinder head for admission of the charge and air valves with connexion to the crank chamber and cylinder, in the first instance, for the supply of air pressure—which is obtained by the piston trunk working into an air-tight crank chamber; and in the second instance, to mix with the oil feed and supply fresh air to scavenge the cylinder, thus cleaning out foul gases before compressing the fresh charge. The oil is fed to the cylinder by gravity and controlled by a governor arrangement cutting off supply in the event of excessive speed. Combustion takes place every down stroke, and is of such a nature that the exhaust temperature on test was as low as 120° F., while there was no objectionable noise from the exhaust as is common with petrol engines of high power. To facilitate starting the engine, a small oil engine driving an air compressor is provided, and compressed air is used as an impulse in moving the main engines which are warmed up round the cylinder heads by the exhaust of the small engine being carried round them. I am not quite positive if the lamp for warming up is now entirely dispensed with, but believe such is the case, and in this type of engine the heat generated by the continuous combustion is sufficient to ensure a regular firing of the charge. Regulation of speed and reversing is accomplished by use of a feathering propeller which enables the pitch to be varied or the blades placed neutral, in which event the governor controlled the engine perfectly on trial, while the Astern movement was prompt, the vessel being brought to a dead stop in her own length. It is considered by the makers that although objections are raised on account of feathering propellers it is mainly from the limited amount of experience in their use, as, when of a strong and simple design as in this case, they admit of quick and easy handling of the vessel, one man working the steering gear and the driving engines. But in view of the actual necessity for a reversing engine where vessels are working in narrow and shallow waters, it is possible to make the engine reverse, and a lighter job of this type is in hand at present. In addition to the drifter mentioned there is in course of construction twin oil engines of 360 B.H.P. for a trawler, now being fitted with the machinery at Leith, also two 60 H.P. engines have been recently delivered, one being duplicate of a set sent to

Burmah, in the latter part of 1905, which is giving good service to its owners. The other has been installed in a sailing barge carrying 60 tons ; this vessel successfully completed her trials recently and at the time of writing was lying at Leith with a cargo of coal for the South, where she resumes her station as a general carrier between the Isle of Wight and Southampton. This, I believe, is the first motor boat for ordinary commercial use built and engined completely in this country, the results from which are looked for with some interest. Other engines of higher power than any mentioned are contemplated, and with the proportions devised, a complication of cylinders is unnecessary and the weight of machinery is cut down to reasonable limits. This could be further decreased, but it is considered desirable to keep on the present lines until further experience is gained over longer runs. I may mention in the case of a vessel engined for Isle of Wight owners that a speed of over nine knots per hour was easily obtained.

Up to the present I have touched on what has been done within my knowledge as regards marine propulsion by paraffin engines of high powers, but as the engine is by reason of its steady running well adapted for electric lighting I may mention that a two-cylinder engine, 150 H.P., has been constructed for a well known engineering firm, and arranged to use so termed crude oil, also several small sets for train lighting in South Africa, and a set driving centrifugal pumps for irrigation purposes ; these have all worked well and open up a point for consideration as to the adoption of oil engines in place of steam for auxiliary engines on board ship. This offers advantages in first cost and actual running, while the engines could be put in full power service in about three to five minutes from dead cold. In construction there would be a great saving in pipe lines, condensing plant, etc., which with the present price of copper would be considerable, not counting the labour in connecting up, the boiler power and consequently space would be capable of substantial reduction, also coal bunkerage in proportion which would outweigh any extra cost for engines. For electric lighting purposes my idea has been that this important plant should be on the main deck, as it has occurred within the memory of the majority that in the case of shipwreck the fact of the machinery being below water line placed the vessel in darkness, thus adding horror

and loss of life which perhaps might have been reduced if those who were lost could have seen what they were doing. Oil engines, being quite independent, would of course run as long as there was oil in their feed tanks. The same argument would apply in case of pumps, as in the event of fire there is no waiting to raise steam, and if engines are fitted with compressed air reservoirs which can be filled by a simple arrangement while at work, starting is quickly accomplished. Of course it may be said that with fire the presence of oil required for engines might aggravate the danger, but fire as a rule does not commence in the machinery space, and even if using high flash oils such could be stored in a double bottom well out of the danger zone. Generally speaking there is a wide opening for auxiliary oil engines, not taking into account what may be done in the way of propelling machinery later on. Steam has taken many years to acquire its present efficiency and has gained that by the experience of many engineers in actual running.

In regard to cost of running oil engines of the type mentioned the consumption of oil is guaranteed not to exceed half pint per B.H.P. per hour, and, as a matter of fact, this has been considerably reduced in practice, figures for which I am not able to give at the moment but the comparison with steam will not be unfavourable with engines of equal brake horse power. The oil engine does not lend itself to waste, as too much fuel will drown or stop it, and cost ceases from the moment of stopping till actually required for service again, while it is at disposal within five minutes as long as there is oil to hand. Stopping and starting at short intervals may hardly be so quick as with steam, but this can be much accelerated with a compressed air arrangement, and there is no danger in the quick start off which must occur with oil engines. Speaking of this point, it would be well to remember that as the crank shaft is given a sudden load it is advisable to allow a good margin of strength, as bending has been known to take place from this cause. An important point in the paraffin oil engine is that the engine be set to consume the class of oil that is to be obtained in the locality where it is to work, as it will be readily understood different oils vary in flash point, and using the wrong oil will occasion considerable trouble; this is much aggravated in the case of engines sent abroad and considerable difficulty has arisen from this cause. Another trouble that has come to my notice has been lack of allowance for difference in temperature of

circulating water in tropical climates, and in the case of a barge engine recently tested the conditions of running were made as near as possible similar to where the engine was to be located. When the engine is running, the exhaust vapour should be clear, and if of a smoky nature this shows too much oil is being supplied. Such may be remedied by putting a smaller nipple in the supply pipe, but there should be no sign of this defect with a properly adjusted engine when running full. If when starting up there is difficulty in getting away it will generally be found due to an overdose of oil which must be cleared away before a correct start can be made. In the engine I speak of it is considered correct after heating the cylinder head to turn on oil 10 seconds before applying impulse to the engine; of course, every engine will have its peculiarities which the attendant will soon become accustomed to. The matter of variation of speed in oil engines will still bear improvement, as supplies of air and oil require adjustment; this, I think, will soon be perfected and allow the same ease in speed variation as with steam. Another very important point is the maximum speed at which an oil engine can be driven with economy; high speeds may give greater power with a smaller engine, but there is a time limit for combustion and any cutting of this means a passing of fuel through the exhaust; it would be considered good practice to make adjustments which allow for steady combustion throughout the downstroke; this leads to a steadier mean pressure and turning movement of crank. Many engines are more explosive than the internal combustion type. One is often asked how frequently oil engine cylinders require cleaning; this depends greatly on the attendance, and while in some cases engines may run for months others require looking to more often. It would not be a laborious job to have an inspection once a month, and certainly it is a very much easier process than boiler cleaning. Gumming up of the cylinder is increased by using unsuitable lubricating oil or using different oil fuel than the engine is set for; a case which came to my notice recently was caused by putting paraffin for the engine in a linseed-oil cask, with the result that the engine soon gummed up and would not work. In engines of the enclosed type with piston trunk working into a crank chamber some difficulty is found in the inspection of bearings which may become dangerously hot before being noticed; this point has determined the construction of the open type as a necessity in large sizes.

This gives greater security and also allows more expeditious overhauling and examination of the main shaft. Objections were raised against this on account of the height of engine, but these objections are found to be uncalled for in large engines, and not necessary in small sizes, as the entire upper structure can be easily lifted. A feature in oil engines for marine propulsion is that engines, whether 1, 2 or 3 cylinder are independent units and can be cut out to reduce speed and consumption of fuel, while the arrangement of engines should be that the break-down of any one should not affect working of others. The parts should be made in standard sizes to gauge, enabling them to be used for any of the driving engines. Cutting out one engine was tried in vessels mentioned which gave a fair rate of speed with reduced oil consumption proportionate to the power cut out; this is certainly an advantage, as in steam practice the economy is not always proportionate in reduced powers. Of recent years gas engines with producing plant have been tried in canal barges with some degree of success, but this type of machinery is more complicated than the simple oil engines, and it is an open question as to any gain in economy over results from the oil engine I have mentioned. The price of oil governs this, and I find considerable anxiety is occasioned by the present monopoly of the world's oil supply. Likely users say—What guarantee have we that with increased demand there will be no rise in price of oil ? in which they are seemingly correct judging from the increased cost of petrol with larger demand owing to the number of motor cars, etc. Our late President mentioned in course of address to us in this room that his Company had to destroy large quantities of crude oil for which they had no market, and advised us to give our attention to the internal combustion engine whose further adoption would doubtless widen demand for oil. I am sure the fact of any surplus supply is not common property, and it is more commonly considered that any increased demand would be met with higher prices. Some definite announcement by the Oil Trusts as to their line of action in case of increased consumption—which would be very largely augmented by general adoption of oil engines—would, I am sure, assist in getting them into use. This point has been brought up to me on many occasions and by people whose opinions are of weight. At the present we have several types of power in use—steam, hydraulic and electricity, all of which have a starting source in the boiler.

Accumulator and dynamo and, I believe, oil coupled with compressed air, will be yet found equal in elasticity and reliability to any. It will be allowed by all that a considerable amount of experiment is required in a new industry, with failure and disappointment, in gaining perfection, but I have good reason to believe that the way is clear for higher powered oil engines. The firm I speak of will take on engines to 3,000 B.H.P., and, with practical demonstration of reversing engine, anticipate to have a number at work shortly in every day commercial work, anticipating from results to date that they will hold their own with, if not be more economical than, steam-driven vessels. One question which arises in the adoption of motor power is that of handling cargo, as with steam vessels the boiler is always available for winches, and there is, of course, no such reservoir of power in the motor installation, but it may be overcome by using compressed air, which was done in the case of the drifter built and worked with satisfactory results on capstan and winch. Otherwise motor winches may be fitted, and to ensure efficient working, a thoroughly reliable friction clutch must be fitted to handle the winch, preferably one with clutch gear handle controlling both clutch and brake. Motors are not good starters on a dead load, so for hauling or lifting purposes the aforementioned requires careful consideration to ensure good working. A coil clutch manufactured by the Coil Clutch Co., Johnstone, would give efficient working in this service, and is adapted to couple with the winch brake as mentioned. As a general rule, in internal combustion engines the one that has been designed for steadiest pressure throughout its stroke and not to exceed rate of piston speed suitable for complete combustion should give the best results in practice ; simplicity with accessibility of parts is essential to success, a complicated arrangement of springs and motions, as in some types, being not at all conducive to confidence, and for barge and fishing craft work, the machine must be such that its working can be readily understood by any person of ordinary intelligence, trained engineers not being employed as a rule in these services. In closing this paper I wish to mention I am not pretending to be an expert in oil engines, but such information as I have gained in daily contact with the development of the Peck Engine may be beneficial in raising discussion on this important industry which is as yet in the early stages.

Mr. TIMPSON then said that during the past week the motor barge *Vixen*, to which he had referred, had undergone trials in the south of England, and those trials had been very satisfactory to all concerned. She brought up alongside Southampton Docks, after calling at various places. They took her to Portsmouth, and during the run they had rather heavy weather ; yet all had gone well, and they had no trouble with the engine.

Mr. W. LAWRIE said he feared it was rather more than one could do to discuss a subject of which they knew so very little. The paper had been very clear, and had given them a pretty good idea of the oil engine. But he thought it would have been an improvement if there had been one or two drawings on a fairly large scale, to show the construction of the engine. That, at a glance, would have given them a better idea than they could get from reading the paper. It appeared that this engine could be run so easily that engineers might require to look for some other vocation presently. The oil engine would probably come into general use on rivers like the Thames, where they had a great number of small craft which simply ran up or down with the tide. With a very simple engine such as had been described, the machinery could be got to work at very short notice, and no very great expert knowledge was required. One of the points about the oil engine was the fouling. He understood that the residue from the oil in some particular engines gave more or less trouble. Of course he had no doubt that could be got over, and no doubt Mr. Timpson could give them his experience on the matter. The author had mentioned sets of one, two, and three cylinders, which were independent units, each connected to its own crank. He wished to know what B.H.P. could now be got from one cylinder. The feathering propeller seemed to be a drawback. Still, from what Mr. Timpson had said about the design of that particular propeller it might be quite suitable for ordinary purposes. He noted that these oil engines did not reverse so quickly as the steam ; and such would certainly be a drawback, at any rate if the loss of time in starting was at all appreciable. But perhaps Mr. Timpson would further enlighten them on that. As a rule they were left to find out such defects for themselves. When the engines were eased down and the combustion of the oil was not so complete as

when they were running full, did they throw out any great amount of smoke ?

Mr. TIMPSON : No. The engines were slowed down by cutting out the cylinders, and further reduced speed was got by lowering the oil supply, but care had to be taken to set the adjustment to a minimum point ; there was a little difficulty about that. The range of speed was about 150 revolutions.

Mr. LAWRIE said he was just trying to get at the points which appealed to him. He dared say if one had time to go through the paper carefully there were many points which might occur to one.

Mr. W. E. FARENDEN said he had no experience with oil engines of any kind. He would like, however, to know what boats, besides those engaged in the fishing industry, the author would recommend to use that type of engine. The author had said that combustion took place every down-stroke. Was he to understand that it was only on the down-stroke that combustion took place ? Was it only a single-acting engine ? Could not the main engines be started without the small oil engine mentioned in the paper ? The author had mentioned the feathering propeller for reversing. That seemed rather objectionable. If those engines could be made to reverse it would be a great advantage. He understood that the reversing engine was most necessary, especially when the vessel had to work in shallow and narrow waters, instead of using the feathering propeller. Perhaps Mr. Timpson could explain how the reversing was done. The author had said he had attended the trials of a certain boat at Southampton last week. He would be glad if he would give them a few more particulars as to the results of the runs of that 60-ton barge. What was the space occupied by the machinery as compared with a steam engine and boiler, and the weight of machinery, and also the consumption of the oil for that size of engine ? Also, would the author give them the time it took to start and stop that engine ? He thought he had mentioned that when they wanted to ease down they cut out one or two of the cylinders, thus reducing the power, consumption of fuel, etc., and that that enabled them to keep the

engine going and reduce the speed of the boat. Mr. Timpson mentioned that it was most important that oil engines should consume the one class of oil they were made for. Did that mean that the same class of oil should always be used from the time of starting ? He thought it was a pity that Mr. Timpson had not got a few detailed drawings or a small model of one of those engines. It would have been very instructive if they could have seen a section of one of those oil engines.

It appeared to him that in order to make the internal combustion oil engine suitable for marine purposes, it should be reversible, capable of being promptly regulated to any desired point between full-speed and dead-slow, and also of being quickly stopped, and started either for ahead, or for going astern.

Mr. H. BERTRAM asked what was the slowest possible speed for an oil engine.

Mr. TIMPSON : We could run this engine at about 100 revolutions, the maximum number of revolutions being about 300.

Mr. A. H. MATHER said he thought the absence of any drawings was very unfortunate. The paper was a very good one and brought the subject well before them. Perhaps Mr. Timpson could manage the drawings later on : if he could do so it would bring the paper right up to full requirements. He did not see in the paper any description of the working of the engines, whether it was what was known as a two or a four-stroke motor, or what the principle of the working was. He had had a little bit of handling of petrol motors of the two-stroke plan, and he had found that one of the worst features in connexion with them, especially with single-cylinder engines, was that which had just been raised by Mr. Bertram. There was not sufficient variation of speed to permit of handling the boat with anything like reasonable facility. Unless those engines were kept going at a fairly high rate of revolution they stopped, at a most critical moment generally. If they were trying to make their moorings amongst other boats against the tide, they had to slow down and proceed cautiously, and there was always the risk of the engine stopping altogether. Before they could get the engine away again they had

probably drifted down with the tide and were in a fair way to do some damage. Some men handling these small boats preferred, even in crowded waters, to keep up a good speed on the boat, as it steered better than when travelling slowly, but if they touched any other craft they were sure to do a lot of damage which would have been avoided had the boat been travelling at a lower speed. To keep a low speed on the boat it was a common practice to run the engine at a high enough speed to ensure against its stopping, and work the clutch in and out of gear, giving the propeller a short stoppage and then a race ahead again sufficient to just maintain the required slow speed of boat. If the speed could be varied over a considerable range the oil engine would be a more suitable power for boat propulsion. If they could rely with confidence on the ability to reduce the speed, as with a steam engine, and over the same range, he thought there would be a much better chance of those oil engines being taken up than there was at the present time. He thought that was one of the big faults.

Mr. J. R. Ruthven said it appeared from the paper that not only engineers for taking charge of these engines could be dispensed with, but there would be no more boiler-makers. He could see this engine was going to do away with both steam and boilers. He had no doubt that if Mr. Timpson could give them some further details as to the results, it would enable them to understand it better. If they could only get an engine that would keep speed while the ship was going various speeds, he thought it would enable the engine to do better work ; that was to say, that the ship should go any speed when the engine was going full speed. He thought the author had mentioned that the ship might go at slow or fast speed while the engine was running at the same speed. He should like to see some drawings and tables of results in regard to those engines.

Mr. Shackleton said that Messrs. Priestman were one of the first to bring forward the paraffin engine as a marine motor, and he believed they were almost unique in their particular way. Up to 1895 they had paraffin engines running on marine work as large as 60 B.H.P., which was, of course, well in advance of the times. There had been several makers

who had experimented with oil engines, notably Messrs. Crossley and Hornsby, but the reason they had abandoned the larger engines, or those over 20 B.H.P., was on account of the producer gas plant. He regretted that the author had only given that engine a brief show in his paper. He saw that the engine referred to by the author was of the type which fired its own charge. That, of course, would not be bad for the engine up to probably 20 B.H.P., but as he assumed the author was going to deal with engines up to 3,000 B.H.P., he was afraid that method would be rather unsatisfactory. Even in smaller engines it had frequently been found that the firing had varied, and on a large engine that would be a more serious fluctuation. It would mean no end of broken crank shafts. With an independent ignition it would be possible to advance the sparking in high speeds, which would mean an economy in fuel consumption. He thought that for very large work, about 75 per cent. of the makers had abandoned the oil engine, and were now all turning their attention to marine engines using producer or suction gas plant. He thought Messrs. Crossley had now in hand 200 B.H.P. marine engines with suction plant. He thought that was the ideal power for heavy marine work. He could not say that they had any engine running which had run continuously for six months night and day. With land engines that had been accomplished years ago. The last and most serious thing he would say against the oil engine was that its cost, compared with modern producer plant, was double, and also that with producer plant at work they might have their winch engines working on the same plant as the main engines. In the matter of reversing, he thought it would be almost essential to have a third engine to do the reversing. With regard to the cutting out of one cylinder, it would be quite impossible with engines of a large type to do it. The only way would be by reliable independent ignition and throttling—throttling the oil when easing down. Shafts had frequently been broken by two cylinders firing badly or missing. There was a last factor which might be mentioned, and that was the odour of a paraffin engine. The odour of paraffin pervaded everything : at least that was his experience of the paraffin engine ; and although the other part of the paper was most admirable, he thought, as he had said, that beyond 20 B.H.P. the paraffin engine had no chance in competition with the suction gas engine.

Mr. C. S. Reid said that Mr. Timpson's paper had had a most depressing effect on his spirits. He now realized how hopelessly out of date he was in his knowledge of motor matters. His experience of motors was with a class of boat which the author had dismissed in his first paragraph, viz. the American type, running either with naphtha or benzine. During the past four years he had been on ships trading in the South Sea Islands, and each of those vessels had carried a motor launch. As third engineer, it had been his work to look after that motor launch. In one trade, where the motor launch had to make long runs away from the ship, he had always to accompany it, and thus he had seen its defects. He had also seen the engines put to the hardest test that small launch engines could be put to. In that trade the launch would be sent away from the ship at any hour of the day or night, without any regard to weather, and it might have to go plunging away through the darkness to the island, and might be brought up by a chunk of coral found in the road. Those were specially built wooden launches, and were very heavy. They were all fitted with one-cylinder engines, and were all of one type, and had the old style of sparking. In that sparking device two pieces of metal were brought into contact in the cylinders, one of which was insulated and the other connected with the engine. They were not run off magnets, such as he had seen since he came home. In the first place, those boats were sent out by their makers totally unfitted for heavy sea work. They were unprotected, and the first business was to cover all the wires with paraffin wax wherever they showed. The next trouble was that a splash of spray would stop the engine. Those engines had been put into open launches without any covering at all. If the boat took a sea over the engine would stop. The air-pipes were led down into what would be the bilge of the boat, and when she took a sea over, it would then get into the cylinder. When all those defects were remedied, the engines gave fairly good results, but he believed they would be expensive compared with present-day running. In one round trip he had made a note of the distance the boat travelled during the trip, and the amount of work she did in the way of towing, and the amount of oil used. She would leave the ship on a run and go ashore with two empty barges, or with a little material for trading with the natives in them. She would return to the

ship with eight tons of copra, four tons in each barge. The weather might be anything. In a round trip the launch covered 300 miles, and towed those barges 150 miles fairly light and 150 miles loaded down. Forty-five gallons of benzine were consumed, which gave about 1·2 pints per mile. The engines of those launches were of the one-cylinder type, and they were registered in the builders' price list as $1\frac{3}{4}$ H.P. He did not know whether that would be American nominal horse-power or brake horse-power. (To Mr. Timpson) Do you think that would be brake horse-power ?

Mr. TIMPSON : Probably brake horse-power.

Mr. REID, continuing, said that was the work the launch did through the trip. Working from the price of benzine, which he did not know, they might be able to guess whether it was a cheap run. He was of opinion that things might be done much cheaper now by using an up-to-date engine. For reversing there was an ordinary fast propeller, and the boat was driven ahead by a friction clutch, or astern by geared bevel wheels. There was the same objection as with the turbine : they did not get the same power for going astern. They could slow the boat down to any handling speed and bring her alongside the ship by the throttle valve, or they could throw the engine out of gear for a little while. They would lose no way, and she could be brought alongside the ship as easily as possible, so that passengers could be landed quite comfortably.

Mr. R. COOPER said he would like to take the opportunity as a new member to thank the Institute for the honour it had done him, and he looked forward to being present at many more meetings, from which he had no doubt he would derive considerable benefit. With regard to Mr. Timpson's paper, it threw a certain amount of light on the matter of internal combustion engines, more particularly the one which used paraffin for fuel ; but he was afraid the author was rather sanguine about the future in regard to engines of that type for marine work. To him the position seemed to be that for small powers in small craft those oil engines were all right and could be used with great advantage in conjunction with a reversible propeller, of which there were several good types

on the market. He knew that with a reversible propeller they could bring the launch into narrow waterways and up to jetties and into docks, and manœuvre the boat about with great ease. They could have the tiller in one hand and the reversing gear in the other, thus adjusting their speed and direction at the same time. But the variable propeller was not a new thing, because, roughly speaking, twenty years ago there was a fairly large one fitted by Messrs. Harland & Wolff, where he was brought up. That propeller had a gun-metal boss and bronze blades and internal gear for varying the pitch of the blades, and was not really a reversing, but a feathering propeller. One object was to get the blades fore and aft for sailing purposes. But there was an objection to the feathering propeller. Sand and grit got between the flange of the blades and the boss, so that the blades worked loose. Sometimes also the blades "seized." It seemed to him that the development of very economical engines for marine purposes lay rather in the direction indicated by Mr. Shackleton; that was to say, the suction gas engine. He believed he was right in saying that that was about the cheapest form of power there was at the present time. There were a number of barges fitted with that plant, and a number of makers of good repute were laying themselves out for that work. Last summer he had a trip through Holland, and there he saw quite a number of barges which could carry 300 tons on the canal. Those barges were driven by paraffin motors, and for vessels of that kind he thought that in a very short time the suction gas plant would oust the paraffin motor. There was no doubt that for small craft, launches and river boats and small coasting steamers, there was a good field for paraffin motors within certain limits. Motor boats in general, like motor cars, had come to stay, at any rate until flying machines were a little cheaper and a good deal safer. Mr. Reid had been telling of the troubles he had had in the South Seas with motor boats, and he was sure that gentleman would feel relieved and gratified to know that the modern practice in regard to those boats had improved. They had low tension ignition now. With spray or sea getting on board there was a danger of short circuiting and misfiring. The leads were now much better covered than they were. A great mistake which motor builders made in the earlier stage was in putting motor car engines into boats. They ran them

at an unreasonable speed altogether, with the result that a large proportion of the horse-power was used simply in churning up the water and producing cavitation. Now they had seen the error of their ways and had slowed down the speed of the engines. There was one point he would like to ask a question about in regard to the particular engine the author had referred to. What were the means of the preliminary heating up ? How was the necessary temperature obtained ? He understood that once that was obtained and the engine set going the heat was maintained.

Mr. JAMES ANDERSON said he would like to know the method of vaporizing the oil. He gathered from the author that the oil was injected into the cylinder in the form of a spray. But he would like to know more definitely, because that seemed to him one of the weak points that might be with the engine, if the oil were injected in the form of a stream instead of as a spray. The oil would be inclined to carbonize on the cylinder heads. The question of ignition had been brought up, and relying upon the temperature of the cylinder walls and cover meant that when different mixtures were employed for different powers the ignition took place approximately at the one point. To him that seemed a very serious drawback in the engine. With electric ignition the point of ignition could be advanced, as had been said before, and very much more economical results obtained from the engine. Coming to a comparison of the oil engine with the producer gas engine or steam, he said that the principal advantage claimed for an oil engine was reduction in weight and simplicity in working, over steam and over producer gas plant. It was the case that the oil engine was lighter and gave more space for cargo than steam. By going in for producer gas plant they were going back somewhat to the state of the steam engine, because with that plant one required producer and boilers which needed attendance. For coasters and canal barges, where the cost of running bore a fairly large proportion to the amount of cargo carried, it seemed to him absolutely essential that the engine should be as cheaply run as possible. With a producer plant one would almost require to have a man to look after the firing of the boiler and the producer. With an oil engine one turned round a tap, started the engine, and went up to the reversing handle and tiller, and then the engine did the

rest. One could not steer and fire a boiler at the same time. It seemed to him that in point of running, the oil engine had a decided advantage. Another point was weight. An engine for using oil went into a very small space. With the steam engine they had the extra space taken up by the boiler. In the case of producer gas that also was necessary, and must detract very considerably from the carrying capacity and earning of the vessel. It seemed to him that for canal work and small coasting boats the oil engine had the advantage over both steam and producer gas. Unfortunately, Mr. Timpson had only mentioned one fact in connexion with the oil consumption, and that was that the motor required half a pint of paraffin per B.H.P. per hour. He thought it would have been a great help to them if the author had ascertained what the approximate cost of paraffin was, and had compared it with the consumption and cost of petrol. He thought that if Mr. Timpson could give them one or two figures of that description it would add greatly to the interest of the paper.

Mr. M. Lang said that from what they had heard that night there was a certain future before the internal combustion engine for marine work, but it was very uncertain in which line it was most likely to develop. There was the producer gas plant, and also a likelihood of the development of the oil engine, of which Mr. Timpson had spoken. There were huge supplies of oil fuel throughout the world, and the oil "trusts" would be sure to get their hands on them if there was any possibility of making anything out of them. After all, the principal thing which would decide how the thing would develop was the commercial aspect of the question: which could be done most cheaply? The question of weight and the amount of space taken up by the engine were both minor considerations to the commercial aspect as to which would pay and which could be done more cheaply—the producer plant carrying stocks of fuel on board or the oil engine. The internal combustion engine, compared with the steam engine, was still comparatively in its infancy. It had not reached anything like the stage of perfection that the steam engine had. There were defects to be overcome, while gas and oil engines usually required to have a big fly-wheel, which was rather a hindrance, placed in a ship. Vibration, too, was an undesirable thing. Notwithstanding all its advantages,

however, the progress of the internal combustion engine for marine purposes must be but gradual, and steam engineers need not fear the possibility of the bread being taken out of their mouths for many years to come, at any rate. The steam engine would take a lot of killing yet.

Mr. J. THOM said he had not had the pleasure of hearing the paper read, as he was late in arriving. Speaking of internal combustion engines of all classes, he thought there was no question but that they must be considered, as there is very little doubt they are more efficient than steam engines in regard to heat efficiency. The fuel might be dearer in the first instance but it would go further. The economy of the steam engine had been greatly improved by superheating the steam, conservation of the waste gases and by the creation of high vacuum, but even then it can hardly be compared with the internal combustion engine of to-day which one might say is only in its infancy. He did not know what points had been brought out by Mr. Timpson or the kind of engine referred to in his paper. With reference to the more volatile oils used for internal combustion engines—petrol, benzine and the like—he did not think they would be suitable for large ship work. They are dearer than the heavier grades of oil and more liable to cause accidents by explosion. Heavy grade oil can be purchased at 2*d.* to 3*d.* per gallon, which, used in an internal combustion engine, would bring it more than in line with steam. In his opinion the Diesel engine was one of the most efficient for heavy grade oils and the freest from complications in the matter of ignition, etc. In it the air is compressed to something like 700 lb. per square inch, giving a temperature sufficient to ignite the fuel when delivered into the cylinder. This high pressure has the effect of allowing the gradual expansion of the gas, which might be compared to the action of steam. There are one or two electrical installations, where Diesel engines are used entirely, producing power at ·1 of a penny per brake horse power and the Board of Trade unit of electricity at ·145 of a penny. In one of these installations the Board of Trade unit, including works costs, is only ·362 pence, i.e. delivered at the switch-board. This engine is only a four-cycle ; if we could have a two-cycle it is very evident one cylinder would do double the work, and the cost of the engine would be only about half. With reference to weight, an engine of this class should not

much exceed that of a steam marine type, saving all the weight of boilers. A lighter engine than this, and very suitable for marine work, is the one using paraffin oil, which can be stored on board ship with small chance of accident or little increase of premium. Something has been seen of what it can do, and it is hoped it may soon come well to the front, for it will undoubtedly find a place. It might be mentioned by the way, that petrol engines have been made weighing as little as 4 to 6 lb. per brake horse power for light land work, an exceedingly low figure. Referring to producer gas, one gentleman had spoken of a boiler being necessary: this is so with a pressure gas plant, but not with suction gas, which is the most likely to be of use on board ship. The latter requires less attention and is the most economical. A steady turning moment can always be obtained by multiplying the cranks or increasing the weight of flywheel. There is very little difficulty in starting a four-cylinder engine. All classes of internal combustion engines had to be taken into consideration now, and no engineer could afford to say he did not know something about them. They are all workable and mostly suitable for one purpose or another.

Mr. J. H. REDMAN said that on a sailing ship he had seen a little vertical paraffin engine driving a winch. That was the only instance where he had seen paraffin being used for such a purpose. In the engine Mr. Timpson had spoken of, he thought there must be three separate crank centres. How did he keep them independent and prevent the charge from leaking from one to another ? Also, how was the vaporizing carried out ?

Mr. W. LAWRIE said they had heard it asserted that night that the producer gas plant was superior to the other. In regard to the oil engine, would Mr. Timpson tell them the space it occupied for a given power ? Could any member give them figures to prove the superiority of the producer gas plant ? It would be as well to have the comparison brought forward in some way or another.

The CHAIRMAN said he thought it would be interesting to know the limit of diameter of the cylinder for the varied powers. What was the limit ?

Mr. TIMPSON : We now have cylinders up to 16 inches.

The CHAIRMAN : Have you any idea of the pressure in the explosion chamber ?

Mr. TIMPSON : From 250 to 400 lb.

The CHAIRMAN : It would need a pretty strong cylinder to stand that.

Mr. TIMPSON then replied to the various questions which had been raised during the discussion. Mr. Lawrie, he said, had referred to the fouling of the engine. In regard to that point, however, a great deal depended on the attendance. The attendant might tamper with the oil supply and give the engine too much oil. That would cause fouling very rapidly. They would also get fouling if they used too much lubricating oil in the enclosed crank case. That lubricating oil would get carried up into the cylinder. The man associated with his firm, who had gone out to Burmah, was out in the East for six months, and he never opened up the vaporiser for cleaning for over two months, and when he did there was very little to deal with. He had then recommended that they should take it off once a fortnight. The job would only take about half an hour. There was no carbonizing in the cylinder itself : it was all in the head. In regard to the B.H.P. for one cylinder, they could get 80 H.P. for one cylinder. There was no difficulty with the reversing propeller. They could handle a boat so equipped as quickly as they could an ordinary vessel. There was a reversing engine, and by turning a handle they could put the engine one way or another. The point of the reversing engine had been explained. The feathering propeller allowed a good range of speed. They could put it full out or to a very fine pitch. They were able to take the barge *Vixen* to the wharf, and there was no difficulty. Another gentleman had spoken of one cylinder being cut out as conveying an element of danger. They had two engines running and they cut out a cylinder regularly, without causing any breaking of shafts. It was not an explosive engine, but an internal combustion engine. Mr. Farenden had referred to the type of boats for which the oil engines were

adaptable. He would say that they were available for almost any type of boat—yacht, trawler, barge, or tow-boat. His firm had just given quotations for several tow-boats, one of which was, he thought, to have engines of the reversing type. In the drifter there was a great variation of speed. Easily handled by one man, they thought the feathering propeller was preferable to the reversing engine. There was no difficulty whatever, as he had seen it work regularly. In regard to ignition of charge: in the first place they had to get heat to vaporize the oil. They placed a blow-lamp on the cylinder head for two or three minutes. Heating too much did harm: they got the correct time by experience. Two minutes was sufficient. When they had the cylinder sufficiently hot, they turned the engine to the position mark, then opened on the air, and it would go away immediately. There was no trouble. In regard to space occupied, the 60 B.H.P. engine on the *Vixen* occupied about 3 ft. 6 in. by 4 ft. 9 in. by 2 ft. That point was brought home to him by the carriers. They wanted to have the same cargo space on the barge as before. The engine was placed in the crew's space, and the forecastle refitted, so there was no alteration in the carrying capacity whatever. Reference had also been made to the class of oil which should be used. He had mentioned that particularly, because people sent home from Australia and New Zealand ordering a paraffin oil engine, and they neglected to say what class of oil was available. They could get different brands. The engine would be sent out, and then it gave trouble or did not run any time at all. Then the purchasers said, "The engine is no good." If the oil were stated, and a sample sent home, and the engine timed to burn that oil, there was no trouble in working the engine. They could readjust the engine, but it took a little time. Again, the oil engine did not always fall into the hands of an expert. Mr. Mather had spoken of the type of working. He would call it a single-acting engine. They might call it a two or three-stroke engine, but it was just purely and simply a single-acting engine, taking pressure on the one side at either down-stroke. In the better types of engine it was better to have a copious supply of air, and by having a little engine they could always have 160 lb. of air pressure. With the smaller type they had driven an air compressor off the main engine shaft, and could throw it out of gear whenever they wanted. The question of the oil

versus the producer plant had been raised. He might say that he knew of some results, which he was not at present able to give, but he did not think many suction gas plants could do better than these. There was no comparison as to space, and the weight was light in comparison with suction gas plant. He knew canal people who had tried suction gas, and so far they were not taken with it. A man who had never seen an engine in his life could become acquainted with an oil engine, and within five days be able to handle it. That was the kind of thing that would appeal to the ordinary carrier. He had seen youngsters of twelve or fourteen years of age handling oil engines on the river. Mr. Cooper had asked as to the means of heating, but he had already referred to the fact that they used a blow-lamp. They used no petrol whatever. It was all paraffin right through. Vaporizing almost took place before it entered the cylinder. On the opening of the central valve it met a certain part of mixture inside the cylinder. Another point referred to was the cost of paraffin as compared with petrol. If they took a paraffin engine of that type, and 100 B.H.P. running for twelve hours a day, they reckoned it would cost £5 per week, whilst petrol would cost £20 for similar power, taking average price of the two commodities. Mr. Lang had spoken of vibration. He could say that the vibration of the 60 H.P. engine was nothing. He did hear, before the official trial took place, that the engine vibrated. If the engine vibrated somebody must have meddled with the adjustment of the oil. That was what Mr. Peck, the patentee, said. Then another gentleman had referred to the smell of paraffin. He himself had put his hand over the exhaust vapour and could not smell it. There was no smell when the engine was properly adjusted. Crude oil could be used in that engine if required, but it necessitated special apparatus. They found that if they took on crude oil very likely the price would rise beyond that of ordinary paraffin. He thought the inclination would be more to use a partially refined oil than crude oil. They had a partition between each cylinder, and when he spoke of "unit" he meant that each cylinder was a unit which could be cut out. If they cut out one cylinder they would have half the power. They had no trouble with leakage.

The CHAIRMAN said he thought Mr. Timpson deserved sincere thanks for the very interesting paper he had given

them, and for the lucid way he had replied to the questions asked. He was very pleased to hear the young members of the Institute taking such an interest in the subject, because it would no doubt develop upon them in after years.

Mr. John Thom seconded the proposed vote of thanks to Mr. Timpson.

Mr. TIMPSON said it was a pleasure to him to be able to bring a matter of any interest forward. It was their duty to do as much as they could for the interests of the Institute in expressing as much as they knew on various subjects. He thought he could get some sketches and photographs for the adjourned meeting.

The discussion was then adjourned to Monday, January 7, 1907.

A vote of thanks to the Chairman concluded the proceedings.

ADJOURNED DISCUSSION.

January 7, 1907.

CHAIRMAN: MR. W. LAWRIE.

THE CHAIRMAN: When Mr. Timpson read his paper some time ago, it was quite evident that most of the members had only a very hazy idea of the engine he was describing, and it was thought that if a few drawings were introduced it would have helped very much towards understanding the system on which the engine worked. Mr. Timpson has done what he could in the matter, but it was rather difficult to get detailed drawings, so we have to depend very much on the explanation which Mr. Timpson will be able to give us. No doubt he will be able to make the details clear.

Mr. TIMPSON said that the engines were used for three classes of work, namely, pumping water, electric lighting, and marine propulsion. He had with him three slides showing engines of each type. He would be very pleased to answer any inquiries in regard to the various points in connexion with the engine. Very likely some fresh points had occurred since last meeting, and those he would be pleased to answer as far as possible. He had obtained three lantern slides and a couple of prints of the engines, which were now being passed round, but he regretted these did not show the details and sections.

Mr. W. E. FARENDEN expressed regret that Mr. Timpson had not been able to supply any sectional drawings of the engine as asked for at the last meeting on his paper, so that they could see the formation and construction of the engine in question.

Mr. TIMPSON said in this engine it was by compression. On the head there was a chamber with an air valve on the side which admitted air on the down-stroke of the piston. The up-stroke sucked in the air to crank case and the down stroke caused compression by 5 to 6 lb. per square inch. That air went up the pipe at the back, and mixed with paraffin coming from feed reservoirs. At a certain point the valve opened and admitted a supply. When the engine came up that ignited, and

an explosion took place. In the first starting they had to heat the engine : that took about three minutes, and was quite sufficient to get a start. He had seen an engine running for about eight hours without a stop. That was a 2-cycle engine, and they had no occasion to run more than four hours. They went with that engine from Newport (I.W.) to Southampton and then to Portsmouth.

Mr. J. Macartney (Member from Sydney) said he thought he had had about 200 to 300 oil engines through his hands. After an inadvertent stop to get a fresh start they had to sweep out the cylinder by taking a few turns by hand in order to get away again. He had seen oil engines running both valveless and as described by Mr. Timpson. Mr. Timpson had referred to 250 H.P. 3-cylinder engines. He had not seen one of that size. Most of his experience had been with the four-cycle engines running from $1\frac{3}{4}$ up to 60 H.P. He was at present specially interested in two ; one of 50 and the other of 60 H.P. They were American engines, but they also had engines made locally in New South Wales. The difference in price between benzine and kerosene was so small that they had found it better to work with benzine, as they had a cleaner cylinder and no trouble with it. He did not know much about the English paraffin, but, judging from the colour and the smoke given off, he would call it a low grade kerosene. They worked entirely either with naphtha or benzine. In land practice in Australia there were at the present time hundreds of those oil engines in use. They mostly used benzine, and were employed in sheep-shearing sheds, butter making, wood-cutting, creameries, etc. The oil engine in recent years had certainly come to the front. Mr. Timpson had referred to the feathering propeller. He would like to know how long that would run without giving trouble.

Mr. Timpson said he knew of one running now which had been in use for over twelve months without getting into trouble. That was fitted on a boat plying on the Irrawaddy River. Referring to the fouling of cylinders, Mr. Timpson said he had never had a stoppage from that cause, and he had seen the engine opened up after running for fourteen days and there was no deposit in it ; so that trouble seemed to be entirely done away with by the proportions of the engine he

had described, as it seemed to consume the oil entirely, giving perfect combustion. By a man who went to Burmah he had been told some interesting particulars as to the working of the engine. He assured him that he had run the engine for over three months without cleaning, and that when he opened it up there was no residue ; ordinary Burmah paraffin oil was used.

Mr. MACARTNEY : In marine practice do you work with an under-water exhaust, or do you exhaust direct into the atmosphere ?

Mr. TIMPSON : Into the atmosphere.

Mr. MACARTNEY, continuing, referred to the remarks made at the previous meeting by Mr. C. S. Reid, who had had a good deal of experience in the South Pacific with motor launches. Mr. Reid had spoken of using 45 gallons of benzine for a 300 mile run. He himself would not like to say how much those engines used. With engines of $1\frac{3}{4}$ H.P. up to 10 H.P. he found that $\frac{1}{8}$ gallon of benzine was used per horse-power per hour. In a larger engine, say of 50 or 60 H.P., the consumption would come down to about ·09 gallons per H.P. per hour. That was with benzine and they could get down to about the same with kerosene.

Mr. TIMPSON said they could take a proportion between the consumption given and a 100 H.P. petrol motor, and draw a comparison on prices current here on the basis that the oil engine could be run at about £5 per week as against £20 for the petrol engine.

Mr. MACARTNEY : How do you test the horse-power ?

Mr. TIMPSON : With a brake. Continuing he said that at the previous meeting a point had been raised in relation to weight of machinery. He had been taking notes of some suction gas plant of 2,000 H.P. That worked out at 240 tons, whereas the oil engine would only work out at 55 tons for the same horse-power.

The CHAIRMAN referred to the producer gas plant, which he had heard was a thing worth looking into. He happened to see in the *Shipping World* for the previous week a comparison, and that journal also gave a sketch of a gas suction plant, together with figures which were supplied by Mr. W. W. May, the managing engineer to Messrs. Beardmore. That gentleman had dealt with the weights for a cargo steamer of 2,000 H.P. His comparison of engine-weights was as follows :—

Gas engine 8 cylinders, 1,000 B.H.P.	
Weight in working order	85 tons
Producer for same	35 ,,
	120 tons
2 in number	240 tons
2,000 i.h.p. triple expansion marines steam engine	110 tons
Boilers for the same	210 ,,
	320 tons

Thus it would be seen that the comparative weights were as three to four.

But there was no question of the two classes. With the suction gas plant they had to have a producer, and they must have coal. One difficulty was that all classes of coal were not very good for producing gas. The ordinary coal they could burn with a steam boiler could not be used for a gas producer plant. Anthracite coal was all right. That was one of the great difficulties against producer gas plant. On the face of it, the engine which Mr. Timpson had described seemed a very simple affair, for they only required oil. They required no coal nor machinery. All that was needed was a tank of oil, and it seemed to him that the suction gas plant was out of it in comparison. Still, one or two members at the previous meeting had spoken very favourably of it; however, there seemed several things against it. Of course, there might be something against the engine which Mr. Timpson was describing and that was what they would like to get at.

Mr. ARNOLD (Visitor), said he and his brother had received an invitation from their honorary secretary to attend that evening. He and his brother were interested in the navigation of the Upper Medway, with barges trading principally from

Tonbridge and round to London, down the Medway and up the Thames as far as London. Those barges, which carried about seventy to eighty tons, were towed at various stages by tugs and horses, and they were now on the look-out for a better and cheaper method of running the boats. He had been struck by Mr. Timpson's paper, an entract of which he had read in *The Mechanical World*, and he ventured to write to the secretary of the Institute, asking if he might be permitted to attend the discussion.

The CHAIRMAN : It would seem as if this engine is just the type required for the work you refer to ; it is so simple, and the man on deck can work it.

Mr. ARNOLD said they were used extensively on the Continent in barges. He had seen them in Dordrecht, in Holland.

Mr. TIMPSON said the system was apart from any other. It was a 2-cycle engine. There was an impulse every down-stroke. There had been a good deal of trouble with 2-cycle engines through fouling, but the proportions which had now been arrived at had overcome that difficulty so far as he could learn. He knew of certain boats which had been sent abroad. They were worked with native labour, and there seemed to be no complaint of any kind made in regard to them.

Mr. MACARTNEY said the author stated that twice the power with equal weight was got from this engine over others. In his own experience he had found on taking out the weights of 2-cycle engines against 4-cycle engines of 6 B.H.P., they did not vary 15 lb. in weight. Usually the difference was very little.

Mr. TIMPSON said it depended greatly on the design of the engine. He knew of one make of engine on the 2-cycle principle, and for equal powers it was nearly double the engine he advocated, both in size and weight.

Mr. MACARTNEY said he had not found such a difference between the 2-cycle and the 4-cycle. They also got better results out of the 4-cycle engines. They got a purer mixture in the cylinders.

Mr. TIMPSON : That is quite true, but these defects are to be overcome.

Mr. MACARTNEY said the oil engineer's ideal was the 2-cycle valveless engine, if he could possibly get it, but so far he thought he had failed. He had not seen the engine described by Mr. Timpson, but if he saw one in section he would be able to understand it a great deal better. So far as weight was concerned they had not found a great difference between the 2-cycle and the 4-cycle used in the Colonies, and the speed of revolutions still remained about the same.

Mr. TIMPSON said that the purer the mixture was, the better the power would be. With the engine he had dealt with, when running full speed the exhaust was perfectly clear. He could put his hand over the exhaust outlet, and they could hardly trace the odour of paraffin. They might when starting away, but when the engine was heated up and thoroughly under way she was perfectly clear.

Mr. MACARTNEY : From what you say in your paper it appears to be an ideal 2-cycle engine.

Mr. TIMPSON : That is what the inventor claims it to be.

Mr. W. BRITTON said he understood that the system in this engine for dealing with the oil was by atomizing it, whereas in other engines the oil was vaporized. What was the difference and what was the advantage of one over the other ?

Mr. TIMPSON : The advantage of atomizing the oil and passing it into the cylinder is that you get more power than by vaporizing it outside.

Mr. BRITTON : How is it atomized ?

Mr. TIMPSON : The air and oil mix, and there is a peculiarly formed head in which they mingle with a motion which breaks the oil in pieces and sprays it in.

Mr. A. ROBERTSON said : The use of oil engines for marine

work would certainly seem to be confined to small craft, where the advantages as compared with the steam engine are many, as instanced by the reduction in engine and bunker space, weight of machinery and lower capital outlay required. Very little has been said in the paper, or brought out in the discussion, with regard to the future possibilities of the internal combustion engine for ordinary steamers. When we consider their adoption for larger vessels we come in contact with difficulties which, as far as present practice is concerned, have not been overcome. I refer to the reversing chiefly, and I take it from Mr. Timpson's remarks that his firm have a reversible engine under construction. A brief description of how this is done would be of very great interest to all the members of the Institute. This, up to the present not having been demonstrated, our only methods of reversing are by means of a feathering propeller or a reversing clutch, the engine always running in the same direction. The feathering propeller has many working parts which are liable to get out of order, and the clutch does not appeal to practical engineers owing to the amount of gearing it necessitates, though for small power the latter are very efficient, reversing and stopping quite easily, and allowing of smart manœuvring. The question of the carrying of oil for fuel has already been largely overcome, though to be able to obtain the full advantages where oil engines are installed, the oil would need to be carried in the ballast tanks, an arrangement which does not seem to commend itself in practice, as it would necessitate fitting an elaborate system of separating and settling tanks, and there is always the liability of accident by grounding, etc., when the fuel would probably be lost by leakage. When we get an engine that can easily be reversed, will be as elastic as a steam engine, and will run at all speeds, we shall not be far from seeing oil engines fitted to ocean-going steamers, and in this respect I should like to refer to Mr. Timpson's remarks where he says he believes that oil coupled with compressed air will yet be found equal in elasticity and reliability to any type of power at present in use. Here he certainly seems to have made a forecast that is likely to prove true in the near future. I would like to ask whether he refers to compressed air being used directly on the piston for reversing purposes, or in what other way he anticipates developments. I am associated with arrangements that will shortly

be made to build an internal combustion engine in combination with a turbine. Its efficiency, considering it as a heat engine, is very high, but after making ample allowances for the difference that must exist between theory and practice, an efficiency of 50 per cent. of the calorific value of the fuel should easily be obtained, whilst the best heat efficiency obtained in the latest modern engine is 33 per cent. as a maximum. This engine in which I am interested uses compressed air as a medium for the absorption of the heat at present lost in the exhaust gases and water-cooling arrangements. The work thus stored up in this compressed air by raising its temperature is expanded in a specially constructed reversible turbine harnessed to the main engine shaft. Further, over and above the utilization of the heat which is wasted at present, this turbine makes the engine an elastic one, inasmuch as it is made powerful enough with the pressure of the compressed air to overcome the friction and the compressions of the combustion engine, thus making the whole as easily reversible and regulated as a steam engine, which is a great *desideratum*. I should like to ask Mr. Timpson what quantity of circulating water he uses per B.H.P., and the difference of temperature between inlet and outlet. Also, what are the highest temperatures of the gases he has met with in the engine cylinders ? This, I believe, has given a great deal of trouble in the Diesel engine in the past.

Mr. TIMPSON, referring to the air and oil mixture, said the altering of speed depended very much on the mixture. They must have a certain mixture of oil and air to cause combustion. In regard to the amount of circulating water used, he was sorry he could not give them any information. He had not the data with him. Those were some of the points he could not get. All he could speak of was what he had seen running.

Mr. R. COOPER said the subject was one in regard to which the average marine engineer had not a very deep knowledge. He feared he was like the majority of speakers who had preceded him, in that he had expected to see some diagrams, and get some further information. But it would not do to press Mr. Timpson too much on that point, and it was quite possible that it would not be advisable to give away too much in connexion with this engine. He was one of the speakers

who at the previous meeting had raised the point of suction gas power, and he then gave the opinion that that was the cheapest form of power known. He had intended to look much deeper into the subject before attending that evening's meeting, but they knew the disturbing effects of the Christmas and New Year holidays. Just before coming away that evening from the office he picked up a number of makers' catalogues and price lists with the idea of getting from them what they guaranteed. He found that quite a common figure was 10 .B.H.P per hour for one penny. That was $\frac{1}{10}d.$ per B.H.P. Under some conditions that went as low as $\frac{1}{20}d.$ per B.H.P. per hour. In regard to coal consumption, the Chairman was quite right in saying that anthracite seemed to be, if not absolutely necessary, most desirable. The coal consumption he found to be, on an average, 1 lb. per B.H.P. It ranged from $\frac{3}{4}$ lb. to $1\frac{1}{4}$ lb. It should be remembered that they were speaking of brake horse-power and in regard to comparatively small engines—not large marine engines of thousands of horse-power. Then with regard to stoking. It would seem that it was only necessary to stoke at intervals of 5 to 6 hours, so that from those figures it would appear that under certain conditions at least suction gas engines on board a barge or coaster would be the right thing. There was another point he would like to refer to. Mr. Macartney had given them what seemed to be a rather startling statement: that the weight of certain 2-cycle and 4-cycle engines of the same horse-power were as nearly as possible equal—only a few pounds difference. He would like to ask whether the two engines he referred to were of about the same revolutions per minute. A fast-running engine of 100 horse-power and a slower running engine of the same horse-power would be widely different in weight.

Mr. A. Robertson said he would like to refer to the 80 per cent. efficiency mentioned in regard to suction gas plant. Such an efficiency was, he thought, impossible : they could not have taken into account the friction and various other losses. Efficiency meant the actual work got out of the engine compared with the calorific value of the fuel they were using.

Mr. R. Cooper : The makers give 80 per cent. of the calorific value of the fuel.

Mr. RAINEY also referred to the 80 per cent. efficiency mentioned by Mr. Cooper. So far as he remembered, Professor Ewing had said that the highest efficiency was 136 per cent. with a Diesel oil engine. He believed that was the highest efficiency he would give, either for a steam, gas, or oil engine.

Mr. R. COOPER : It must be understood that the 80 per cent. efficiency I mentioned was not the combined efficiency of engine and producer, but 80 per cent. of the possible value of the fuel.

The CHAIRMAN said that for small power, whether it was this particular type of oil engine or some other type, he was strongly of opinion that before long they would be used very freely. There was always a difficulty with single-acting engines, because of their having a fly-wheel, which was not very desirable on board a ship, if they could avoid it. There was not the least doubt that their drawbacks would soon become apparent, but no doubt those would be met in some way until they had a good working engine. The question of applying this gas to turbines had been raised, but he did not know whether that would ever come about. It was one of those things which might come along in the future, but with their present knowledge it looked as if it were a long way off.

Mr. F. E. SHEPPARD said he had seen the efficiency of those engines in the Australasian Colonies as referred to by Mr. Macartney. In Auckland (N. Z.) the pilots used an oil-engine launch, and the same applied to Wellington. But the New Zealand Government had rather killed the small launches by deciding that they must carry a certificated engineer, which meant an expense of £20 a month for a small cutter. The small fishing boats were so equipped, and he thought they all had certificated engineers. They were a long way ahead of our waters in the use of such engines. The Americans were also ahead of our makers, and had a store or workship in Auckland. The British manufacturer was but little known there with his oil engine. They had those oil engines in some of the big three-masted schooners running between the islands and the colonies. Some of those boats were under the Samoan, and others under the German flag, and they got on very well. They came into harbour all right, and went alongside the

wharves without a tug. But he could not quite agree with Mr. Timpson about the smell. From rather a long way off one could smell them like a G.E.R. engine when it was burning paraffin.

Mr. TIMPSON : Internal combustion means combustion of oil gas in the engine cylinders.

Mr. SHEPPARD, continuing, said that from what he had seen of the oil engines in New Zealand, he thought there was a brilliant future before them. He could not say whether they used the feathering propeller or not. The only launches he had been in had clutches. He could not tell them anything about the larger ones.

Mr. MACARTNEY : There are very few feathering propellers in the Colonies. He thought the Union Co., of San Francisco, was the first company to come into the market in the Colonies. It was followed by the Hercules Co., and the Standard Co., of New York. Now their name was legion. There were four good reliable engines, and they were all of the 4-cycle type. They would find very few working with reversible propellers. They mostly worked on the clutch principle. There was a friction clutch for going ahead, and a bevelled gear for going astern. The engine could run, and the shaft stand still. The clutch was cumbersome and hard to operate, but still it was reliable. When the vessel was under sail alone they would put the two blades of the propeller vertically behind the stern-post. Reference had been made to the danger of handling naphtha and benzine. So far, however, they had had very little trouble in that respect. He knew of one twin-screw auxiliary schooner burning paraffin. He knew of two using benzine that were burnt. One of those casualties occurred in the following manner :—The engineer found something checking his oil as it came down the vaporizer. Instead of turning the oil off he disconnected at the vaporizer in order to blow through. He got a nigger to hold his thumb over the pipe whilst he blew through. He struck a match to examine it—well, the nigger jumped and so did the white man—in fact they both jumped overboard. He had found the Kanaka the most reliable man for those engines. The Kanaka did what he was told and did not try to alter things. He had known

a first-class certificated engineer to alter his timing gear and was firing half-way down the stroke, and then complain that his engine would not work. That engine was well over half stroke before firing. As they knew, in retarding the spark she was well over the centre before the charge fired, and he thought that was the safest way to handle the boat when going alongside. In Sydney harbour he thought there were 300 registered pleasure boats fitted with oil engines, and another 300 employed commercially, ranging from $1\frac{3}{4}$ H.P. up to 50 and 60 H.P. He was sorry to say, however, that they were nearly all American built. There was a big market out there for the British manufacturers if they cared to go into it and give the people what they wanted. What was needed was a light, strong engine, burning benzine, that could be started away at once. A man wanted to step on board his boat, give a turn to the fly-wheel, and the boat was off and away. That was the engine that would take the market.

Mr. TIMPSON said the States had been well ahead for many years in boat propulsion. But nearer home than Australia, in the lower provinces of Canada, they could see the American maker had a market alongside. They were all wanting kerosene engines. If in the American engines everything was satisfactory they would not be looking for the kerosene engine. Those kerosene engines were now coming to the front. Accidents had been common in connexion with naphtha launches. Until a few years ago they used to carry naphtha pipes inside the boat. A slight leak would often result in the boat taking fire. Those launches were often used by careless people. They wanted as little danger as possible. He knew of a large 4-cycle engine built last year for a wealthy American which was close on 300 horse-power. They had a great deal of trouble with the starting to get them all properly timed. They had troubles even with the 4-cycle engine. It was a very wide subject, and every maker claimed his own as the best idea. He could only state that his knowledge was merely general, and more especially with the engine he had referred to. He really thought that that engine had proportions and arrangements of the 2-cycle type which would give a better result than any yet brought out. He could only regret that it had not been in his power to show them full detailed drawings.

Mr. G. SHEARER : Did I understand you to say that you had a reversing engine ? You spoke of timing gear in some cases where the explosion took place with men who did not know their business when the engine was about half stroke. You spoke of backing the timing gear. Was that a reversing gear, or only a go-ahead ?

Mr. MACARTNEY : The engine ran only one way.

Mr. SHEARER, continuing, said he had had no practical experience with oil engines, but he could not see what difficulty there was in having a go-ahead and go-astern engine. It was a matter purely of the timing gear, which position they had the engine in if under compression.

Mr. MACARTNEY : You require to stop each time.

Mr. SHEARER : All engines have to be stopped to go astern.

Mr. MACARTNEY : There is always some difficulty in stopping an oil engine, even a 2-cycle one.

Mr. SHEARER : It is only a matter of getting it over to the other centre. With a single-acting engine you can get the crank over.

Mr. MACARTNEY : They are all single-acting engines.

Mr. SHEARER : There are several multiple cylinders. Why cannot that engine be reversed without using gear and keeping the engine running continuously ?

Mr. MACARTNEY : You have got to do it with the fly-wheel : there are several hundredweights to move round.

Mr. SHEARER : With a multiple cylinder oil engine, is it absolutely necessary to have a fly-wheel ?

Mr. MACARTNEY : I would not like to say.

Mr. SHEARER : Not any more than it is with a steam engine. With a single-acting steam engine with multiple cylinders

we can run astern just as easily as run ahead. I cannot see the difficulty. You will always have one piston in position for taking the explosion, having a receiver with compressed air. It would be admitted to the cylinder with piston in position.

Mr. MACARTNEY : If you can inject it.

Mr. SHEARER : An arrangement would have to be made. But I cannot see any difficulty with a multiple cylinder engine. With a single engine and a fly-wheel you would certainly have to back the fly-wheel to get it into position. We have to do that even with a double-acting single engine.

Mr. MACARTNEY : I think you would have to compress your gas before you could do that.

Mr. SHEARER : It could only be done in multiple cylinders. You would have the compression in some of the cylinders.

Mr. MACARTNEY : If you could force it into the one that is going up.

Mr. SHEARER : It was merely an idea : I was wanting an expression of opinions.

Mr. MACARTNEY : I think it could be done by making gas outside the engine and compressing it.

Mr. SHEARER : Regarding reversing gear : with your engine I suppose there are two friction clutches—one to go ahead and one astern.

Mr. MACARTNEY : No ; just the friction going ahead. You don't get the same speed going astern. You can get fairly good speed, however.

Mr. SHEARER : I am sorry I was not here when the paper was read, as I have not looked over it. Yet it is a most interesting subject, and I do not think there is the slightest doubt but that it is the engine of the future. A combination of the oil engine and turbine has been mentioned. I think there is a big field to look into there.

Mr. A. ROBERTSON : With reference to the question of reversing : I think there has been some misunderstanding about the substance that we use for turning the turbine. It is not the gas, but compressed air that is used for doing work on the turbine, which is of sufficient power to reverse the engine when necessary. When not required to reverse it adds power to the engine. It will go either way.

Mr. SHEARER : Do you speak of a gas turbine or an oil turbine ?

Mr. A. ROBERTSON : It is a gas engine, but has an air turbine, for getting extra work out of the engine, as well as making it reversible and elastic.

Mr. SHEARER : That is merely for mixing the gas with compressed air ?

Mr. A. ROBERTSON : No ; it does not mix at all. These are only a few brief remarks, for I am not at liberty to go into details of the engine.

Mr. R. COOPER : Where do you obtain the power for compressing the air ?

Mr. A. ROBERTSON : We use a compressor.

Mr. R. COOPER : Where do you get the power ?

Mr. A. ROBERTSON : Off the main shaft. You have a continuous supply.

Mr. MACARTNEY : For reversing you use a turbine. Then you are compressing your air all the time you are running.

Mr. A. ROBERTSON : As I said, you are taking heat from the cylinders which increases the pressure, whereby you are getting the increased work on the turbine.

Mr. MACARTNEY : You are using your incoming air to cool your gas cylinder instead of water. Is that sufficient to keep the cylinder cool ?

Mr A. ROBERTSON : That is the intention; the experimental engine has not been built yet.

The CHAIRMAN said that if there was no further question to put to Mr. Timpson they would bring the meeting to a close. The subject of oil engines was, he thought, one that would bear a little more looking into and a little more information. No doubt that would be forthcoming in time. They were to have a paper on March 4 by Mr. T. D. Kelly on " High Speed Two-Stroke Engines." Probably by that time some of the members would have had more opportunity of looking up the subject and helping on that paper. He was sure they were all very much indebted to Mr. Timpson for giving two nights to that paper. He had already been accorded a vote of thanks, but there would be no harm in passing him another vote of thanks. They were still a little bit in the dark for want of drawings, but he had no doubt they now understood more about the paper. At any rate their friends from " down under " seemed to know more about it than they did.

Votes of thanks to Mr. Timpson and to the Chairman concluded the business of the meeting.