bustion Engineering," claimed that the efficiency of the Diesel type was largely independent of the men working it; the mechanical efficiency was much more independent of the load than in any other type of prime mover; the cold engine starts at a few moments' notice without previous preparation or stand-by losses; as compared with coal, fuel for four times the distance can be carried in a given space, and that the average fuel consumption was only slightly higher in actual work than at official trials. Professor Hoeltze states this increased consumption to be only 14 per cent. in the Diesel engine as compared with up to 102 per cent. increase in the steam engine.

It was then quite natural that shipowners would pay considerable attention to the development of the marine engine. There was a large number of vessels building which would be fitted with Diesel and semi-Diesel engines, while the performance of the "Selandia," "Vulcanus." "Juno," and others already running had equalled the expectations of their owners.

The "Selandia" had a displacement of 10,000 tons, being 370 feet in length and 53 feet beam, and was propelled by two sets of 8-cylinder engines on the Diesel 4-stroke cycle; each developed 1,250 B.H.P. at 140 R.P.M., besides two auxiliaries of 250 H.P. each. The pilot who took this vessel into the Thames stated that he had never before found a vessel so easy to handle. In less than 20 seconds she reversed her engines from full speed ahead to full speed astern. At 12 knots she consumed only 9½ tons of oil per day. In her double bottoms, which had a capacity of 1000 tons, she carried sufficient bunkers for her maiden voyage from Copenhagen to Yokohama and back.

The M.V. "Vulcanus" was a tank vessel with a displacement of 1900 tons. She was owned by the Anglo-Saxon Petroleum Company, and her dimensions were: Length, 208 feet; breadth, 37 feet 9 inches. She had a single screw 6-cylinder 4-cycle Diesel engine of 450 B.H.P. and 586 I.H.P., and developed a speed of 8½ knots. A 40-H.P. 2-cylinder auxiliary motor was used for compressing air in port for auxiliaries and centrifugal pump for cargo, and as a stand-by for the main engine compressor. She consumed about 2 tons of oil per day, which worked out at .41 lbs. per B.H.P. hour, as against 10 tons of coal required for a similar steam vessel.

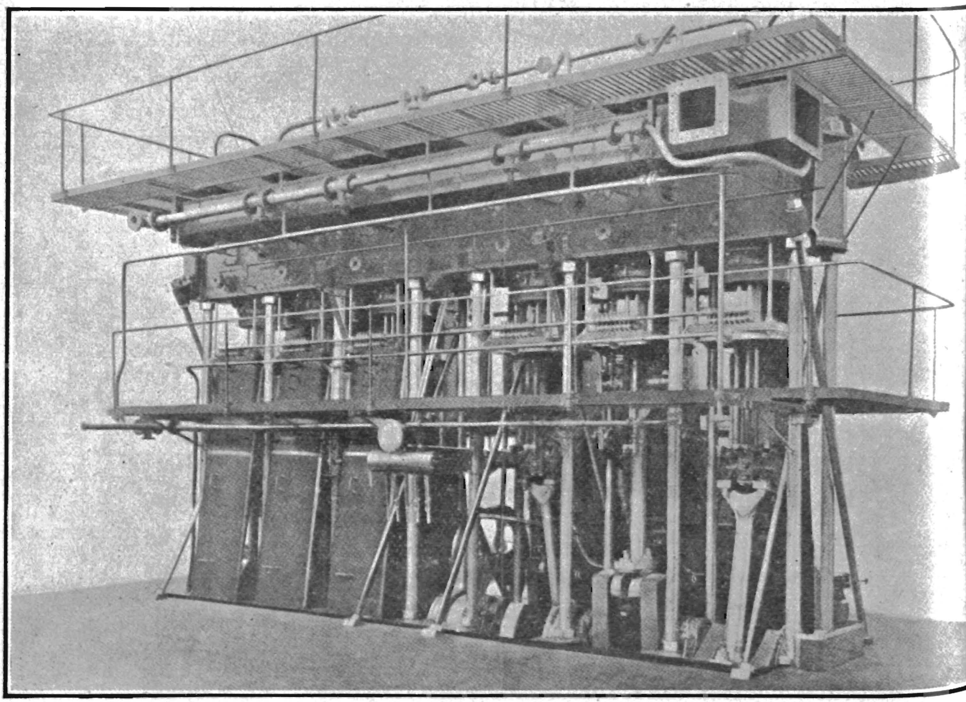

Fig. 9.

The "Juno" was a large motor ship belonging to the Anglo-Saxon Petroleum Company. She was 258 feet x 45 feet x 18 feet 6 inches, with a displacement of 4300 tons. She had one set of 4-cycle Werkspoor Diesel engines, 1100 B.H.P. single-acting, and developed a speed of 10½ knots—Fig. IX.

The cylinders were supported on mild steel columns of about 5 inches diameter, in place of the usual cast-iron standards. The engines were more accessible, and the weight was appreciably reduced. Improvements had also been made in the arrangements for oil feeding and reversing. This vessel had now run over 50,000 miles on a fuel consumption of about 2 tons per day, without engine troubles. The same company had also ordered a tank vessel of 2675 tons dead weight, and several 5000-ton tankers. Several other oil companies were constructing similar vessels, so that it was clear that the petroleum trade had every confidence in the result of the application of the Diesel type of motor to marine work. Some notable vessels were also under construction for general cargo and passenger service, including a vessel of 8000 tons registered tonnage for combined cargo and passenger work, the engine being 6000 B.H.P. 4-stroke reversible. The largest vessel of this class in hand was a tanker of 15,000 tons dead weight and 3500 I.H.P. engines, 2-stroke reversible.

The German naval authorities were said to be fitting a cruiser with a 6-cylinder reversible Diesel type engine of 12,000 B.H.P.

The British Admiralty had under construction a destroyer to which Diesel engines were to be fitted, and had taken the steam engines out of a cruiser in order to replace them with oil motors.

Lord Furness was conducting a very interesting experiment to test the comparative efficiency of steam and oil engined boats. The sister ships "Eavestone" and "Saltburn," each of 4360 tons loaded displacement, had been equipped with oil engines and steam engines respectively, and comparative records were being kept of their performances. The "Eavestone" was driven by means of a set of "Carels-Westgarth" Diesel single-acting engines, with four 20-in. diameter cylinders, 36in. stroke, running at 95 revolutions per minute on the two-stroke cycle. The compressors were worked direct from the main engines, and included a Reavell high-pressure three-stage compressor for oil injection, direct driven at the forward end of the main shaft, and two ordinary compressors worked by levers at the back of the engines. The value of the experiment was somewhat marred by the fact that the vessel was fitted with two auxiliary boilers, 7ft. diameter by 14ft. high, working at 100 lbs. pressure, and used for driving winches, steering gear, ballast pump, and an auxiliary Reavell compressor for starting up. Arrangements had now been made for driving the steering gear with compressed air, and found most successful. It should be possible to extend this system to the various other accessories, and to do away with the steam auxiliaries.

The working results of five voyages showed that the "Saltburn" made 8.4 knots under a daily consumption of 12.1 tons of coal. The "Eavestone" averaged 8.75 knots and consumed 3.64 tons of fuel oil per day, besides 13 cwt. of coal for the auxiliary boilers. For a thirty-days' voyage the "Saltburn" shipped 405 tons of coal and the "Eavestone" 110 tons of oil and 20 tons of coal, thus saving 275 tons in the weight of bunkers carried.

Fig. X. shows an interesting engine. It is a submarine set built by Maschinenfabrik Augsberg. There were six working cylinders and two air compressors, the latter being arranged vertically over the shaft. The engines were direct reversible, and were worked on the four-stroke cycle, and developed from 850 to 1000 B.H.P.

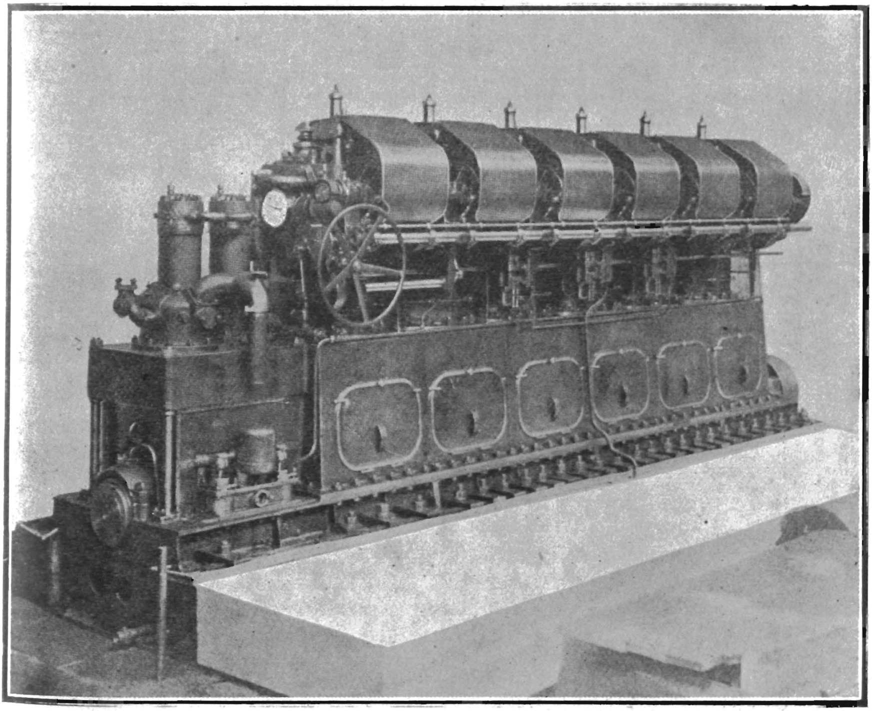

Fig. 10.

In 1905 Sulzer Bros. built the first directly reversible Diesel engine, and made practicable the application of the Diesel motor to large vessels. This firm supplied the engines for the Hamburg Sudamerika M.V. "Monte Penedo," of 6500 tons. They were direct reversible two-stroke cycle engines, each of 1000 I.H.P. Sulzer Bros. have lately supplied engines for use in the new German lightship, "Elbe 1," a service to which the Diesel motor is peculiarly adapted. These engines were intended for use in dropping moorings and in relieving the strain on them during a storm. The four engine cylinders were supported on steel columns. At 280 R.P.M. they developed 220 H.P. The engines were reversed by rotating the cam shaft through a certain angle relative to the crankshaft.

A larger set of vertical, single-acting, two-stroke cycle engines of 2400 H.P. was shown at Fig. XI. These engines ran at a speed of 150 R.P.M.

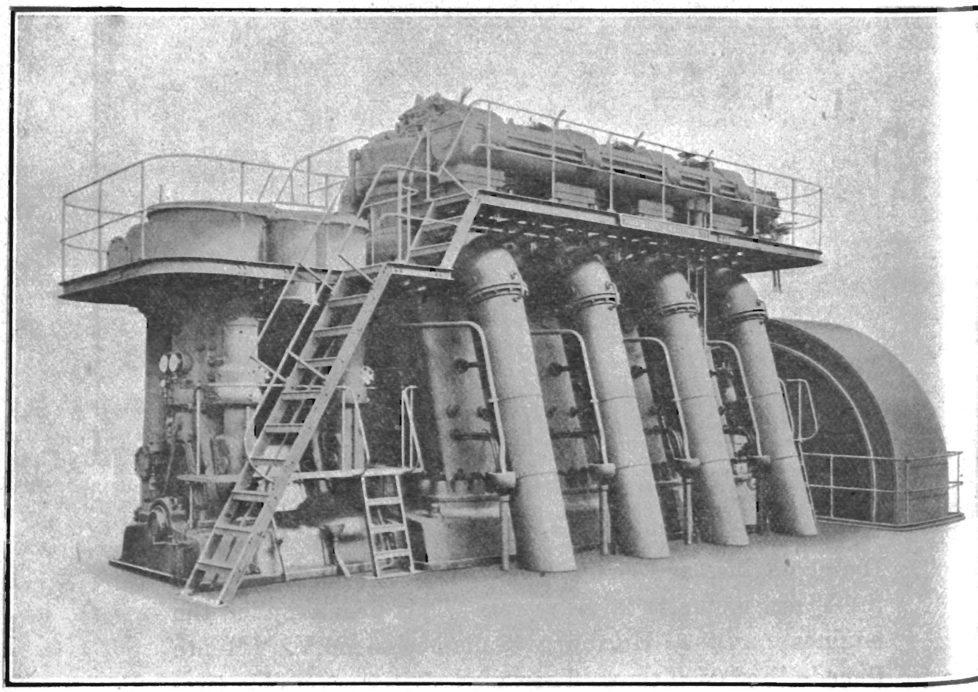

Fig. 11.

Turning now to land engines, the first British Diesel engine was constructed by Mirrlees, Watson Co., Ltd., fifteen years ago. This engine is still working. It was

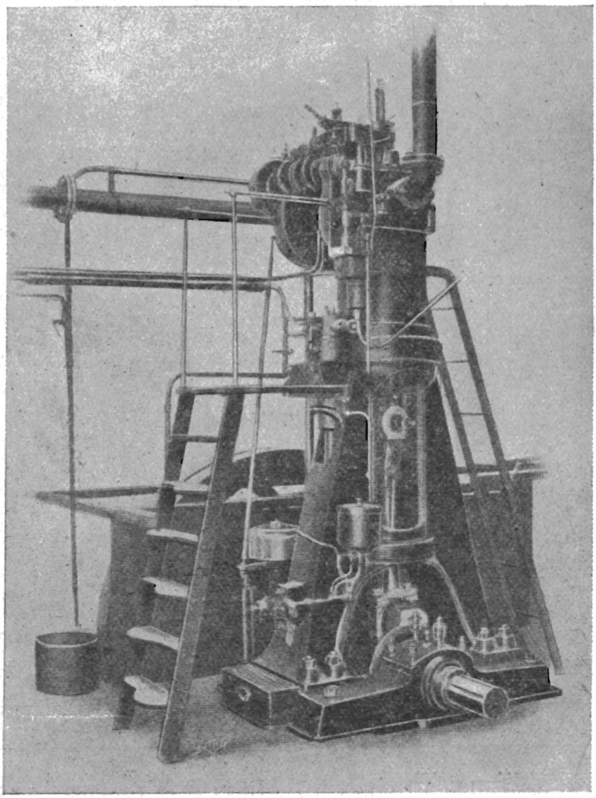

Fig. 12.

shown in Fig. XII., and made an interesting comparison with the modern 1000 H.P. British built stationary type engine shown in Fig. XIII.

The uniform economy of the Diesel motor at varying loads was well illustrated in a series of tests with a 50 B.H.P. stationary engine at the works of the Oxygen and Drum Co., Ltd., at Shanghai. The fuel used was Eastern oil, with a flash point of 222 deg. F., and a calorific value of 19,250 B.T.U. The engine ran at 250 R.P.M.

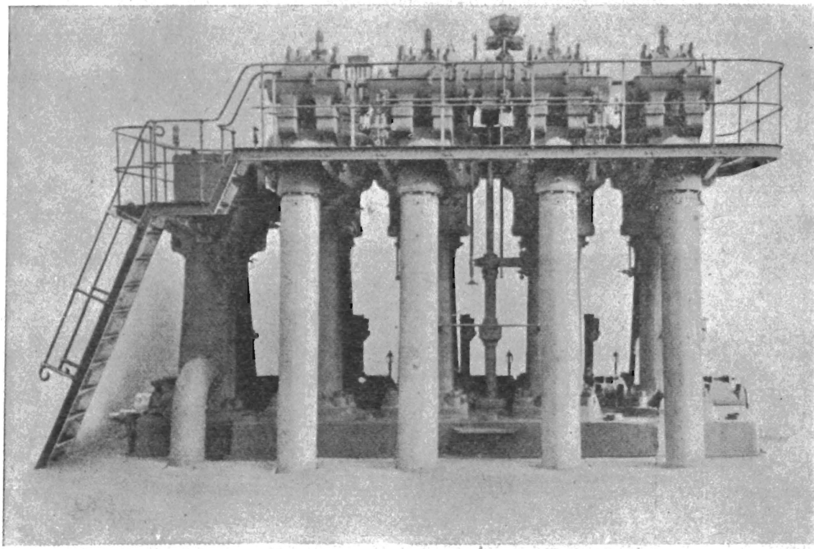

Fig. 13.

SUMMARY OF TESTS.

	Test No. 1.	Test No. 2.	Test No. 3.	Test No. 4
B. H. P.	50	36	25·2	52·6
Fuel Oil used ...	90 81 lbs.	16·44 lbs.	12·5 lbs.	22·69 lbs.
Duration of Test ...	4 hours	1 hour	1 hour	1 hour.
Fuel per hour ...	22·703 lbs.	16·44 lbs.	12·5 lbs.	22·69 lbs.
Fuel per B.H.P. hour	0·454 lbs.	0·457 lbs.	0 496 lbs.	0·432 lbs.

It would be seen that the variation between full and half loads was very small.

A difficulty which has stood largely in the way of the progress of the Diesel type of motor was the fear that a sufficient supply of suitably-trained engineers was not yet available to undertake the proper care of such plants. In view of this idea, it was refreshing to note the confidence of Eastern industrial concerns in this type of prime mover. This was the more remarkable in view of the fact that the engineers in charge had to rely entirely on Asiatics for all the more unskilled labour and

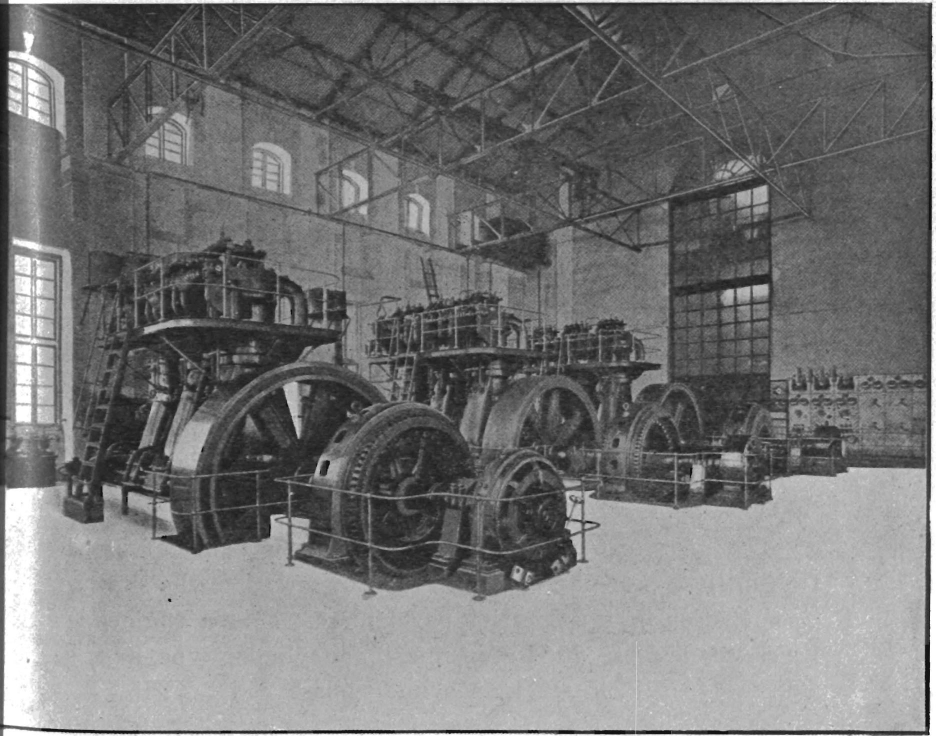

Fig. 14.

assistance required. A very modern plant was that installed in a Bombay cotton mill, where three 400 H.P. Diesel type engines were in use for supplying electric power. They were shown in Figure XIV. In the semi-Diesel type of stationary land engines British manufacturers had more than held their own, particularly in the horizontal types. In Cassier's Magazine some very interesting oil motor indicator diagrams were published. In Fig. XV. were shown diagrams from

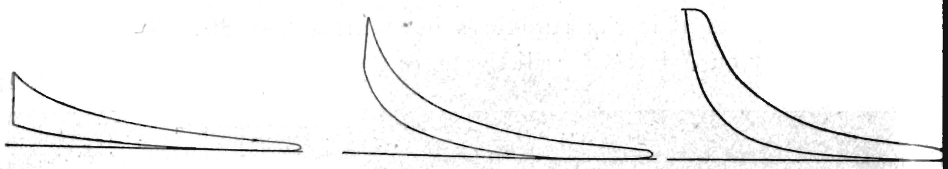

Fig. 15.

Crossley engines taken respectively from ordinary semi-Diesel and Diesel type engines. The increase of pressure due to combustion was very marked in the two former, and quite absent in the latter one.

Published in the same journal was another diagram taken from the Campbell high compression engine. This engine was of the semi-Diesel type, and ran on a compression of 200-300 lbs. per square inch. The engine from which the card was taken was 7¾ B.H.P., running at 8 B.H.P. at 280 revolutions per minute.

The latter diagram showed that the performance of the oil in the cylinder very closely approximated to the slow combustion of the Diesel type of motor. These engines were made up to 70 H.P. in the single cylinder type, and up to 140 H.P. in the twin cylinder class. Fig. XVI.

The Ruston complete combustion type oil engine was made in sizes up to 200 H.P. Considerable strength was gained by the fact that the cylinder and bed-plate were in one casting. This engine was worked on the four-cycle principle on a compression of 270 lbs. to the square inch. Just before the point of greatest compression, the fuel was mechanically injected through an ingenious atomiser. Reference

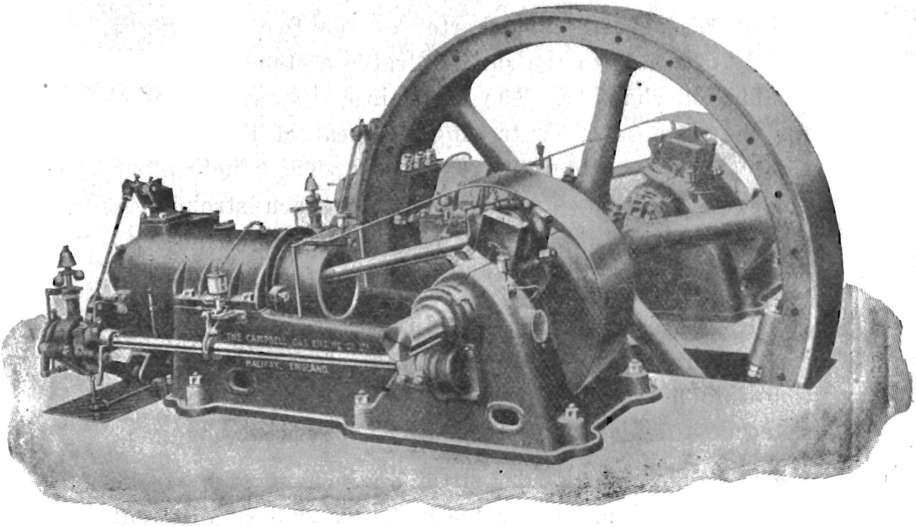

Fig. 16.

to Fig. XVII. would show the atomiser on the top of the combustion chamber. On each side of the feed pipe was seen the pipes for water circulation about

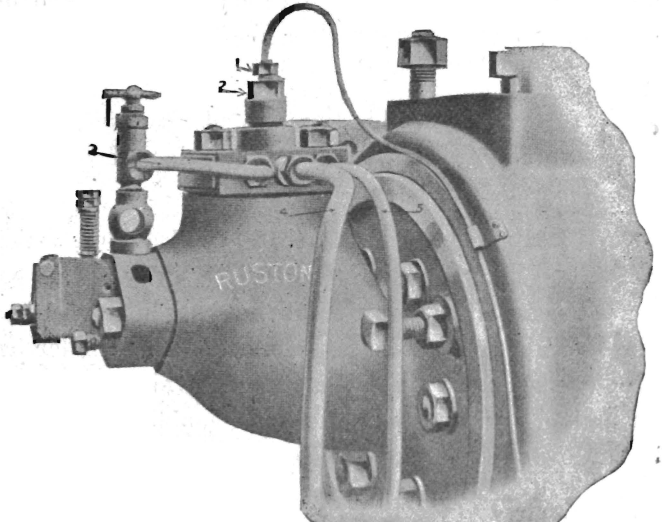

Fig. 17.

the atomiser valve, the shorter of the two carrying a supply of water to the snifting valve at the rear of the combustion chamber. The water injection was supplied for the purpose of controlling the heat of the combustion chamber under heavy loads. The fuel pump moved a constant quantity of oil at each stroke, the governing being obtained by returning a small quantity of the delivered oil back to the supply tank.

A leak pipe was also provided from the top of the atomiser, through which surplus oil was returned to the suction side of the pump. The mechanical atomiser consisted of a duplex valve loaded by a powerful spring.

This valve was lifted 1-40 of an inch at each stroke of the fuel pump. The valve had two seats of different diameters, the smaller of which closed the opening of the combustion chamber, and the larger the opening to the leak pipe. When the smaller valve lifted, the oil was forced through channels converging to a central outlet, which so split up the stream that it emerged on either side of the nozzle in a cone-shaped cloud of oil particles.

A 50 H.P. engine of this type tested recently at Nottingham University showed a consumption of only .45 lb. of oil per B.H.P. hour.

A 25 H.P. Ruston horizontal semi-Diesel engine, which used residual oil, was now installed in Sydney. This engine was easily started by hand, but was fitted with a compressed air tank for self-starting, the air cylinder being replenished from the main cylinder while the engine was running. An auxiliary fuel tank enabled the engine to be run for a few minutes on kerosene every day for the purpose of dislodging any carbon and for ensuring clean running. The engine was coupled by means of a clutch to a three-throw fire service pump. On a long run recently this engine developed 26 H.P. on a fuel consumption of .533 lbs. per calculated horse-power per hour at 240 R.P.M. As part of the delivery was made through a small pipe, the head equivalent to the pressure on the delivery side of the pump was taken as the actual head, and after allowing for the height of suction, the calculation of horse-power was made accordingly. Under the circumstances, proper allowance could not be made for friction in the pump and engine, and for occasional choking of the suction rose, so that the figures are really much better than they appear to be.

The whole position of the oil engine was, of course, vitally affected by the question of oil supplies. Excluding the possible use in Diesel engines of oils other than petroleum, there was no need to fear a real shortage in the lifetime of any plants that were likely to be constructed for a long time to come. In Russia, for instance, development of large virgin areas had been retarded by the caution of the Government. In many other parts of the world development had been suspended by reason of the scarcity of oil transport. The demand for oil had grown at a quicker rate than the existing tank steamers could cope with. Over seventy tank steamers were under construcion to meet the new business. The production of Mexico was increasing at an abnormal rate, and right at our doors we had the potential wealth of the oil fields of the Eastern Archipelago.

A recent calculation by Dr. Engler placed the world's oil reserves at 5,000,000,000 tons, which will last 100 years at the present rate of production. On a conservative estimate then, the internal combustion engine was assured of an ample supply of petroleum fuel for at least another 50 years, and as the use of other fuels was increasing, for many years beyond.

During the past 75 years there had been a criminal waste of fuel going on all over the world. The ordinary wasteful method of using coal was really stealing from posterity, and it would not be long before enlightened nations would prohibit the use for power purposes of any distillable fuel that was not in the form of oil. The transformation of coal into oil for use in internal combustion engines, and the reserving of petroleum residuals and other suitable oils for a like purpose, would be a move in the interests of economy, and would materially postpone the day when the world's fuel supply would be exhausted.

Discussion.

Mr. Sykes said he had very much pleasure in proposing a hearty vote of thanks to Mr. McEwin for the paper to which it had been their privilege to listen. He did not think a more unsuitable person could be found for the task he had now in hand, as for all practical purposes he had had little or no experience with oil fuel, and, consequently, any remarks he might make must be regarded as purely of a general nature, and which might readily occur to any engineer unversed in this subject. There were, however, one or two points about which he would like some further explanation.

He noticed, in one of the illustrations of a furnace which appeared on the screen, that the combustion took place all round the chamber, and he believed Mr. McEwin stated that the nozzles or feeders could be applied to a furnace fitted with fire-bars. He had always been under the impression that all the oxygen necessary for burning fuel was conveyed through the nozzle. He would, therefore,