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THE "PRIESTMAN" OIL ENGINE.

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MUCH attention of late has been given to the problem of the production of a moderately powerful self-contained motor, simple to manage, and capable of working steadily and economically without danger, noise, or other inconvenience. A great deal has been done with steam and gas as working agents, but there is at present every indication that oil is rapidly coming to the front and promising to be a dangerous rival, on a certain scale, of each of these substances. Notwithstanding the success and general popularity of the "Otto" gas engine, Messrs. Crossley have just placed a new oil engine on the market, and for which they claim a remarkable economy. Of the comparatively large number of oil engines now in use the 'Priestman" engine seems to meet with by far the most favour, and on account of the scientific interest felt in the engine, its generally good character, adaptability, and almost unprecedented economy in fuel, the author has thought the matter of sufficient importance to bring before the Engineering Association.

A 7 h.p. nominal "Priestman" engine has recently been installed in the Sydney Technical College for driving the electrical machinery. This engine will also be used as an experimental oil engine for the instruction of the students, and will be available to persons desiring practical knowledge of the management and working of this class of motor.

The engine was first introduced about the year 1888, and since its inception has been largely adopted for a great variety of purposes, such as electric lighting, charging accumulators, driving pumping machinery in mines without danger of causing explosions, and working rock drills and refrigerating machinery.

It ranges in power from 1 to 30 h.p., and is built in three types—the horizontal, vertical marine, and portable; as a launch engine it is unique and absolutely free from danger. For isolated places, where ordinary fuel is difficult and expensive to procure, the engine is eminently suitable, inasmuch as a 5 h.p. engine only requires about 50 pounds of oil per day, and the trouble of carrying this to the engine is inconsiderable, even over long distances through the bush.

The principle on which the engine works is very simple, and it requires no more attention than an ordinary gas engine. An iron reservoir under the bed of the engine contains kerosene oil under an air pressure of about 12 lbs. for a 7 h.p. engine From this two small pipes pass, one conveying air and the other oil regulated by the governor of the engine; these are mixed in a spraying nozzle, which reduces the oil to very fine particles. The mixed air and spray are received in a vaporising chamber, which in the larger engines is kept at a temperature of something like 300° Fah.; in small engines these temperatures are somewhat lower. During the suction stroke an additional air supply, also regulated by the governor, enters the vaporiser and carries forward the charge into the cylinder, about $2\frac{1}{2}$ times more air is admitted than is theoretically required to burn the charge, but is found necessary to render the heat of combustion of the oil available and so give a properly shaped indicator diagram. By heating the vapouriser with the exhaust a saving of about ten per cent. of the total heat is effected. The charge is compressed to about 30 lbs. on the return stroke, and a small portion of the vapour thereby condensed, which serves to lubricate the piston. The charge is then fired by an electric spark from an induction coil worked by a bichromate battery, the initial pressure being about 160 lbs., and the mean pressure approximately one-third of this amount in a 5 h.p. engine working at full load. After explosion the gases expand doing work and are exhausted in the return stroke; the cycle being the same as in the "Otto" gas engine. The supply and exhaust valves are mushroom-shaped, and are held on their seats by spiral springs; the supply valve opens automatically, but the exhaust valve is opened by means of an eccentric worked from a counter-shaft rotating at half the speed of the crank shaft. The "make" and "break" of the primary circuit working the electric ignition is also effected by the same eccentric.

From the description of its working it will be seen that the engine is an internal furnace motor using its working agent as fuel and consuming it within the cylinder. Such an engine might be expected to have a high thermodynamic efficiency, which is actually the case in practice, inasmuch as something like fourteen to fifteen per cent. of the total heat is converted into useful work in the smaller sizes of the motor. As far as the author's tests have been as yet conducted, the engine would appear to run steadily under a variable load; the action of the governor being very apparent from the indicator diagram. With a reduction of load on the engine there is shown a corresponding reduction in the compression before ignition owing to the cutting off of the supply of oil and air. With this lowered initial compression the diagram also shows that the maximum combustion pressure is not attained before something like half the stroke, proving that the burning of the charge is very much more gradual under these circumstances. In order to keep it cool the cylinder is water-jacketed, and a continuous circulation is kept up by a force pump worked from a constant supply provided in a tank adjacent to the engine. In long continuous runs the water becomes heated, and in that case must be replaced, but for ordinary cases no difficulty is experienced, for an 8 h.p. engine about a thousand gallons of cooling water is required.

The electrical ignition has proved thoroughly reliable, and is simple to manage. When properly charged it is impossible for the engine to miss explosions. By this arrangement the charge can be ignited with the greatest possible rapidity, and the indispensable condition of a safe and powerful ignition is amply fulfilled. The danger of tube ignition is entirely obviated, and it is affirmed that the electric ignition can be employed with perfect safety in the explosive atmospheres of coal mines. It is estimated that electric ignition costs about three half-pence per day of ten hours. There is very little chance for the sparking points to become bridged by a conducting substance, as oil and carbon are extremely bad conductors and these are the only substances which can possibly reach the points. All short-circuiting is carefully avoided. A number of the motors in the recent Paris Exhibition used electric ignition, and the author believes that it is generally admitted to be by far the best method. The oils used are the ordinary commercial kerosenes, having a specific gravity of from ·75 to ·85 and a flashing point, by the close test, ranging from 76° to 152° Fahrenheit, 73° F. being considered the lowest safe flashing point. Gradually raised in temperature the oils lose weight, but the pressure of the vapour produced is considerably below the pressure of the vapour from water at the same temperature. The vapour pressure curve is continuous but varies considerably for the different classes of oils; the lighter oils give a much steeper curve than the heavier ones. These points are important as showing the fixed nature of the oils under ordinary temperatures. A burning taper plunged in the oil is immediately extinguished. The specific heat of these oils varies from ·4 to ·5, but the latent heat is very nearly the same as water, but, on account of the want of uniformity of composition of the oil, is not constant. One part of Royal Daylight requires about 12,500 parts of air to make an explosive mixture. By removing the indicator and opening the cock a clear white flame is seen at the instant of explosion, and when the engine is working properly the porcelains in the igniting plug are perfectly white, showing the completeness of the combustion. The author had been informed by local manufacturers that the oil could be made and sold for 6d. a gallon, but the tardy sale of the by-products keep the prices up at present. Nevertheless it is believed there is a near future for the petroleum industry in the colony. At the present time the author is engaged in carrying out a series of tests on locally manufactured oils, with a view of determining their suitability and relative economy for use in oil engines, but these being incomplete he has had recourse to some elaborate tests recently made by Professor Unwin, F.R.S. and submitted to the Institution of Civil Engineers. In this case the tests were made on a 5 h.p. engine having a cylinder 8½ inches in diameter and 12 inch stroke, making 200 revolutions per minute. A rope friction brake was employed and indicator diagrams were taken every 15 minutes, together with brake records, and the air was measured by an anemometer.

The more important results are given in the following table :—

——	Trial I., Full Power.	Trial II., Full Power.	Trial III., Full Power.	Trial IV., Half Power.
Oil used	Royal Daylight.	Russolene.	Russolene.	Russolene.
Brake h.p.	7·722	6·765	6·882	3·620
Indicated h.p.	9·369	7·408	8 332	4·706
Mechanical efficiency	0·824	0·91	0·826	0·769
Oils used per brake h.p. hour lbs. ...	0·842	0·946	0·988	1·381
Oil used per indicated h.p. hour lbs.	0·694	0·864	0·816	1·063
Lbs of air per lb. of oil...	33·4	31·7	43·2	21·7
Mean explosion pressure lbs. per sq. in.	151·4	134·3	128·5	48·5
Mean compression pres. lbs. per sq. in.	35·0	27 6	26·0	14 8
Mean terminal pressure lbs. per sq. in.	35·4	23·7	25·5	15·6

To compare the fuel consumption in oil engines with that in steam engines, one pound of oil may be taken as equivalent in calorific power to one and a quarter pounds of coal. This might appear to some a low estimate, but the author believes that the calorific power of oil is generally over estimated. The analysis of kerosene is carbon 86 per cent. and hydrogen 14 per cent. At this rate the consumption of coal per brake horse power per hour in trials I, II, and III is 1·02 lbs., 1·18 lbs., and 1.23 lbs., which are certainly most remarkable results. The lowest known consumption in triple-expansion engines is about 1·61 lbs. of coal per brake horse power per hour. The above trials show a consumption of about a pint of oil per brake horse power per hour at a corresponding cost of about a half-penny in England.

From Trial III the following values of the expenditure of the heat can be obtained :—

Useful work at brake...	13·31	per cent.
Engine friction	2·81	„
Heat shown on diagram	16·12	„
Rejected in jacket water	47·54	„
Rejected in exhaust gases	26·72	„
Radiation, &c., ...	9·61	„
Total	99·99	„