18 4-10 lbs. per indicated Horse Power hour was obtained when the engine was developing 122<sup>1</sup>/<sub>2</sub> Horse Power and running at 202 R.P.M. The steam pressure was 155.4 lbs. This four-valve engine is not by any means an untried



## Fig. 7.—Medium-speed four-valve self-contained Frame. (Centre-crank).

machine, as a number have been in continual service since the spring of 1902.

Valves and Valve Gear.—These are the distinguishing features of this engine. The admission and exhaust valves  $p^{\star}$  each end are placed in the cylinder heads, and lie across the ends of the cylinder. The valve casing is, therefore, as close to the cylinder cavity as it is possible to make it, and the volume of the connecting ports is practically nothing. The total clearance varies from 3 to 4 per cent. in different sizes as compared with 6 to 8 per cent. in other four-valve engines. The valves themselves are the most improved form of the rotating type. They are double ported and give free passage to the steam.

The exhaust valves are operated directly from a fixed eccentric through levers and rods, and open and close the ports quickly. These rods lie in a straight line, with no off-sets from the levers to the eccentrics. The points of opening and closing of exhaust valves are fixed, and the



Fig. 8.-Main Bearing.

engine, therefore, has constant compression and release. The admission values are operated in the same simple way by levers and rods connected to a shifting eccentric, which is controlled by an automatic shaft governor similar to the band-wheel type of governor used on Atlas automatic selfcontained single-value engines.

The travel and period of opening of the steam valves depend, therefore, upon the action of the governor, and the cut-off is varied from zero to three-quarter stroke.

Governor.—The automatic shaft governor regulates the supply of steam to the engine in proportion to the load, reducing the period of steam admission by shortening the valve travel as the load diminishes. The movements of the governor parts thus not only control the speed of the engine under changes of load, however wide, but also offer proper conditions for low steam consumption.

The same type of governor is used on medium-speed four-valve engines as is used on self-contained single-valve engines, this governor being particularly adapted to the four-valve movement because it maintains practically constant steam lead for all loads on the engine, while decreasing the lead to zero when the entire load is thrown off. The eccentric is pivoted on the same side of the shaft as the crank, and as the eccentric swings across the shaft, decreasing valve travel, the lead is well maintained throughout all working conditions of the engine, ensuring prompt opening of the steam ports, with consequent proper steam distribution.



## Fig. 9.-Four-valve Centre-crank Shaft.

The important principle of inertia is made effective in this governor by the manner of weight suspension. This is combined with a very strong centrifugal element, without which no governor is reliable. Thus this governor is powerful, positive and very sensitive, and not unstable, as are some governors in which the centrifugal element is almost entirely lacking.

The governor has spiral springs acting in compression, not in tension. Therefore, the springs retain their power, cannot be overstrained, and if they should break they are not free to fly about the engine-room or cause other damage, as is often the case with springs in tension.

This governor is practically in perfect gravity balance, is free from excessive friction, simple and easy to adjust, and the speed and direction of rotation can be readily changed.

All parts of these engines are carefully tooled to standard limit gauges and templates, and each part is interchangeable with all others of the same class and size.

Fig. 10.—Cross-head of Medium-speed four-valve Engine. (End view).

In its mechanical construction the medium-speed fourvalve engine embodies the improved details developed during thirty years of steam engine building. The engine is built in both self-contained or centre-crank and heavy duty or

