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INTERNAL COMBUSTION ENGINE

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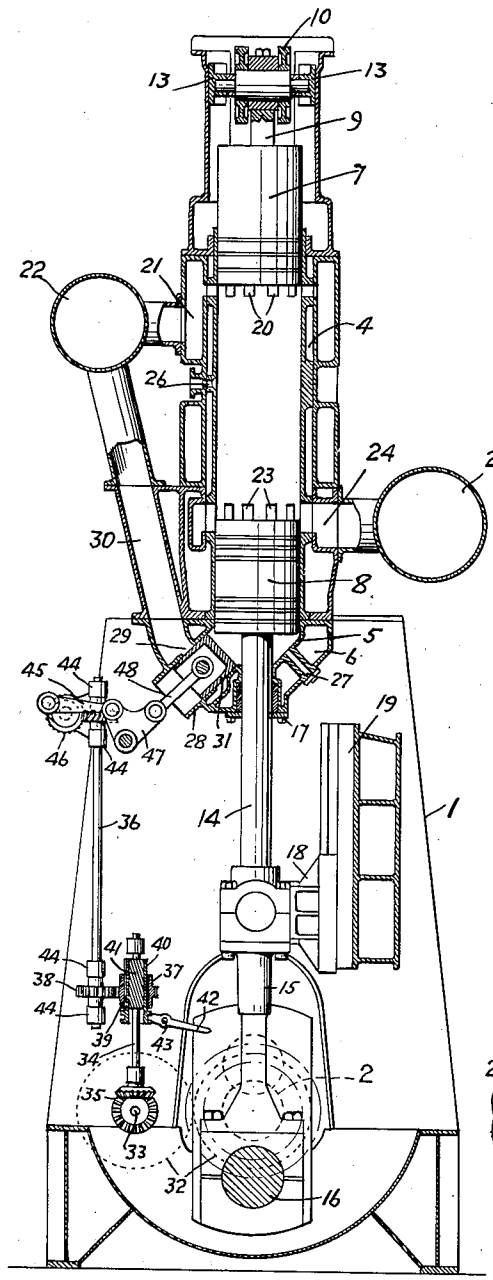


FIG. 1.

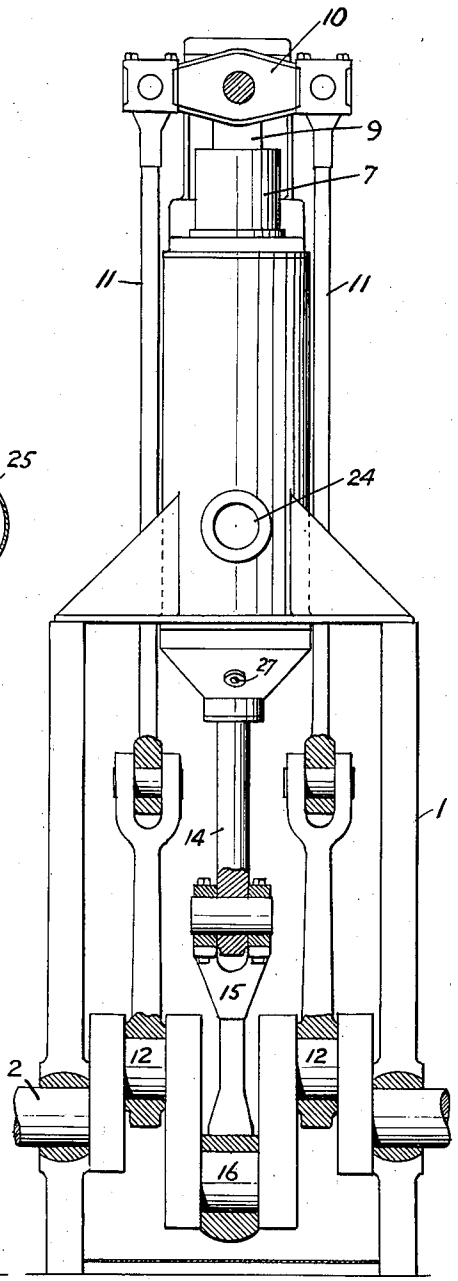


FIG. 2.

WITNESS:

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INTERNAL COMBUSTION ENGINE

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3 Claims. (Cl. 123—51)

This invention relates to an improvement in internal combustion engines and more particularly to Diesel engines of the opposed piston type.

This invention has for its object the provision of a Diesel type engine of the opposed piston type which will have greatly increased power over such engines as are presently available and, at the same time, will not be substantially increased in size.

In general, the engine in accordance with this invention will comprise a working cylinder arranged vertically and a pair of opposed pistons adapted to form a combustion chamber between them and suitably connected with a crank shaft. The cylinder will be open at its upper end and will be provided with a head at its lower end, which will form a combustion chamber below the lower piston rendering the engine double acting in the lower piston.

More specifically, though not essentially, the cylinder will be provided with service ports, controlled by the upper piston, for the combustion chamber between the pistons, a mechanical valve controlling a service port for the combustion chamber below the lower piston and common service ports controlled by the lower piston and serving both of the combustion chambers.

Various more specific features and details of construction will be made apparent from the following detailed description of a preferred embodiment of this invention, with reference to the accompanying drawing, in which:

Figure 1 is a vertical sectional view of an engine embodying this invention.

Figure 2 is a vertical view, partly in section, taken at right angles to that of Figure 1.

In the several figures 1 indicates the base of the engine within which is supported a crank shaft 2 and upon which is mounted a cylinder 3 provided with cooling water jackets 4. The cylinder is open at its upper end and is provided with a head 5, adapted to form a combustion chamber with the lower end of the lower piston 8, and provided with cooling water jacket 6 at its lower end.

Within the cylinder is an upper piston 7 and a lower piston 8. The upper piston 7 is connected by means of a rod 9 to a cross-head 10, which in turn is connected by means of side rods 11, 11 to a pair of cranks 12, 12 on the crank shaft 2. Guides 13, 13 are provided for guiding the cross-head 10.

The lower piston 8 is connected by a rod 14, which extends through the head 5, to a connecting rod 15, which is in turn connected with the crank 16 on the crank shaft 2. The throw of the crank 16 is greater than that of the cranks 12, 12 to the end that the lower piston 8 will have a greater length of travel or stroke than has the upper piston 7. The rod 14 is packed in the head 5 by means of any suitable metallic packing 17 and carries a shoe 18, which engages a guide 19 for the guidance of the rod.

Ports 20 are provided adjacent the upper end of the cylinder 3 and communicate through passage 21 with a scavenging air receiver 22. The ports 20 are adapted to be controlled by the upper piston 7.

Ports 23 are provided adjacent the lower end of the cylinder and communicate through a passage 24 with an exhaust manifold 25. The exhaust ports 23 are adapted to be controlled by the lower piston 8 and are of a height adapting them to serve for the exhaust of burned gases from between the pistons and from the combustion chamber formed between the lower end of the lower piston 8 and the head 5.

The cylinder 3 is provided with an opening 26 for a liquid fuel injection valve and the head 5 is provided with an opening 27 for similar means.

Opening through the head 5 is a cylinder 28, provided with a port 29 in communication with a passage 30 leading from the scavenging air receiver 22. The port 29 in the cylinder 28 is controlled by a piston valve 31.

The piston valve 31 is adapted to be operated from the main crank shaft through gearing 32, which serves to drive jack shaft 33, from which a shaft 34 is driven through beveled gearing 35. The shaft 34 serves to drive a lay shaft 36 through gears 37 and 38. The gear 37 is mounted on straight splines 39 on a sleeve 40, which in turn is mounted on shaft 34 through spiral splines 41. The lower end of the sleeve 40 is grooved for engagement by the forked end of a hand lever 42, pivotally mounted on a suitable fulcrum pin 43.

The shaft 36, which is mounted in suitable bearings, 44, 44, drives a crank 45 through spiral gearing 46. The crank 45 is connected to a pivotally mounted bell crank lever 47, one arm of which is connected to the piston valve 31 by a rod 48.

The various gearing involved in the mechanism for driving the piston valve 31 is arranged so that the piston valve 31 will be driven at engine speed. The mounting of the gear 37 through the medium of straight splines on sleeve 40 and the mounting of sleeve 40 on the shaft 34

through the medium of spiral splines 41 enables the timing of the piston valve 31 to be changed for reverse operation of the engine by manipulation of hand lever 42, which, raising or lowering the sleeve on its spiral splined connection with shaft 44, effects a rotation of gear 37 and hence of the lay shaft 36, with consequent changing of the timing of the piston valve 31, independently of the crank shaft.

The operation of the engine in accordance with this invention as above described will, it is believed, be apparent. From an inspection of Figure 1, it will be noted that the pistons 7 and 8 are respectively at their upper and lower dead center positions and that the piston valve 31 closes the scavenging air port 29, while the exhaust ports 23 are open between the pistons and the scavenging air ports 20 are open.

In the position shown scavenging air will enter the cylinder between the pistons and pass out the exhaust ports 23 and compression will have taken place between the lower end of piston 8 and the cylinder head 5. Assuming now that fuel has just been injected into the combustion chamber between the lower end of piston 8 and the cylinder head 5, the piston 8 will move upwardly in the cylinder on a power stroke under the influence of expansion of gases below it and will close the exhaust ports 23.

At the same time the piston 7 will necessarily move downward with closure of the scavenging air ports 20. As the pistons move together, the piston 8 will uncover the lower ends of the exhaust ports 23. Meanwhile, the piston valve 31 will be moving outward in its cylinder 28 and shortly after the opening of the exhaust ports 23 below the piston 8, the piston valve 31 will open the scavenging air port 29. With the movement of the pistons toward each other for the closing of the scavenging air ports 20, compression will take place between them. When the pistons have reached the proper point in their movement toward each other the exhaust and scavenging of the gases below the piston 8 will have been effected and injection of liquid fuel between the pistons will cause them to move apart on a power stroke. As the pistons move apart, the piston 8 will first uncover the upper ends of the exhaust ports 23 and then the upper piston 7 will uncover the ports 20, for exhaust and scavenging between the pistons. In the downward movement of the lower piston 8, it will operate to cover the exhaust ports 23, thus shutting off exhaust from below the piston and shortly thereafter the piston valve 31 will have moved to close the scavenging air port 29. Further downward movement of the piston 8 will establish compression between its lower end and the head 5. The engine the operation of which is described may be readily timed for the efficient carrying out of the cycle of operations described.

When it is desired to reverse the direction of operation of the engine, as will be appreciated, it is only necessary to change the timing of the piston valve 31, which may be readily accomplished by manipulation of the hand lever 42 which, as has been described, effects a rotation of the lay shaft 36 independently of the main crank shaft 2 to the extent necessary to shift the position of the piston valve 31 with respect to the crank shaft for reverse operation. Usually, the position of piston valve 31 will be shifted, by manipulation of hand lever 42, for reverse operation through rotation of lay shaft 36 a distance of about 30° one way or the other.

In the above detailed description of the preferred embodiment of this invention illustrated in the drawing the ports 20 and the port 29 have been described as scavenging air ports while the ports 23 have been described as exhaust ports. It will be appreciated that if desired the ports 23 may be utilized for the introduction of scavenging air, while the ports 20 and 29 may be used as exhaust ports, suitable connections with the scavenging air receiver and exhaust manifold being made. The ports 20, 23 and 29 hence are properly defined as service ports, it being only important to note that the ports 23, whether used as scavenging air ports or exhaust ports, serve both the combustion chamber between the pistons and the combustion chamber between the lower end of the lower piston 8 and the cylinder head 5, under control of the lower piston 8.

It will now be noted that in accordance with this invention there is provided a Diesel, or liquid fuel injection type, engine of the opposed piston type which is double acting on the lower piston only. The engine will be found to develop greatly increased power for a given bore and stroke over the ordinary opposed piston Diesel engine. At the same time, it will be noted that the overall dimensions of the engine, and particularly the height, is but little increased in that the double acting feature is confined to the lower end of the cylinder.

The engine in accordance with this invention is, as will be obvious, economical to produce and it will be found to be of high efficiency and desirable in view of its greatly increased power without substantial increase in size.

What I claim and desire to protect by Letters Patent is:

1. A Diesel engine comprising, in combination, a crank shaft, a vertical working cylinder open at its upper end, a pair of opposed pistons in the cylinder adapted to form a combustion chamber between them, a cylinder head on the lower end of the cylinder adapted to form a combustion chamber with the lower end of the lower piston, piston rods connected to the pistons, means for connecting the piston rods to the crank shaft, a pair of vertically spaced ports in the cylinder, the lower of said ports being controlled by the lower piston and being adapted, when the lower piston is in a position approaching lower dead center, to serve the combustion chamber between the pistons and when the lower piston is in a position approaching upper dead center to serve the combustion chamber between the cylinder head and the lower end of the lower piston and the upper of said ports being controlled by the upper piston and adapted to serve the combustion chamber between the pistons only, a port in the cylinder head and opening into the combustion chamber between the cylinder head and the lower end of the lower piston, a mechanical valve arranged to control said port in the cylinder head and means driven from the crank shaft for operating said valve in timed relation with the travel of the pistons

2. A Diesel engine comprising, in combination, a crank shaft having a pair of cranks of different lengths, a vertical working cylinder open at its upper end, a pair of opposed pistons in the cylinder adapted to form a combustion chamber between them, a cylinder head on the lower end of the cylinder adapted to form a combustion chamber with the lower end of the lower piston, piston rods connected to the pistons, means for connecting the upper piston to the shorter of said

pair of cranks, means for connecting the lower piston to the longer of said pair of cranks, a pair of vertically spaced ports in the cylinder, the lower of said ports being controlled by the lower piston and being adapted, when the lower piston is in a position approaching lower dead center, to serve the combustion chamber between the pistons and when the lower piston is in a position approaching upper dead center to serve the combustion chamber between the cylinder head and the lower end of the lower piston and the upper of said ports being controlled by the upper piston and adapted to serve the combustion chamber between the pistons only, a port in the cylinder head and opening into the combustion chamber between the cylinder head and the lower end of the lower piston, a mechanical valve arranged to control said port in the cylinder head and means driven from the crank shaft for operating said valve in timed relation with the travel of the pistons.

3. A Diesel engine comprising, in combination, a crank shaft, a vertical working cylinder open at its upper end, a pair of opposed pistons in the cylinder adapted to form a combustion chamber between them, a cylinder head on the lower end of the cylinder adapted to form a combustion chamber with the lower end of the lower piston, piston rods connected to the pistons, means for connecting the piston rods to the crank shaft, longitudinally spaced ports in the cylinder adapted to be controlled by the pistons respectively for the emission of exhaust gases and admission of scavenging air for the central combustion chamber, a port in the cylinder controlled by the lower piston, a port in the cylinder head and a mechanically operated valve for controlling the port in the cylinder head, said last mentioned ports being adapted for the emission of exhaust gases and the admission of scavenging air for the combustion chamber formed between the lower end of the lower piston and the cylinder head.

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