Nov. 16, 1937. R. E. OLDS 2,099,371

DIESEL ENGINE

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FIG.1.

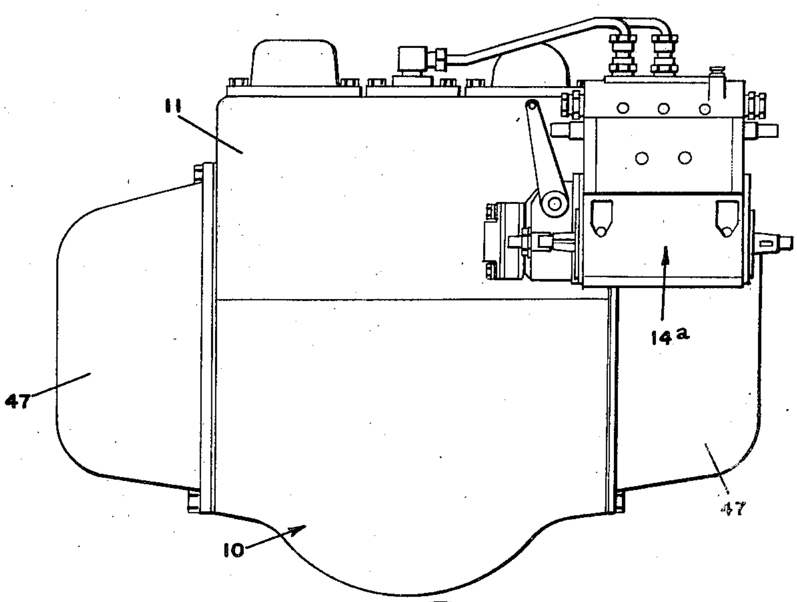
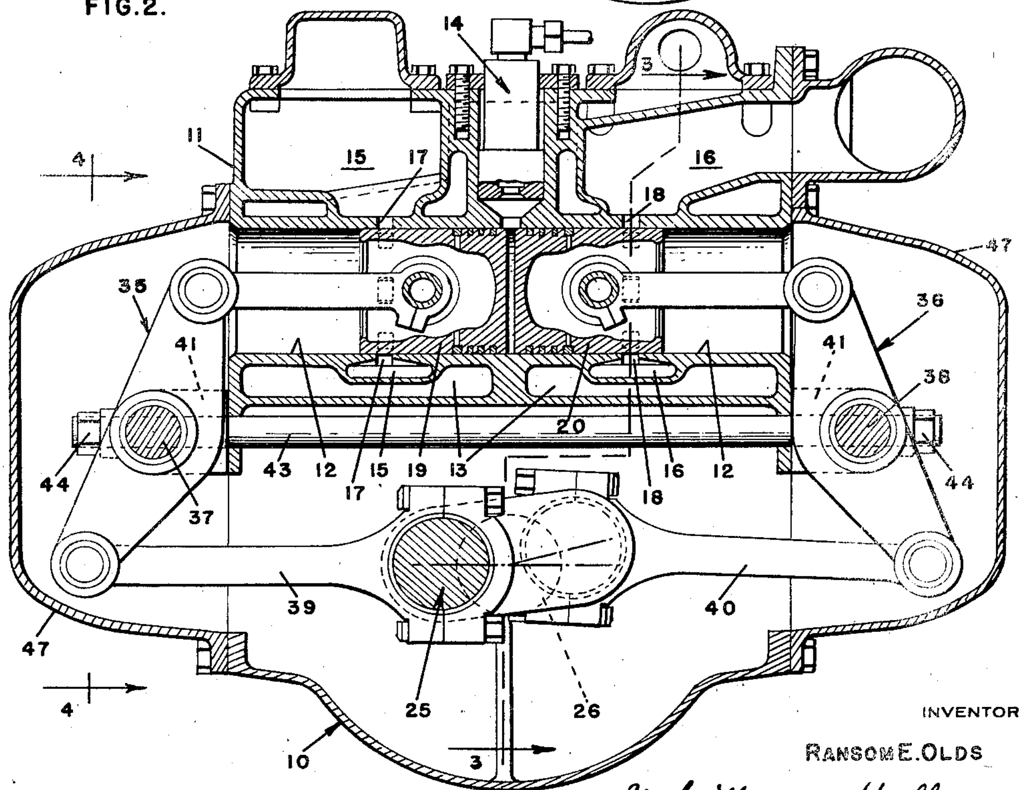


FIG.2.



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DIESEL ENGINE

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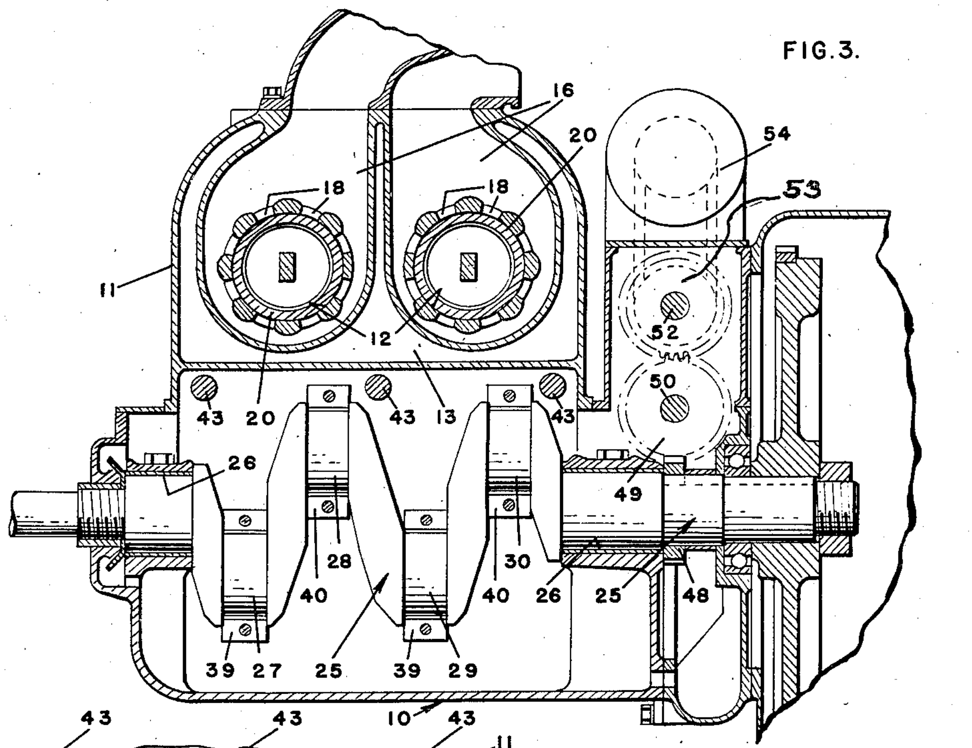

FIG.3.

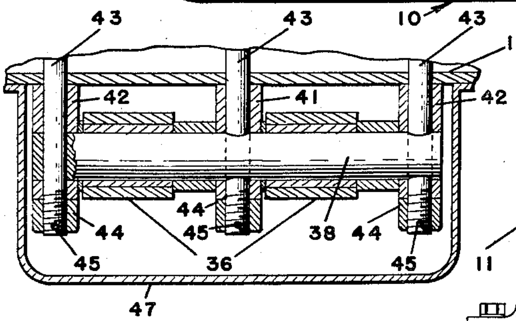

FIG.5.

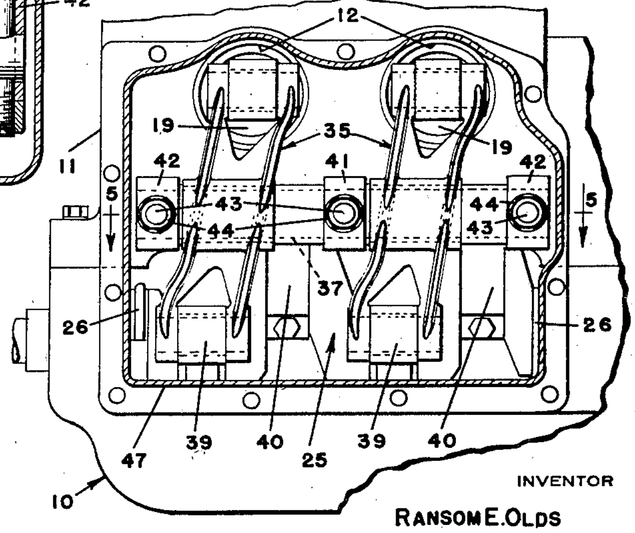

FIG.4.

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DIESEL ENGINE

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2 Claims. (Cl. 123—51)

This invention relates generally to internal combustion engines and refers more particularly to Diesel engines of the two-cycle double piston type.

The basic principles as well as the particular advantages of the two-stroke cycle for Diesel engines over the four-stroke Diesel have long been recognized and one of the most important advantages is that the power output having a given piston displacement will be twice as great in the two-stroke cycle engine as in the four-stroke engine, due to the fact that every stroke of the piston in a direction away from the compression chamber in a two-stroke cycle engine is a power stroke, as distinguished from a four-stroke engine wherein only every other stroke of the piston away from the compression chamber is a power stroke. Consequently, the two-stroke cycle engine will produce the same uniformity of torque on the crank shaft as the four-stroke engine, with only half the number of cylinders, and minimizing the number of cylinders is of particular importance in a Diesel engine, since it permits correspondingly reducing the number of fuel injector pumps and injector valves.

The advantage of a two-cycle engine having two pistons in each cylinder respectively, controlling the intake and exhaust ports adjacent opposite ends of the cylinder, over the conventional two-stroke engine of the type having both the inlet and exhaust ports arranged to be controlled by a single piston operating in the cylinder will be readily apparent when considering that in the former type of engine the differential port timing, essential for supercharging, may be secured by operating the piston controlling the exhaust port in advance of the piston controlling the intake port so that the former port may be opened prior to the latter port and closed before the latter port. This latter arrangement when combined with a scavenging pump of proper capacity at the intake port permits forcing a charge of fresh air into the cylinder greater than the maximum cylinder volume at atmospheric pressure and temperature. This supercharging action cannot be obtained in the conventional two-stroke engine utilizing a single piston in the cylinder for controlling both ports, since with such an arrangement the exhaust port must open before the inlet port, and as a consequence will close later than the inlet port.

The present invention contemplates a double piston two-stroke engine possessing all of the foregoing, as well as the numerous other advantages peculiar to two-cycle engines incorporating two pistons in each cylinder, and in addition contemplates simplifying, materially reducing the cost of manufacture and providing a more compact engine of substantially less weight than heretofore produced.

One of the principal features of the present invention which contributes materially to securing the advantages set forth in the preceding paragraph resides in the relatively simple and novel means provided for establishing an operative connection between the opposed pistons and the crank shaft of the engine.

A further advantageous feature of this invention which contributes materially to reducing the weight of the engine without sacrificing rigidity resides in the novel means provided for relieving the cylinder block and associated parts of the engine from the stresses resulting from the relatively high compression pressures developed in the cylinders.

The foregoing as well as other objects will be made more apparent as this description proceeds, especially when considered in connection with the accompanying drawings, wherein:

Fig. 1 is a semi-diagrammatic elevational view of the rear end of a Diesel engine constructed in accordance with this invention;

Fig. 2 is a vertical transverse sectional view of the construction shown in Fig. 1;

Fig. 3 is a vertical longitudinal sectional view taken substantially on the line 3—3 of Fig. 2;

Fig. 4 is a sectional view taken substantially on the line 4—4 of Fig. 2;

Fig. 5 is a sectional view taken substantially on the line 5—5 of Fig. 4.

For the purpose of illustration I have shown a two-cycle Diesel engine of the type having horizontally disposed cylinders and having two opposed pistons in each cylinder operatively connected to a common crank shaft extending at right angles to the axes of the cylinders intermediate opposite ends of the latter. Before discussing the detailed construction of the particular engine selected herein for the purpose of illustration, it may be pointed out that the principle of uniflow scavenging is utilized in that the air intake or transfer port is located adjacent one end of the cylinder to be controlled by one of the pistons in the cylinder and the exhaust port is positioned adjacent the opposite end of the cylinder to be controlled by the other piston in the cylinder. The two pistons cooperate with each other in the innermost positions thereof to form a compression chamber of the desired size substantially centrally within the cylinder opposite a suitable fuel injector, and the crank is so designed as to effect a phase difference of approximately 15 degrees between the motions of the two pistons. In the specific construction shown herein the piston controlling the exhaust port is operated in the cylinder in advance of the other piston so that it necessarily follows that the exhaust ports are not only opened ahead of the inlet ports, but are also closed before the latter ports, permitting the cylinder to be effectively supercharged by employing a scavenging pump of greater capacity than the displacement of the working cylinders.

Referring now more in detail to the particular construction of the engine forming the subject matter of this invention, it will be noted that the same comprises a crank case 10 and a cylinder block 11 suitably removably secured to the crank case. In the present instance a two cylinder engine is selected for the purpose of illustrating the invention, and accordingly, two cylinders 12 are shown as cast in the block 11 in juxtaposition to each other with jackets 13 for a cooling medium surrounding each cylinder. As shown particularly in Figs. 2 and 3, the cylinders are cast in the block with the axes thereof extending substantially horizontally in parallel relationship and each cylinder communicates intermediate the ends thereof with a fuel injector 14 supplied with fuel under pressure from a pump 14a and which may be of any one of the various different accepted types. Although it is not the intention to limit this invention to engines having horizontally extending cylinders, nevertheless, such a disposition of the latter is advantageous when it is desired to install the engine in a space of limited vertical dimension.

Surrounding each of the cylinders 12 upon opposite sides of the fuel injector 14 are intake and exhaust chambers 15 and 16 respectively, communicating with the interior of the cylinders adjacent opposite ends thereof through the medium of intake and exhaust ports 17 and 18 respectively. Both of the aforesaid chambers are cast in the block in such a manner that a substantial portion of the wall area thereof is exposed to the cooling medium adapted to be circulated through the water jackets 13, and the intake and exhaust ports of each cylinder are, respectively, controlled by a pair of pistons 19 and 20 mounted in opposed relationship in each cylinder. In addition to controlling the intake and exhaust ports, the opposed pistons in each cylinder cooperate with each other to form the proper combustion space opposite the points of communication of the fuel injector pumps with the cylinders, as clearly shown in Fig. 2.

In general, when the opposed pistons are in their outermost positions in the cylinders both the intake and exhaust ports are opened permitting air to flow through the cylinder under the pressure of a scavenging pump (not shown) communicating with the intake chambers and driven from the crank shaft of the engine in any suitable manner. As will be more fully understood from the description of the crank shaft, to be presently described, the pistons 20 controlling the exhaust ports 18 operate in advance of the pistons 19 controlling the intake ports 17, so that upon inward movement of the two pistons the exhaust ports are closed before the intake ports permitting the scavenging pumps to build up a charge of air in the cylinders between the opposed pistons greater than the volumetric efficiency of the space between the pistons so as to obtain the desired supercharging action. Upon continued movement of the pistons in the cylinders toward each other, the intake ports are of course closed, and the air trapped between the pistons is compressed into the relatively small combustion chambers existing between the heads of the pistons in the innermost positions of the latter. As previously stated, the construction is such that the combustion chambers, resulting from moving the pistons to their innermost positions in the cylinders, register with the fuel injector pumps 14, and the operation of the latter is so timed with respect to the piston travel as to inject fuel into the extremely high pressure areas between the heads of the pistons in their innermost positions. The air in the cylinders is compressed by the opposed pistons to such an extent that the temperature thereof is sufficiently high to ignite the fuel as the same is injected into the combustion chambers. The pressure in the combustion chambers is, of course, further increased by the burning of the fuel and the construction is such that peak pressure is reached in the combustion chambers when the pistons have started on their power strokes so as to transmit maximum torque to the crank shaft of the engine.

The crank shaft of the engine is perhaps best shown in Fig. 3 and is designated herein by the reference character 25. As will be observed from this figure, the axis of rotation of the crank shaft 25 extends at substantially right angles to the axes of the cylinders 12 intermediate the ends of the latter, and the opposite ends of the crank shaft are journaled in suitable bearings 26 cast integral with the crank case 10. The shaft 25 has four throws, designated in Fig. 3 by the reference characters 27, 28, 29 and 30. Two of these throws 28 and 30 are respectively, operatively connected to the pistons 20 in the two cylinders, while the other throws 27 and 29 are, respectively operatively connected to the pistons 19 in the cylinders. The throws are so arranged that the opposed pistons in both cylinders move in the same direction, but the throws 27 and 29 controlling the movement of the pistons 19 in the cylinders are disposed approximately 15 degrees back of the throws 28 and 30 so as to effect a phase difference of approximately 15 degrees between the motions of the pistons 19 and 20. In other words, the throws of the crank for operating the pistons controlling the exhaust ports are disposed in advance of the throws for operating the pistons controlling the intake ports, so that the exhaust ports will not only be opened before the intake ports for scavenging purposes, but will also be closed before the latter ports for supercharging purposes.

Referring now more in detail to the particular means for operatively connecting the several throws on the crank shaft to the pistons in the cylinders, it will be noted that this means comprises two pairs of rock arms, designated in Figure 1 by the reference characters 35 and 36. The pair of rock arms 35 is journaled upon a shaft 37 mounted upon one side of the engine with its axis extending substantially parallel to the crank shaft axis and the pair of rock arms 36 is journaled upon a similar shaft 38 mounted upon the opposite side of the engine with its axis in parallel relation to the axis of the shaft 37. The upper ends of the rock arms 35 are respectively, connected to the pistons 19 in the two cylinders 12 in such a manner that, as the arms are rocked about the axis of the shaft 37, the pistons 19 travel axially of the cylinders 12. The lower ends of the rock arms 35 are respectively, connected to the throws 27 and 29 of the crank shaft through the medium of suitable connecting rods designated in Figure 2 by the reference character 39. The upper ends of the pair of rock arms 36 are respectively, connected to the pistons 20 in the cylinders 12 for reciprocating the pistons axially of the cylinders upon rocking movement of the arms and the required rocking movement of the arms is effected by respectively, connecting the lower ends of the arms to the throws 28 and 30 through the medium of the connecting rods 40. Inasmuch as the throws 28 and 30 are arranged slightly ahead of the throws 27 and 29, and in view of the fact that the pistons 20 controlling the exhaust ports are directly connected to the former throws through the medium of the rock arms 36 and associated linkage, it necessarily follows that the pistons 20 will be operated slightly ahead of the pistons 19 during the working cycle so as to provide the differential port timing required for supercharging.

Although every effort is made to operate the engine with as little compression pressure as is practical in order to keep down maximum cylinder pressures, and thereby reduce stresses on the engine parts, nevertheless, these stresses are relatively high in Diesel engines, and as a consequence, rigidity is an important factor in designing Diesel engines. By reason of the construction set forth in the preceding paragraph, it will be noted that practically all of the stresses, resulting from compression pressures in the present engine, are transmitted to the shafts 37 and 38 by the opposed pistons in the cylinders. Consequently, the rock shafts are so supported as to effectively take the maximum stresses without transferring the latter to the crank case or cylinder block. The required rigidity of the shaft mountings is obtained herein by supporting each of the shafts 37 and 38 at three distinct points upon opposite sides of the engine. As shown in Figure 5, each of the shafts is supported at a point between the rock arms thereon by means of an intermediate bearing block 41 and at the free ends thereof by similar bearing blocks 42. Each of the bearing blocks is rigidly clamped to the engine by means of a rod 43 extending through openings formed in the cylinder block 11 below the cylinders 12 and having the opposite ends extending through the bearing blocks and shafts 37 and 38. The free ends of the rods projecting beyond the bearing blocks are threaded for receiving the clamping nuts 44 and accidental displacement of the latter is prevented by means of the pins 45 extending transversely through the ends of the rods and clamping nuts. The bearing blocks and associated parts thereof previously described are concealed by housings 47 suitably removably secured to opposite sides of the engine. Thus it will be apparent that each of the bearing blocks for supporting the shaft 37 and the corresponding bearing blocks for supporting the shaft 38 is clamped to opposite sides of the engine by common bolts in the form of rods extending entirely through the cylinder block. The arrangement is such that the stresses, resulting from the relatively high compression pressures in the cylinders and exerted on the pistons 19, is opposed, through the rods 43, by the stresses exerted on the pistons 20, thereby relieving the cylinder block and associated engine parts from the maximum stresses. This feature is of importance, since it offers the possibility of forming the cylinder block and associated engine parts of lighter construction without sacrificing the rigidity required to withstand the relatively high stresses resulting from high compression pressures developed in the cylinders.

In Fig. 3 of the drawings, I have shown a gear 48 keyed or otherwise suitably secured to the crank shaft 25 and adapted to mesh with the gear 49 fixedly secured to an accessory shaft 50. The accessory shaft 50 is employed to drive the fuel pumps 14^a and may also be utilized to operate a governor (not shown). In the present instance, the engine is provided with a second accessory shaft 52 having a gear 53 fixed thereto, and meshing with the gear 49. The second accessory shaft 52 is utilized to operate the generator 54, and may also be employed to operate oil and water pumps (not shown).

Thus from the foregoing it will be observed that I have provided a relatively simple and inexpensive two-cycle double piston engine of the Diesel type capable of being installed in a relatively small space due to the compact nature of the same. It will further be observed that the several parts of the engine, including the cylinder block and crank case, may be formed relatively light without sacrificing rigidity due to the novel manner in which the stresses, resulting from relatively high compression pressures developed in the cylinders, are dissipated.

What I claim as my invention is:

1. In an internal combustion engine of the Diesel type, a block having a pair of parallel cylinders extending therethrough and open at their opposite ends, each of said cylinders having a central fuel injection port and air intake and exhaust ports symmetrically arranged on opposite sides thereof, a crank shaft having its axis extending transverse to the axes of the cylinders at one side and centrally thereof, said crank shaft having oppositely arranged throws slightly displaced from an angle of 180°, opposed pistons in said cylinders cooperating with each other in the inmost position thereof to form a combustion chamber, walking beams arranged at opposite ends of the block, one end of each being connected with a piston, rods connecting the opposite ends of said walking beams with said crank throws, shafts on which said walking beams are fulcrumed and tie rods connecting said shafts and extending therethrough, said tie rods being arranged on opposite sides of said walking beams.

2. In an internal combustion engine of the Diesel type, a block having a pair of parallel cylinders extending therethrough and open at their opposite ends, each of said cylinders having a central fuel injection port and air intake and exhaust ports symmetrically arranged on opposite sides thereof, a crank shaft having its axis extending transverse to the axes of the cylinders at one side and centrally thereof, said crank shaft having oppositely arranged throws slightly displaced from an angle of 180°, opposed pistons in said cylinders cooperating with each other in the inmost position thereof to form a combustion chamber, walking beams at opposite ends of said block, one end of each being connected to a piston, rods connecting the opposite ends of said walking beams with said crank throws, the angular displacement of said crank throws with respect to each other being such as to cause the exhaust ports to open and close respectively before and after the opening and closing of the intake port, shafts on which said walking beams are fulcrumed, bearings for said shafts on opposite sides of said walking beams and abutting against said block, a tie connection between said bearings comprising rods extending therethrough and through said shafts in the axial plane thereof, and clamping nuts engaging threaded ends of said rods to hold said bearings against said block and to transmit stresses between the fulcrums of the opposite walking beams.

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