Dec. 19, 1939. C. G. CURTIS 2,184,093

DOUBLE-ACTING TWO-CYCLE DIESEL ENGINE

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Fig.1

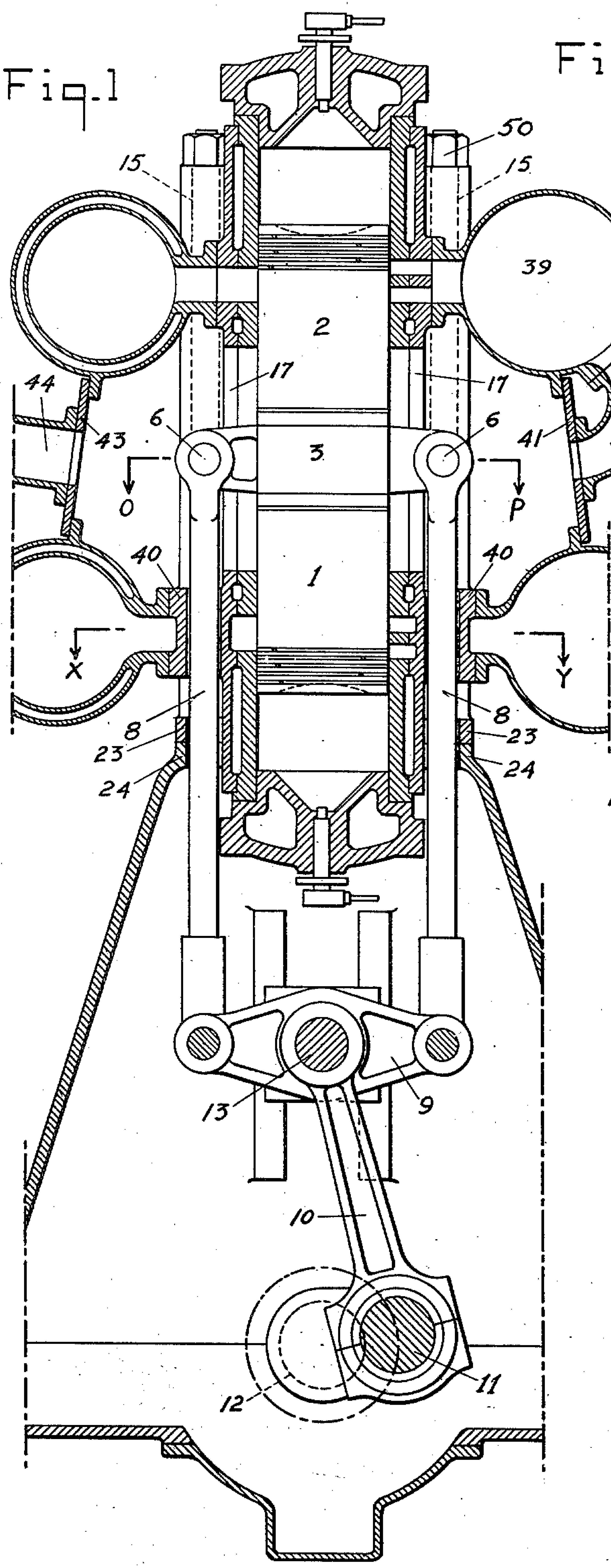


Fig.2

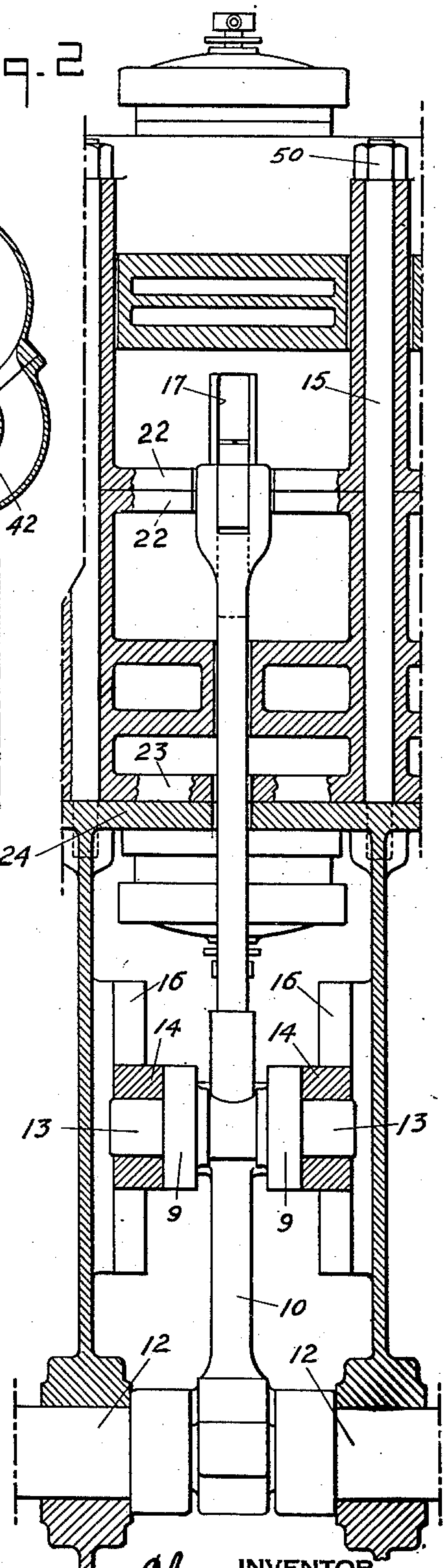


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Fig.3

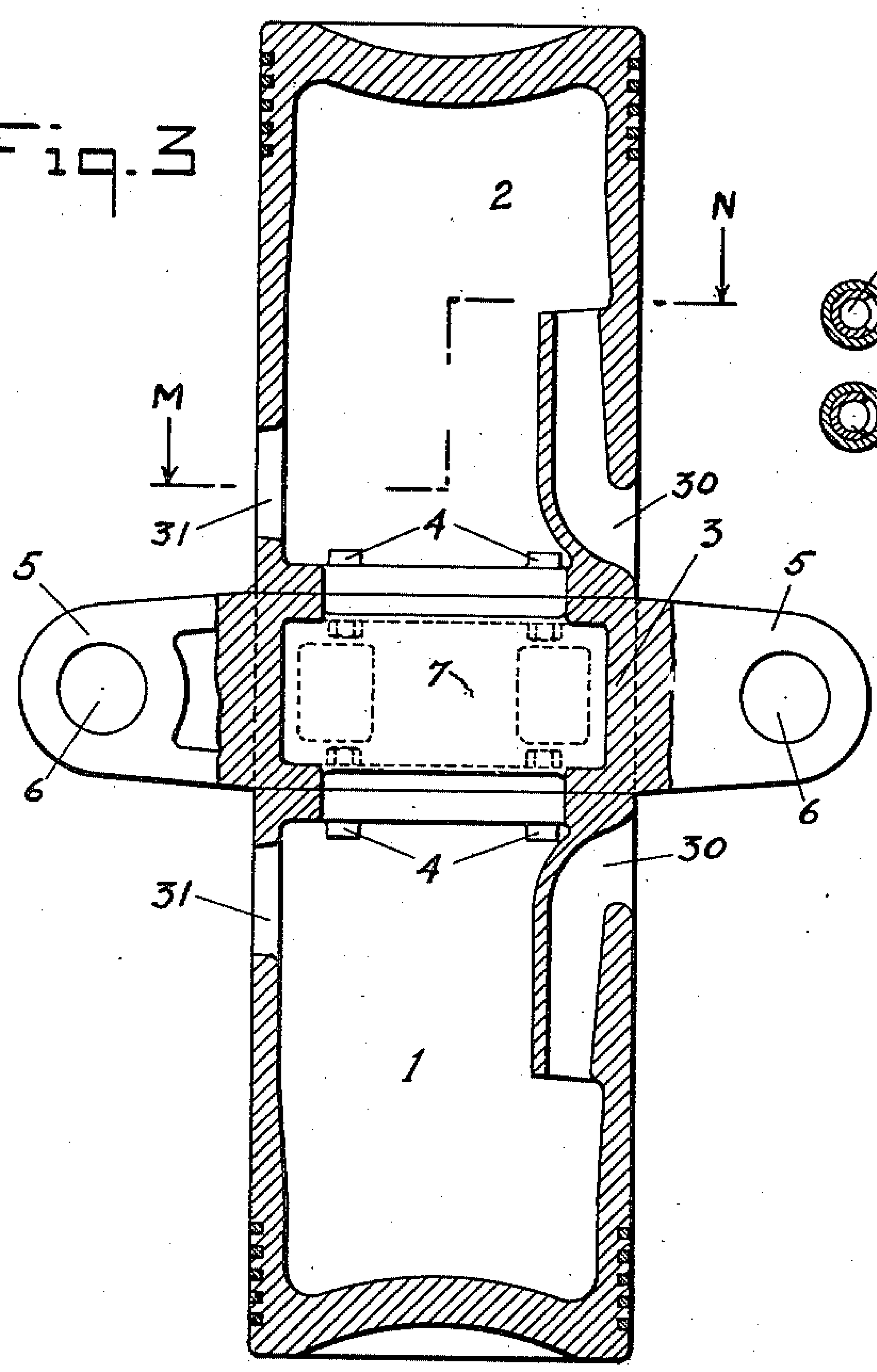



Fig.10

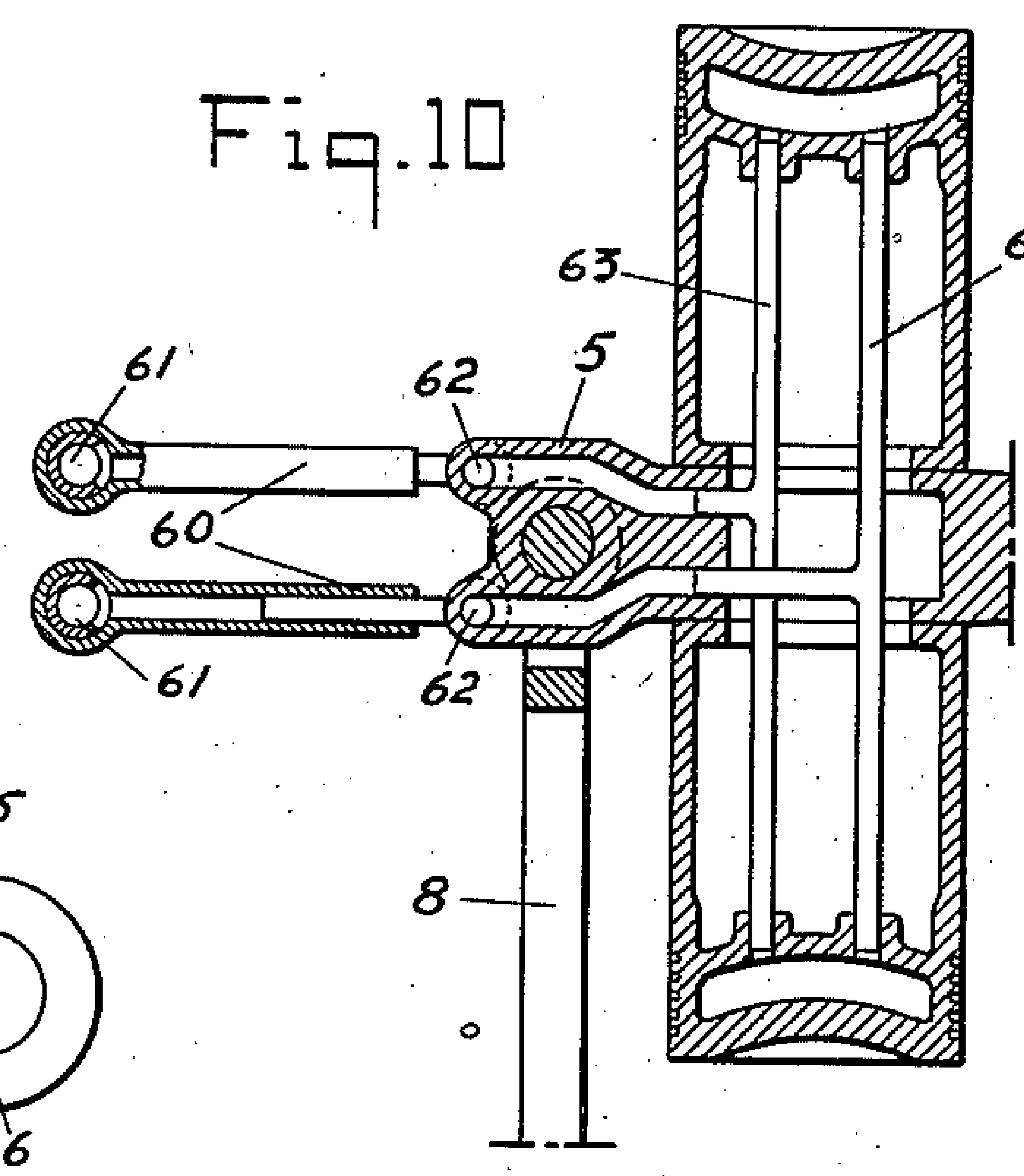



Fig.4

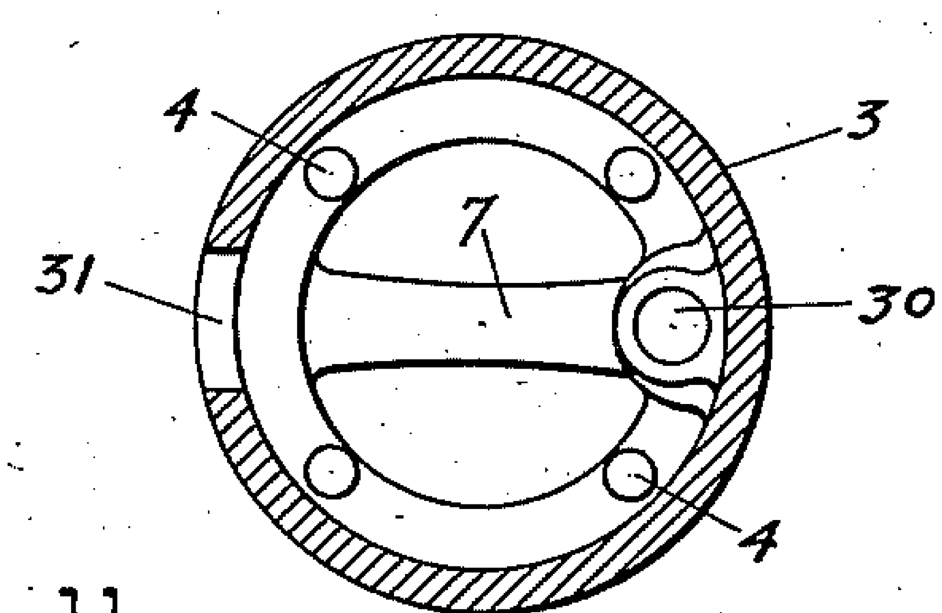



Fig.5

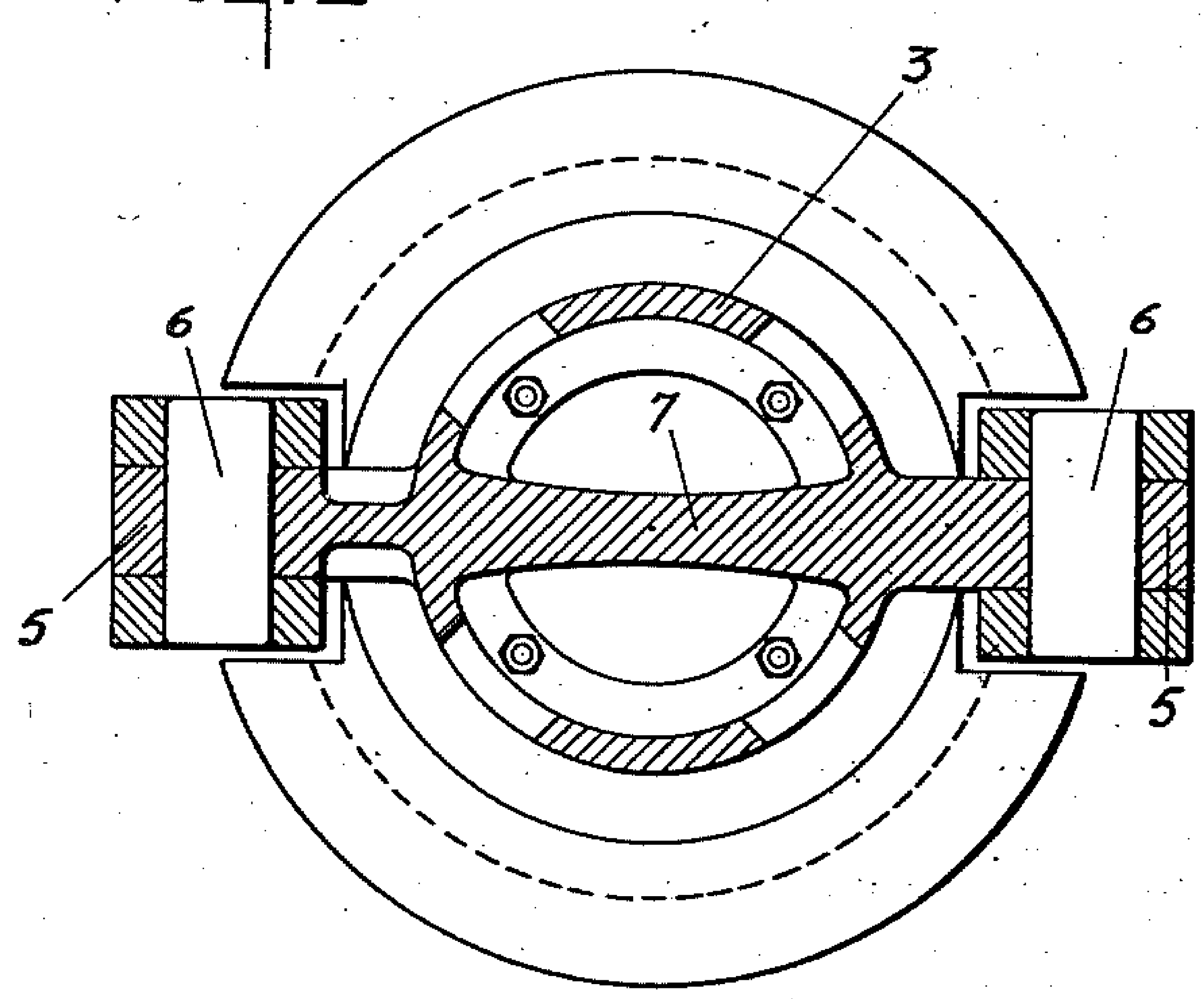
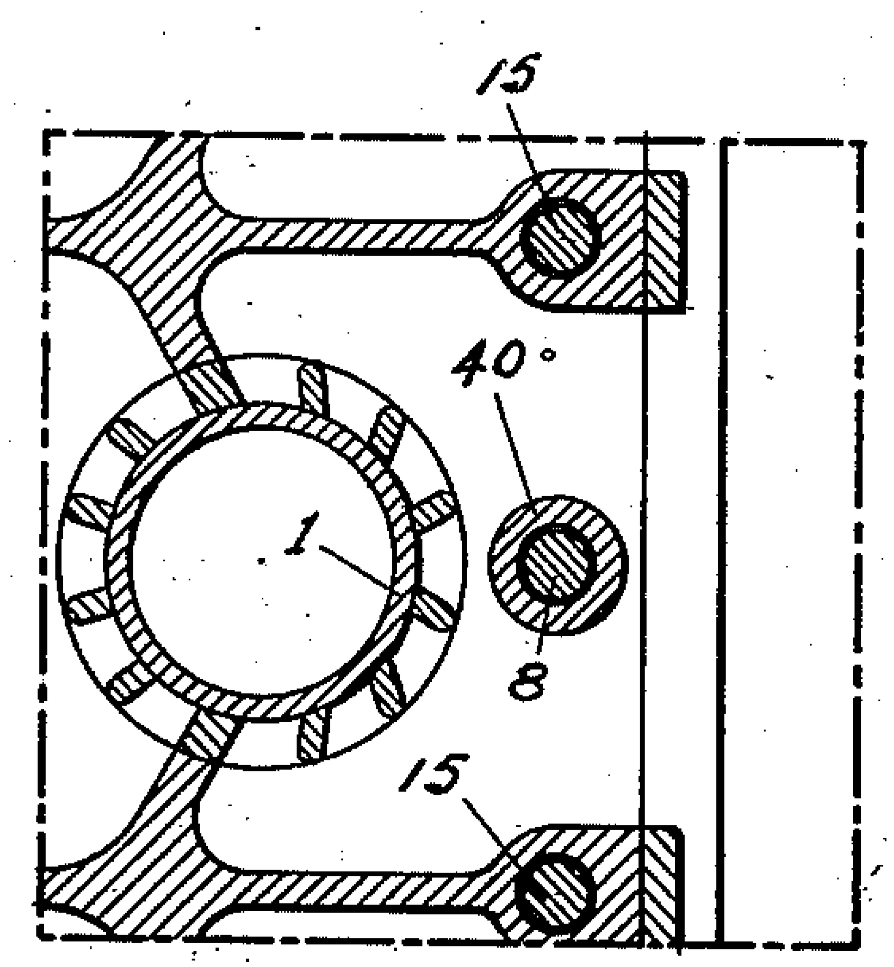



Fig.11

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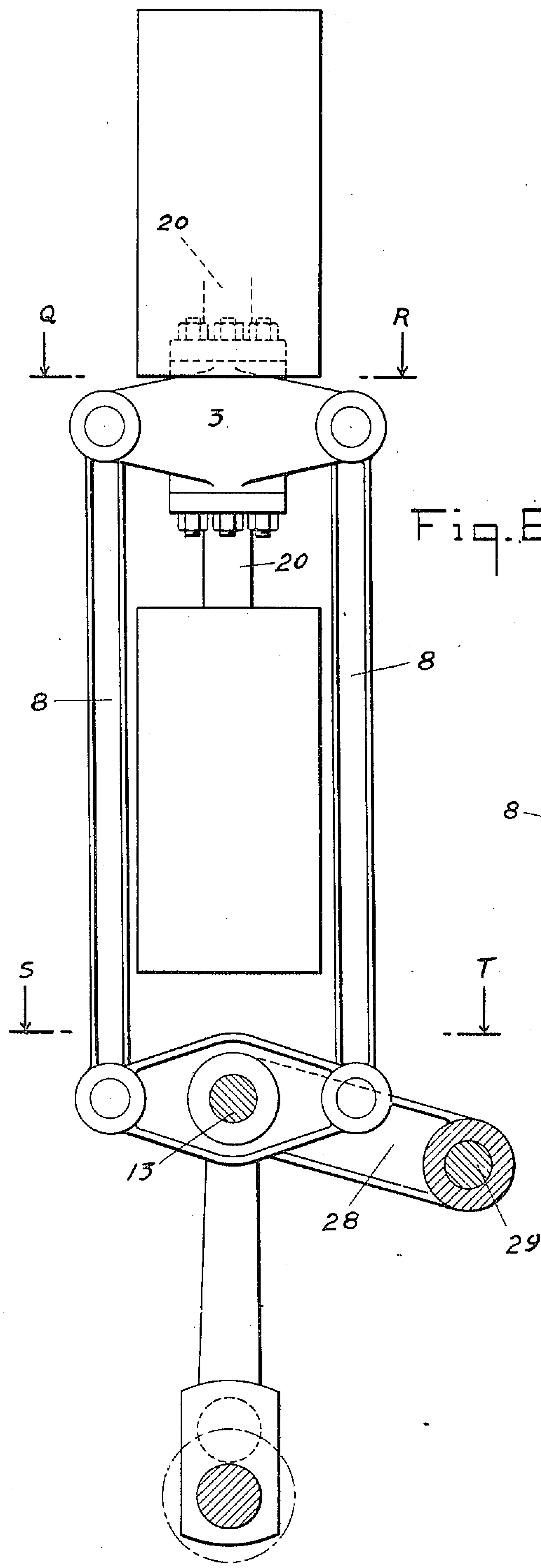


Fig. 6

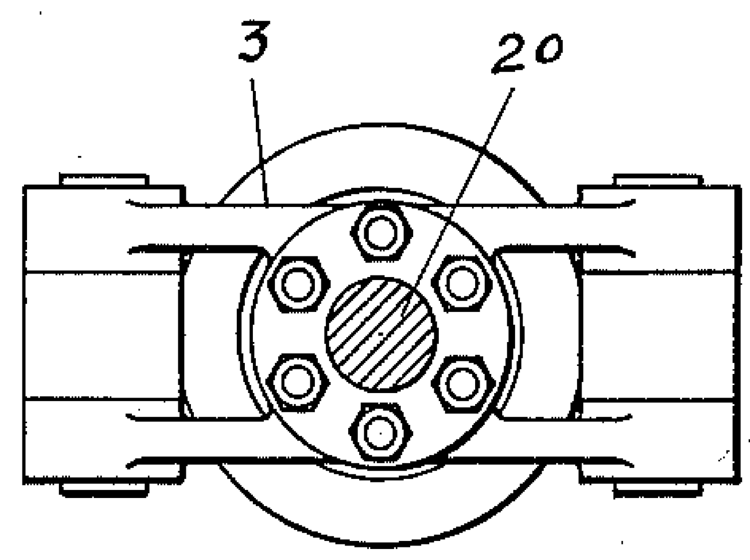


Fig. 7

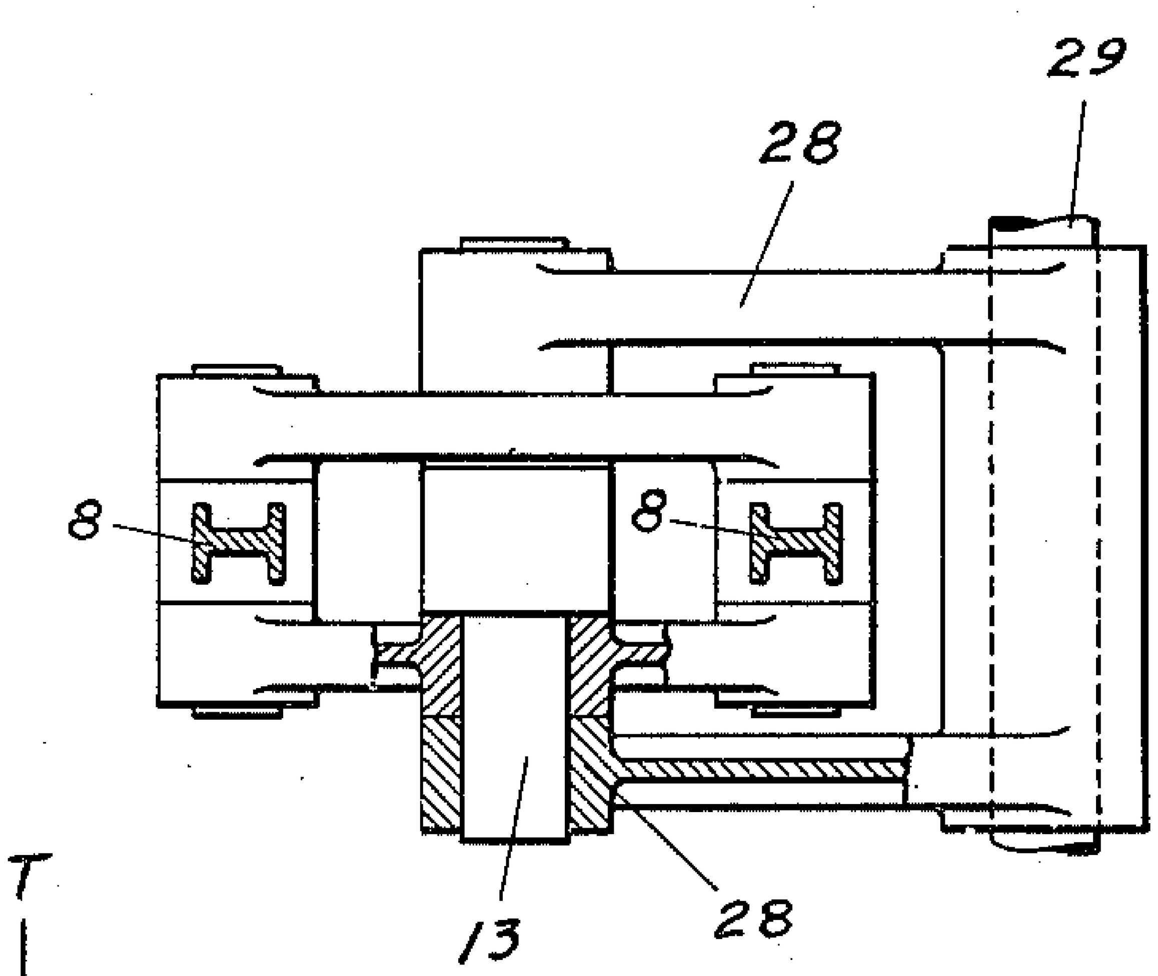


Fig. 8

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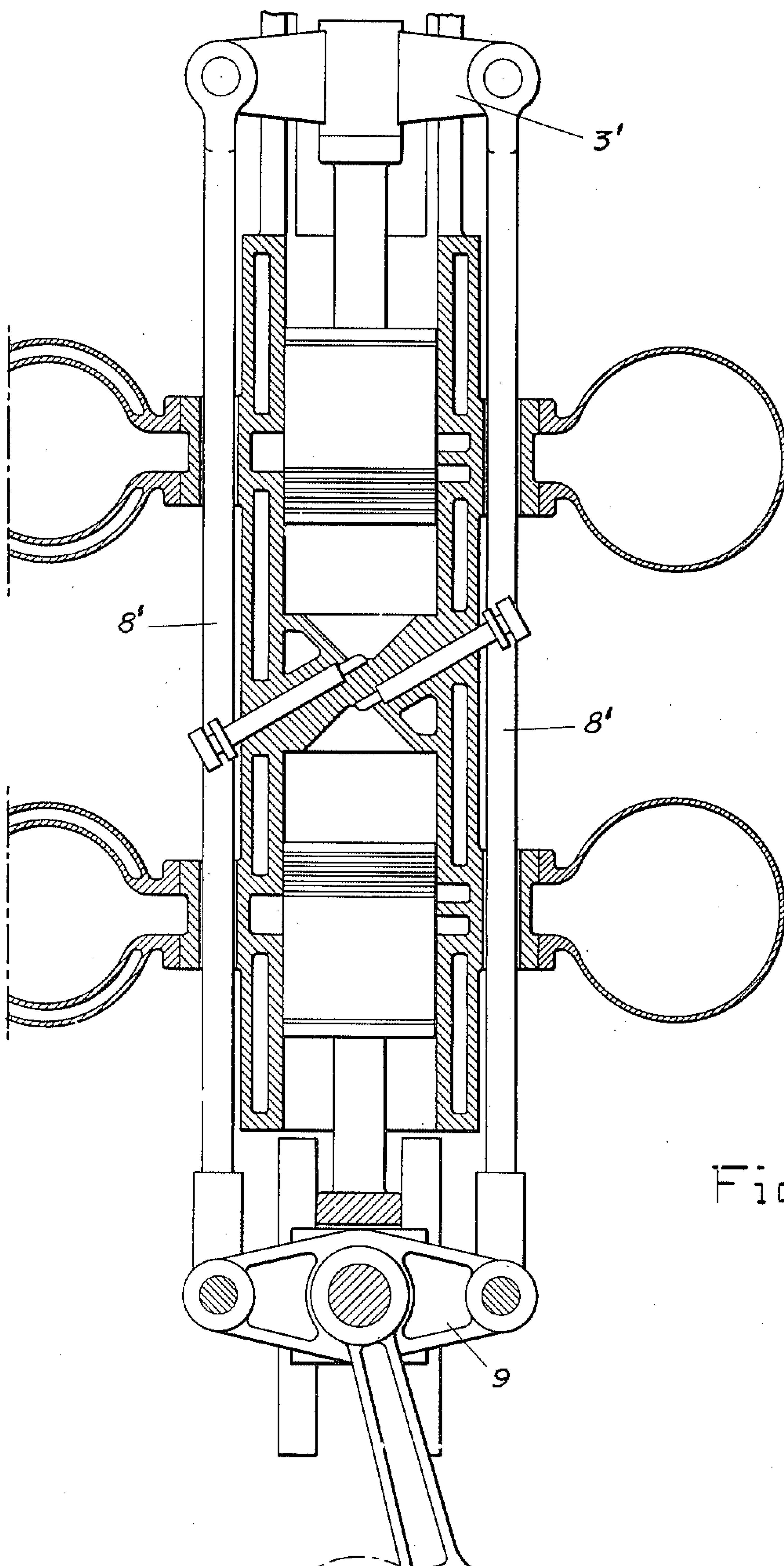


Fig. 9

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# UNITED STATES PATENT OFFICE

2,184,093

## DOUBLE-ACTING TWO-CYCLE DIESEL ENGINE

Charles G. Curtis, New York, N. Y.

Application April 3, 1937, Serial No. 134,708

7 Claims. (Cl. 123—61)

The main object of my invention is to provide a form of double-acting engine which does not involve piston rods or stuffing boxes and in which the power and fuel efficiency developed are equal on both strokes, thus eliminating piston and stuffing box troubles and giving from 10 to 15 per cent more power than is obtainable with a piston rod type of engine in which the combustion and the available cylinder volume is materially impaired by the presence of the piston rod.

In the drawings Fig. 1 represents a sectional view in elevation through a section taken at right angles to the shaft axis.

Fig. 2 is a view in elevation partly in section taken through a vertical plane passing through the shaft axis.

Fig. 3 is a sectional view of the pistons or double piston taken through its axis.

Fig. 4 is a sectional view of one of the cylinders taken through the plane M—N, Fig. 3.

Fig. 5 is a sectional view taken through the plane O—P, Fig. 1.

Fig. 6 shows a modification of the mechanism for transmitting the cylinder power to the crankshaft in which the ordinary straight line crosshead is eliminated and a rocking crosshead substituted.

Fig. 7 is a transverse section taken on the plane Q—R, Fig. 6.

Fig. 8 is a transverse section taken on the plane S—T, Fig. 6.

Fig. 9 is a view in elevation partly in section showing a modification of my arrangement with the cylinders reversed in direction as compared with the opposed cylinder arrangement shown in Figs. 1 and 2.

Fig. 10 is a sectional view of the double piston showing special means I provide for piston cooling in this type of engine.

Fig. 11 is a sectional view through the headers of the lower cylinder, taken on the plane X—Y, Fig. 1.

In the form of engine shown in Figs. 1, 2 and 6, I construct the engine in the form of a single piston or what is in effect two pistons connected or bolted together through an intermediate portion, the lower piston being marked 1, the upper piston 2, and the intermediate connecting portion or center-ring 3. Fig. 3 shows how these parts are bolted together so as to form practically a single piston operating in what may be regarded as opposed cylinders or as a single cylinder having two opposing portions. The center portion, or ring 3, I form with flanges which are bolted by bolts 4—4 to corresponding flanges formed on the pistons. The center-ring 3 has also formed on it two projecting arms 5, one at each side which are of sufficient strength to transmit the maximum pressure exerted on either piston to pins 6—6. It is important of course that the center-ring 3 should be of light weight and at the same time be formed in such a way that the two arms 5 and 6, which in reality act as semi-girders, will be strong enough to withstand the heavy strains resulting from the gas pressure on pistons alternately. To give the necessary strength I provide a web 7 of the full depth of the center-ring and extending across from one side to the other so that there is practically a continuous cross girder uniting the arm 5 on one side to the arm 5 on the other side.

Connecting with the pins 6—6 I provide two side rods 8—8 which are forked at their upper ends to grasp the pins and which connect at their lower ends with a double yoke 9—9, which straddles the upper end of the connecting rod 10. The connecting rod 10 grasps the crankpin 11 of the main crankshaft 12 according to the usual practice in double-acting engines. Through the center of the double fork 9—9 a crosshead pin 13 passes so as to transmit the motion from the two side rods 8—8 to the main connecting rod 10. The pin 13 is extended at both ends and carries crosshead shoes or slippers 14—14 which slide on the lubricated guides 16—16 in the usual manner. In this way the double yoke 9—9 is guided vertically in a right line movement and the side thrust due to the obliquity of the connecting rod is taken on the slipper blocks and guides 16 in the usual manner.

If the engine is port-scavenged, I provide holes or passageways through the inlet and exhaust passages through which the side rods 8—8 pass, these passages being formed through the central ports of the inlet and exhaust passages so as not to interfere materially with the free flow of inlet air and exhaust gas. These holes or passageways are formed in solid bosses 40 formed in the cylinder casting and are shown in sectional view in Fig. 11. In this way a considerable clearance can be provided where the connecting rods pass through the headers without resulting in any leak of scavenging air or exhaust gas at these points. I make the upper and lower cylinders exactly alike so that the conditions for combustion and the cylinder volume available are exactly equal in both ends. This enables me to secure the same power and the same fuel efficiency from the lower end as from the upper end. The "uniflow" type of scavenge may of course be used instead of the port-scavenge type.

One of the objections to this form of engine would be its height, but I have discovered that by slotting each cylinder upward and downward so as to provide for movement of the arms of the center-ring 3 the height may be materially reduced and also the length of the double piston. These slots are shown as 17—17 and in order to overcome any tendency of the center-ring and pistons to twist, which might occur on the down stroke, I provide these slots with lubricated surfaces forming bearings for the arm 5 to guide the arm in a straight line and prevent its turning. These guides should be provided on only one side of the cylinder, so that the piston may remain entirely free to float in the cylinder.

In Fig. 6 I have shown an arrangement in which the center-ring or portion 3 is made in a different form and does not enter slots in the cylinders, the cylinders in this case being set further apart so that the height involved is somewhat greater. In this arrangement the center-ring or plate 3 is made in the form of a yoke with flanges which bolt to piston rods 20—20 attached to the piston heads.

As regards the foundation the upper and lower cylinders are provided with flanges 22 by which they are firmly bolted together and the lower cylinder is provided with a flange 23 by which it is bolted to the top of the housing or engine frame 24. The pressure on the lower cylinder head being downward there is no strain on the bolts attaching the flange 23 to the frame 24, but there is a heavy strain on the upper cylinder head due to the gas pressure. This strain may be taken in the usual manner by long bolts or studs which reach downward from the upper end of the upper cylinder and are tapped into the main frame 24, or if desirable, are carried down through holes to the engine base.

One of the advantages of the straight line crosshead arrangement shown in Fig. 1 is that there is no side pull on the pistons either way and therefore the piston floats freely in the cylinder and is not caused to move from side to side which tends to wear out the piston-ring seats.

In the form of transmitting mechanism shown in Fig. 6 in order to avoid the trouble and expense involved in constructing the straight line crosshead mechanism, I use a double rocker arm 28 rocking on a fixed pivot 29 to take the side thrust of the connecting rod on the pin 13, this being a simpler and less expensive construction. The pin in this case travels through a small arc and the result is that the lower end of the side rods 8—8 moves sidewise to a certain extent. In view, however, of the length of these rods the side pull on the pistons becomes an insignificant amount.

One form of piston cooling which I employ is air circulation which is brought in through passages 30—30 formed in the pistons which direct the air upward against the under side of the piston crown, preferably with more or less rotary motion, this air passing downward and out through the ports 31—31. For this purpose ordinary scavenging air may be used and if the diameter of the cylinders is not too great a very material cooling effect may be obtained sufficient to prevent the piston from overheating. In order to introduce the scavenging air into the passage 30—30 I close in the space between the scavenging headers 40—40 by a strip or plate 41 so that this side of the cylinder through the whole length of the engine is enclosed and carries scavenging air under pressure, the air being passed into this space from the header through the connecting elbow 42. After this scavenging air has passed through the pistons and out through the passages 31, it passes into a similar space confined by a plate 43 and passes out through the pipes 44 where it is carried out of the engine room. This is to avoid the hot air resulting from the piston cooling getting into the engine room. Special enclosing hoods may of course be used in place of the arrangement shown.

In Fig. 10 I have shown another method of cooling the two pistons. In this case I introduce oil or water through a swinging telescopic arm 60 which connects with one of the arms 5 of the center-ring by a universal joint. Oil or water is forced from the fixed pipe 61 through the telescopic arm 60 and the universal joint 62 into a passage leading through the arm and through a forked pipe 63 to both piston heads, the oil or water being brought back through a return forked pipe 64 to another universal joint 62 and swinging telescopic arm 60. In this way a continuous stream of oil or water is maintained through both pistons. The angular movement of the telescopic arm 60 is comparatively small and the change of volume of the pipe due to the telescopic movement is so slight as to be negligible. The result is a continuous stream of oil or water under practically uniform pressure through both pistons with a form of mechanism involving comparatively little wear and readily accessible.

In Fig. 9 I have shown another form of mechanism for transmitting the pressure on the cylinders to the crosshead yoke 9. In this arrangement the cylinders are set with their heads adjacent to each other, the lower cylinder pointing down and the upper cylinder pointing up. Yoke 3′ which takes the place of the yoke 3 in Fig. 1 is connected with the crosshead yoke 9 by two tension side rods 8′—8′, which in this arrangement would always be under tension a varying amount. When expansion takes place in the upper cylinder it draws the yoke 3′, rods 8′—8′ and the crosshead yoke up, thereby causing compression in the lower cylinder. When the lower cylinder expands downward the yoke 9 through the rods 8′—8′ pulls the yoke 3′ downward and causes compression in the upper cylinder. By placing the yokes 3′ and 9 and the rods 8′—8′ in a plane at right angles to the axis of the main shaft, as in the arrangement shown in Fig. 1, I am enabled to provide the necessary transmitting mechanism without increasing the length of the engine over what it would be in a double-acting engine of the piston rod type. I am also enabled to bring the transmission rods 8′—8′ through such parts of the air belts where they do not interfere materially with the flow of scavenging air and exhaust gas, these rods passing through holes in bosses formed in the inlet and exhaust passages so that no packing is needed at these points.

The arrangement shown, particularly that in Fig. 1, has very important advantages. It not only eliminates the piston rods and all rod stuffing boxes, but the upper and lower cylinders can be made exactly alike, the form of combustion chamber being identical so that the power developed by the lower cylinder and the fuel efficiency obtained would be exactly the same as that developed by the upper cylinder. The crosshead yoke 9—9 being pivoted on the gudgeon pin can adjust itself freely so that the pull on the pins 6—6 is equalized and there is no tendency to tilt the double piston or to thrust it against the side of the cylinder. In other words, both pistons or the double piston will float freely and will not be thrust from one side to the other at every stroke and there will be no tendency to wear out the ring seats.

It will be observed that the slots in which the arms of the center-ring 3 reciprocate reach up or down to points corresponding to the extreme position of the innermost piston rings. In other words, the piston rings always remain seated and bearing on the cylinder even when the piston is at the bottom of its stroke. This being so none of the hot gas in the cylinder can escape through the slots 17—17.

The method of supporting both top and bottom cylinder shown in the drawings which I regard as preferable consists of mounting the lower cylinder by a flange directly on top of the housing or foundation where it can readily be bolted in place. The upper cylinder I prefer to mount by means of flanges 22—22 where the two are bolted together. In order to carry the gas pressure on the upper cylinder head the usual bolts or studs 15 may be employed holding the upper cylinder casting down to the top of the frame 24.

Another advantage of my new form of engine over the piston rod type is that the crosshead guides do not have to be lined up exactly in line with the axis of the cylinder and do not have to be made precisely parallel with the cylinder. In other words, if the gudgeon pin 13 is a little bit one side or the other of the center it simply tilts the rods 8—8 to a slight degree and does not put a side strain of any appreciable amount on the piston.

I have spoken of the engine as being of the vertical type. Of course, it may stand horizontal, or at an angle and the same mechanism would apply.

What is claimed is:

1. A double-acting engine having two single-acting cylinders and pistons working in opposite direction and mechanically connected so as to move together and by side rods outside the cylinder to a crosshead or yoke carrying the crosshead pin which operates the main connecting rod, such side rods passing through clearance holes in bosses formed in the scavenging passage so as to eliminate the packings at these points.

2. A double-acting engine having cylinders and opposite alined pistons, an engine crank shaft, and means connecting said pistons to one another and to said crank-shaft comprising two yokes having ends extending laterally beyond the cylinder walls and one of which is pivoted on an axis transverse of the cylinder axis, rods at the exterior of the cylinders, pivotal connections between the ends of the rods and the extended ends of said yokes, means connecting the pistons to the rod and yoke assembly so that they move in unison, a cross head, a connection between one of said yokes and said cross head, and a main connecting rod connecting said cross head with a crank on said crank-shaft, said cross-head acting to guide the reciprocations of said rods in a substantially straight line, and said pivoted yoke and pivoted rods acting to equalize the force transmitted by each rod to said cross head.

3. A double-acting engine according to claim 2, wherein said cross-head is arranged in line with the axis of said cylinders and pistons and said pivoted yoke and rods are arranged in a plane substantially at right angles to the axis of said crank-shaft.

4. A double-acting engine according to claim 2, further comprising gas passages, in communication with the cylinders, and bosses in said passages having clearance holes through which said rods pass.

5. A double-acting engine according to claim 2, further comprising a manifold enclosing the space at the ends of the cylinders through which the pistons work, and means for ventilating gases escaping into said manifold.

6. A double-acting engine according to claim 2, further comprising a manifold enclosing the space at the ends of the cylinders through which the pistons work, said cylinders and pistons dividing the space in said manifold at one side of said cylinders and pistons, openings through said pistons through which air can pass from one side of said manifold to the other and an escape passage from said manifold, said arrangement being such that the gases escaping into said manifold are ventilated and said pistons are cooled by air admitted to said manifold.

7. A double-acting engine having cylinders and opposed pistons, an engine crank shaft, means connecting said pistons to one another and to said crank shaft, a manifold enclosing a space at the ends of the cylinders through which the pistons work, said cylinders and pistons dividing the space in said manifold, means for admitting air in the space in said manifold at one side of said cylinders and piston, openings through said pistons through which air can pass from one side of said manifold to the other, and an escape passage from said manifold, said arrangement being such that the gases escaping into said manifold are ventilated and said pistons are cooled by air admitted to said manifold.

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