M. J. MILLER & H. M. NEER.

RECIPROCATING ENGINE.

APPLICATION FILED JULY 16, 1912.

1,245,257.

Patented Nov. 6, 1917.

3 SHEETS—SHEET 1.

Fig. 1.

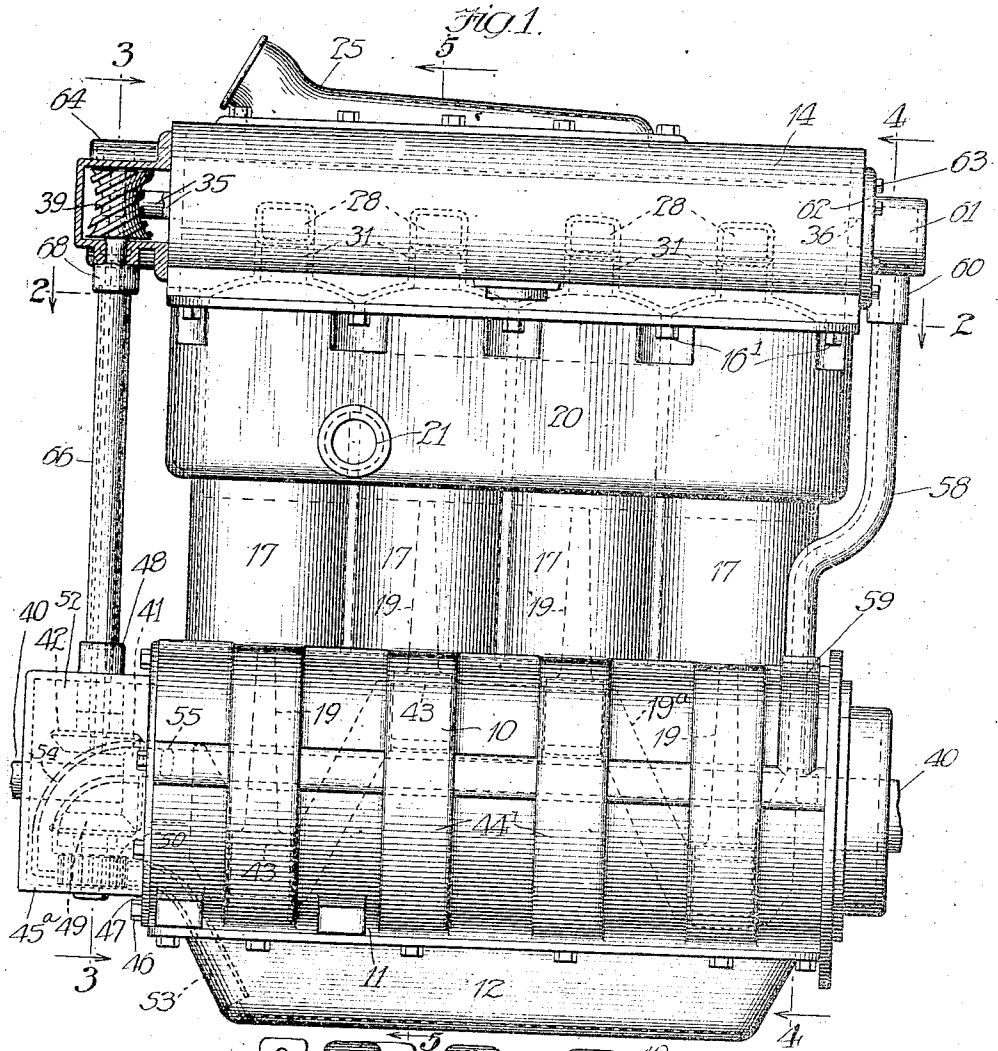
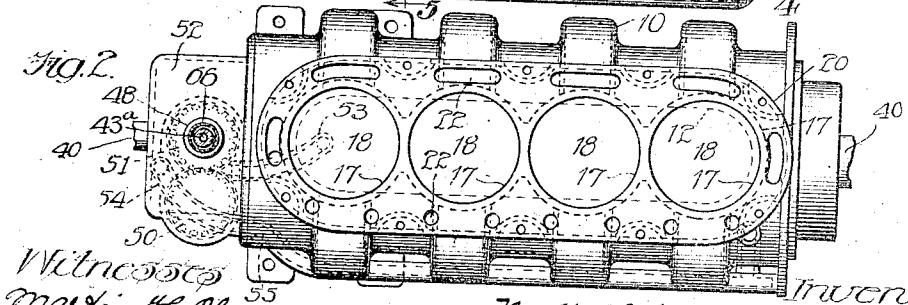


Fig. 2.



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Fig. 3.

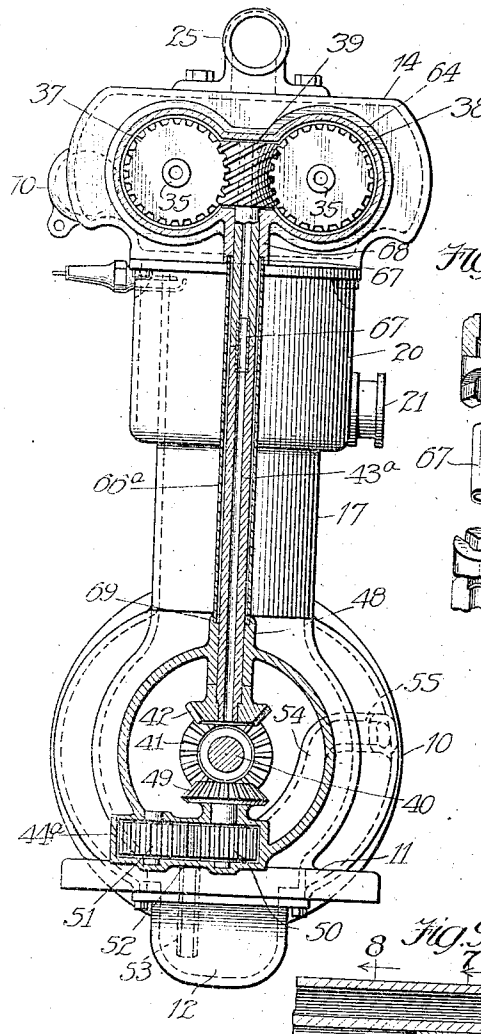


Fig. 10.

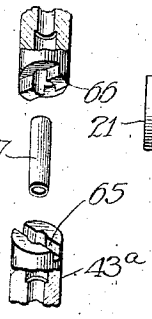


Fig. 4.

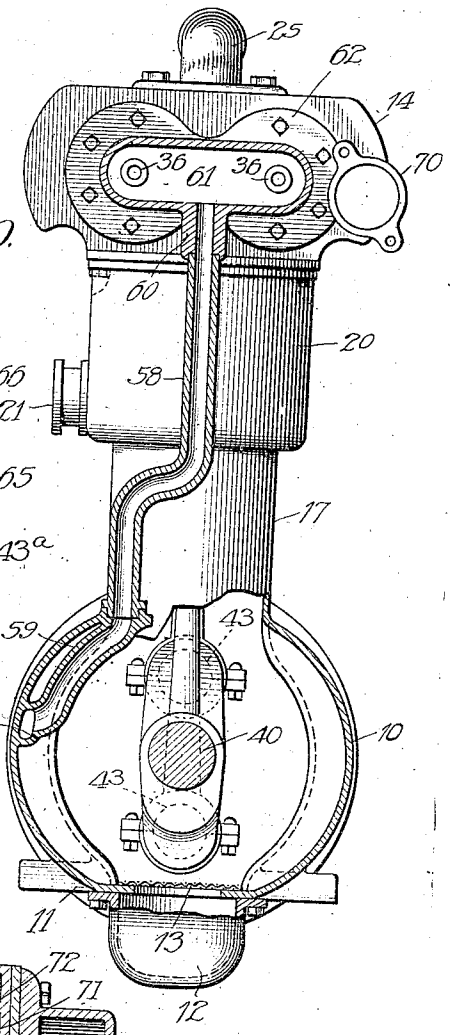
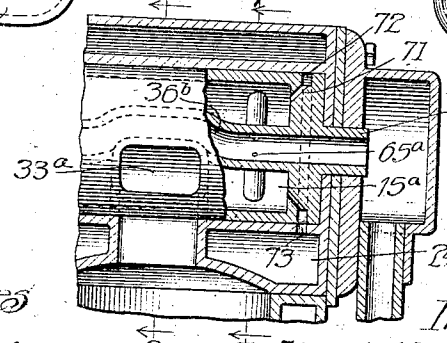


Fig. 9.



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3 SHEETS—SHEET 3.

Fig. 5

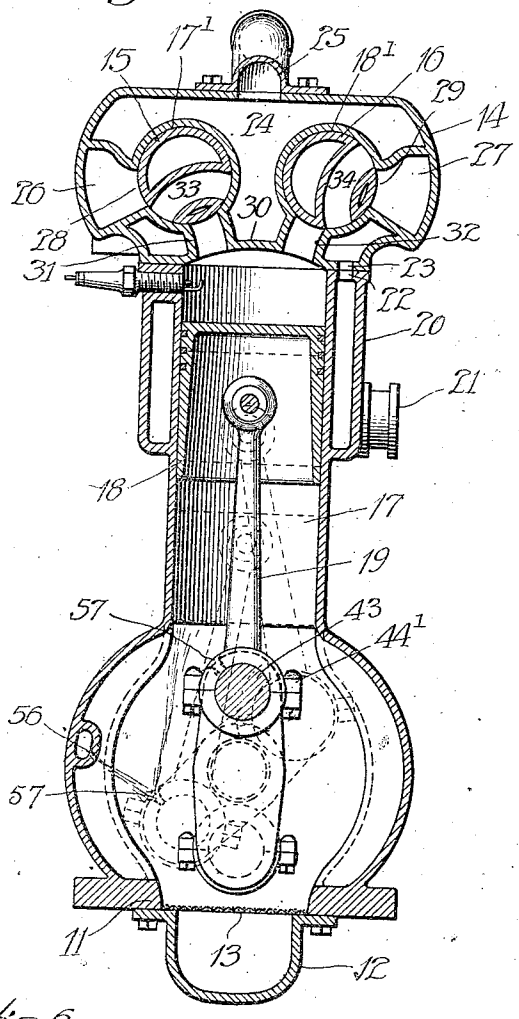


Fig. 6.

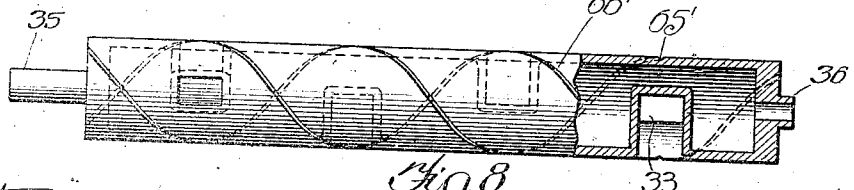
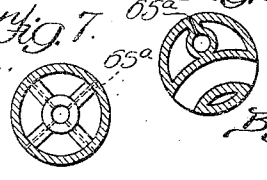


Fig. 8.

Fig. 7.



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UNITED STATES PATENT OFFICE.

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RECIPROCATING ENGINE.

1,245,257. Specification of Letters Patent. Patented Nov. 6, 1917.

Application filed July 16, 1912. Serial No. 709,637.

To all whom it may concern:

Be it known that we, MARTIN J. MILLER and HARRY M. NEER, citizens of the United States, residing, respectively, at Aurora, in the county of Kane and State of Illinois, and Columbus, in the county of Franklin and State of Ohio, have made certain new and useful Improvements in Reciprocating Engines, of which the following is a specification.

Our invention relates more particularly to a system of lubrication or oil distribution in gas engines and, in the accompanying drawings and specification, is shown and described with relation thereto, a four-cylinder, four-cycle engine of an ordinary type, being used for the purpose of illustration and exemplification. It will be readily understood, however, from the following description that our invention is not limited to this type of gas engine or in fact to the class of gas engines but is applicable in certain of its features and in its broadest aspect to reciprocating steam and other engines of a great variety of types and constructions. It is one characteristic of our invention that the oil employed for lubrication is pumped or circulated in considerable quantities throughout the parts which it is desired to lubricate and in the preferred form of our invention, of which two modifications are shown, the oil not only performs the function of a lubricant but also serves to cool certain of the parts with which it is brought in contact, dispensing so far as these parts are concerned, with other cooling agents. Other features of our invention will appear from the following description and the accompanying drawings, which, though they disclose a preferred form or forms of our invention, as stated above, do so for the purpose of exemplification only, the limitation and extent of the invention being defined in the following claims.

In the drawings, Figure 1 is a side elevation showing a four-cycle, four-cylinder engine to which our invention has been applied; Fig. 2 is a plan view of the same in section upon the line 2—2 of Fig. 1; Fig. 3 is a section upon the line 3—3 of Fig. 1 showing however certain details, to be referred to later, in elevation; Fig. 4 is a section upon the broken line 4—4 of Fig. 1; Fig. 5 is a transverse section upon the line 5—5 of Fig. 1; Fig. 6 is an elevation of a preferred form of valve partly in central section; Figs. 7, 8 and 9 represent a modified form of valve, Fig. 7 being in section upon the line 7—7 of Fig. 9, looking in the direction of the arrows, Fig. 8 a transverse section upon the line 8—8 of Fig. 9 and Fig. 9 a vertical longitudinal section through a portion of the valve casing and associated parts showing the valve partly in elevation and partly in section; and Fig. 10 is a detail of a certain part of the machine to be described later.

In the particular machine chosen to illustrate our invention, the cylinders are four in number and cast *en bloc* together with the crank casing as is common in engines of this character. The crank casing is open at 11 upon its under side and has bolted thereto an oil pan or well 12, a screen 13 of fine wire gauze or other suitable material being interposed between the oil pan and crank chamber proper. The valve casing 14 is formed of a separate casting which provides seats or bearings for the rotary intake and exhaust valves 15, 16, and is bolted to the cylinder casting by the bolts 16′. The cylinders 17, pistons 18, connecting rods 19 and crank shaft 19ª are, or may be, of a type well-known in gas engines. About the upper ends of the cylinders is formed a water chamber 20, having an inlet 21 and connected through openings 22 in its upper wall, and registering openings 23 in the bottom wall of the valve casing with the water space 24 of the latter, and a manifold 25 is bolted to the top of the valve chamber and communicates with the interior of the water chamber 24 thereof along a considerable portion of its length to form an exit therefrom for the water of the cooling circulation. Extending longitudinally of the valve chamber and of the series of cylinders are the inlet and outlet valves 15 and 16 before referred to, which are seated within cylindrical chambers 17′—18′ formed within the water chamber of said casing, and the inlet passage 26 for the ignition mixture and the outlet passage 27 for the products of combustion likewise extend throughout the length of the valve casting and communicate with the valve bearings or chambers of the inlet and outlet valves respectively throughout their length. The upper end of the cylinders are open in the

casting in which they are formed but closed by concave caps 30 formed in the valve casting, and passages 31—32 connect the upper ends of the cylinders with the interiors of the bearings of the inlet and outlet valves respectively. Each valve comprises a hollow cylindrical casting open throughout its length but traversed opposite the passages leading to the cylinders by gas ports or ways 33—34 by which at the proper intervals the interiors of the several cylinders are successively connected with the inlet and exhaust passages respectively. At each end each valve is provided with a hollow trunnion 35—36 for the passage of oil as hereinafter described. The trunnions 35 at one end of the valves carry worm gears 37—38 which are keyed thereto and mesh with a common intermediate worm 39 which is driven from the main shaft 40 of the machine. In order that the worm may engage a sufficient extent of the peripheries of the worm wheels on the valves or, in other words, that it may engage simultaneously a sufficient number of the teeth to effect a smooth and easy drive without at the same time necessitating so designing the casing that the valves do not occupy the most advantageous position in which they are comparatively near each other, as shown in Fig. 5, the worm is preferably formed longitudinally concave (see Fig. 3) so that it occupies comparatively little space between the worm wheels and yet has an extended engagement with each of the latter. By reason of this construction it is possible to bring the valves so close together that a symmetrical arrangement results in which the rotary valves are both arranged substantially over the ends of the cylinders permitting short connecting passages therewith and bringing the inlet passage directly over the end of the spark plug. The latter feature is of great importance since it prevents the spark plug becoming fouled by carbon and the shortness of the passage 31 facilitates complete or substantially complete scavenging of the explosion chamber. Moreover this construction of the valve casting avoids any considerable masses of metal or thickening of the walls whereby in previous engines of this type unequal expansion was caused, resulting in binding of the valve when the engine became heated. The main shaft carries a bevel gear 41 at one end which meshes with a corresponding gear 42 upon the hollow vertical shaft 43ª which carries the worm 39 above mentioned for driving the valves.

As will be readily understood by those familiar with gas engine construction, if the engine is of the four-cycle type, each of the valves must be given a single revolution for two revolutions of the main or crank shaft and for this purpose the gearing between the val es and crank shaft may be adjusted by varying the pitch of the worm and worm wheels and by properly proportioning the bevel gears 41—42 upon the crank and vertical shafts respectively. The main shaft may be journaled in any ordinary or approved manner and extends through the crank casing in which it is pro vided with wrists 43 which constitute bearings for the connecting rods 19 referred to above. The crank casing is in the main of a usual construction but provided opposite each cylinder with outward corrugations or hollow ribs 44 to accommodate the path of revolution of split collars 44′ by which the piston or connection rods are attached to the crank shaft.

To provide for the circulation of oil through the engine and its application in generous quantities to the parts to be lubricated, we have provided a circulating system comprising a pump 44ª, which in the present instance we have shown as of the well-known gear type and which is well adapted to the purpose though other forms of pump may be employed. The pump is mounted in a housing 45ª which is attached to the end of the crank casing by bolts 46 passing through its flange 47, and which covers and protects the bevel pinions 41, 42 upon the main shaft and valve drive shaft respectively, and is formed with a hollow boss 48 which constitutes a bearing or journal for the lower end of the valve drive shaft. The pump is driven from the same bevel gear 41, which as above described is employed to drive the valve mechanism and for this purpose is provided with a bevel pinion 49 meshing with pinion 41 and mounted upon the journal of one of the pump gears 50. The twin gear 51 is driven from gear 50 in the usual manner of pumps of this character and the pump casing 52 is cast integral with the housing 45ª, as shown more particularly in Figs. 1 and 3.

At the intake side the pump chamber communicates with a supply conduit 53, which, as shown in dotted lines in Fig. 1, dips to a point near the bottom of the oil well or pan 12 and on the outlet side the chamber communicates with a conduit 54 which leads to a passage 55 cast integral with and extending longitudinally of the crank chamber 10. The position and construction of this passage is best shown in Figs. 1 and 5, it being substantially straight throughout the crank chamber and located upon the inside thereof within the outwardly extending corrugations provided to accommodate the revolution of the collars upon the crank shaft as before described and outside the crank chamber intermediate said corrugations, though this precise arrangement is not essential.

The oil passage 55 is perforated at points

opposite each bearing upon the crank shaft and the perforations 56 are directed downwardly and inwardly at an angle of approximately 45° but which may be varied according to the particular design of the machine, and the passage being normally full of oil under some pressure due to the head of oil in the lubricating system, a stream of the lubricant is directed toward each bearing upon the crank shaft. The upper half of the strap or collar 44′ by which the piston rod is attached to the crank shaft in each instance is provided with a flaring opening 57 extending through the strap to the bearing surface as shown in Fig. 5, and as the crank shaft carrying the straps revolves, each such opening is brought at one point of the revolution into the path of the stream of oil issuing from the corresponding perforation 56, whereby the bearing on the wrist of the crank shaft is maintained in a condition of very thorough lubrication. Furthermore, the construction is such that each wrist and strap is brought into the path of the injected stream of oil as it is rising and since the shaft is revolving at considerable speed the oil is splashed and thrown upwardly within the lower portion of the engine cylinder and thoroughly lubricates the latter.

From the longitudinal passage in the crank case the oil is conveyed by means of a conduit 58 to the interior of the valves, said conduit connecting for this purpose at its lower end with an upward extension 59 of the passage in the crank chamber, and at its upper end the conduit 58, which in the present instance takes the form of a bent pipe or tube is received into a socket 60 which communicates with a horizontal chamber 61 formed within a casting 62 which is attached by bolts 63 to that end of the valve chamber which is opposite the driving mechanism for the valve. The chamber 61 is open on that side which abuts against the end of the valve casting and the end wall of the latter is perforated for the reception of the hollow journals 36, 36, of the rotary valves which extend through said end wall and into the chamber 61 with which their openings communicate. As shown in Fig. 6 the bores of the hollow journals are open to the interior of the valves and a free passage of oil to the latter is provided. The journals 35 upon the opposite ends of the cylindrical valve are also bored longitudinally and extend through the end wall of the valve casting into a housing 64 which surrounds the valve operating mechanism heretofore referred to including the worm wheels on the valve journals and the intermediate worm as shown more particularly in Figs. 1 and 3. The oil is forced through the valves and from the housing 64 through the vertical valve operating shaft 43ª which is made hollow for this purpose, the bore thereof being open at the upper and lower ends of the shaft respectively. In order to provide for the lubrication of these valves their walls are minutely perforated as at 65′ (see Fig. 6) to form a communication between the interior of the valves carrying the lubricating oil and the exterior thereof, and the perforations may be arranged at a suitable intervals but preferably there will be such an oil hole opposite each of the gas passages or ports 33 since at these points the consumption of lubricant is greatest; and we form shallow, spiral grooves 66′ extending the length of each valve body and communicating with the oil holes or perforations therein for the purpose of distributing the oil as evenly as possible throughout the length of the valves, it being apparent that the revolution of the valves is sufficient to cause the lubricant to feed along the helical grooves. By a reference to Figs. 1 and 3 it will be seen that the bore of the vertical shaft 43ª opens from the housing 64 containing the valve gearing at a point almost on a level with the top of the chamber and as this overflow opening, as it may be called, determines the height of the oil in said chamber and therefore the height of the oil in the valves, the latter are kept substantially filled with oil at all times, which not only lubricates them as above described but being constantly circulated by the pump serves also to cool the valves.

In order to provide for the ready removal of the valve casing from the main or cylinder casting, which castings, as stated above, are distinct and separable, the vertical shaft 43ª is made in two sections spliced together at their meeting ends by means of a downwardly extending tenon 66 upon the upper section engaging a corresponding cross groove or mortise 65 in the lower section, as shown more particularly in the detailed view, Fig. 10, there being an intermediate sleeve 67 extending across and covering the joint within the oil passage which is enlarged adjacent the abutting ends of the sections for this purpose. In order to separate the main casting and valve casting the bolts connecting them are unscrewed then the valve casing may be lifted off the spliced shaft 43ª offering no obstacle but parting at the splice. In order, however, that the engine may be readily re-assembled without danger of joining said shaft with the parts in improper relation, the abutting ends may be grooved or otherwise marked, it being then merely necessary to secure registry of the marks in order to assemble the sections of the shaft in proper relation. Any slight leakage of oil that may occur about the vertical shaft is taken care of by the surrounding sleeve 66ª extending between the socket 67ª formed in the shaft bearing 68 upon the

housing 64, and a similar socket 69 formed in the bearing 48 of the housing 45a. At its lower end the sleeve communicates with the lower bearing of the shaft 43a and, at its upper end, with the upper bearing of said shaft and as the latter is open to the interior of the housing 64 there is a constant movement of oil downward through the bearings of the vertical shaft and into the housing 45a. The latter is open to the interior of the crank casing so that the oil received therein flows into the crank casing and together with the surplus oil from the cylinders, crank bearings, etc., passes through the screen 13 into the well or pan 12 from which it is again drawn by the pump and circulated through the lubrication system as above described.

Ordinarily the screen 13 will be found sufficient to prevent objectionable impurities from being circulated with the oil throughout the lubricating channels, but if desired additional purifying means may be inserted in the system at any suitable point but preferably between the pump and the oil passage 55 so that the entire body of oil passing through the pump may be purified.

Obviously, the connections for supplying the explosive mixture and withdrawing the products of combustion may be of any ordinary character and in Fig. 4 at 70 we have shown an ordinary form of connection communicating with the longitudinal exhaust passsage 27 for products of combustion, a similar or any suitable connection being adopted for the inlet passage 26.

The continuous flow of oil through the valves and its circulation through the other parts of the engine prevents undue heating of the valves as well as lubricates them, but in some instances it may be preferred to cool the valves by the water circulation of the engine. In Figs. 7, 8 and 9, we have shown a modified form of valve which is adapted to be so cooled but in which the distribution of oil for the purpose of lubricating the valves is similar to that already described. Instead, however, of the valve bodies constituting portions of the lubricant circulating system the hollow trunnions 36a thereof communicate with a centrally located oil conduit 36b which may be cast integral with the valve body and is diverted around the gas passages 33a as shown more particularly in Figs. 8 and 9. This conduit communicates by a series of perforations 65a with the exterior of the valve body to furnish lubricant for the surface thereof. The interior of the valve body or hollow shell 15a communicates by a series of openings 71 at each end with an annular channel 72 which in turn communicates with the water chamber 24a of the valve casting through a series of openings 73. By this construction the valve is lubricated substantially as in the modification first described but the valve body is maintained comparatively cool by reason of the fact that it forms a part of the water-circulating system.

It will now be obvious that by forming the valves hollow and cooling and lubricating them in either of the manners above described their expansion under the conditions of working will be substantially equal to that of the valve casing and there will, in consequence, be neither undue leakage nor binding as in the case of engines having solid rotary valves. Furthermore, our system of lubrication provides not only for the supply of a suitable quantity of oil to all parts of the engine requiring the same but constantly flushes the lubricated parts and thus maintains them in the best possible condition for the performance of their functions.

We claim:

1. In a reciprocating engine and in combination with the cylinder and piston thereof, a rotary valve having transverse passages for the control of the motive fluid of the engine, an oil passage extending through the valve having perforations extending to the bearing surface thereof for lubricating the same, means at one end of the valve for supplying the passage with oil, and an exhaust passage for the exit of oil at the other end of the valve.

2. In a reciprocating engine and in combination with the cylinder and piston thereof, a rotary valve having transverse passages for controlling the supply of motive fluid therethrough, an oil passage extending through the valve and having inlet and exhaust openings, a circulating system connected to said openings at the opposite ends of said valve and including means for causing the flow of oil therethrough, there being perforations in the valve extending from said oil passage to the bearing surface of the valve for lubricating the same.

3. In an engine of the reciprocating type and in combination with the cylinder and piston thereof, a hollow rotary valve for controlling the admission of motive fluid to the cylinder, inlet and outlet openings to the interior of the valve at its opposite ends, and lubricating perforations extending through the wall thereof, an oil circulating system connected to the inlet and outlet openings of the valve respectively, and means in the system for forcing the oil therethrough.

4. In an engine of the reciprocating type including a series of cylinders having pistons therein, a rotary valve extending longitudinally of the series of cylinders and having transverse ports therein for controlling the supply of motive fluid to the cylinders, an oil passage extending longitudinally of the valve and having perforations

at suitable intervals for supplying the valve bearing or seat with oil, inlet and exhaust passages connected with said oil passage at the respective ends of said valve, and means for forcing the oil through said passages.

5. In a reciprocating engine and in combination with the cylinder and piston thereof, a rotary valve having transverse channels for controlling the supply of motive fluid to the engine cylinder, an oil chamber extending longitudinally of the valve, means for supplying said chamber with oil and permitting its overflow, means for receiving and carrying away said overflow, perforations extending from the oil chambers to the bearing surfaces of the valve, and oil channels formed in the bearing surface of the valve.

6. In a device of the class described, comprising a series of cylinders and pistons and a crank shaft common to the series, a casing surrounding the crank shaft, a valve casing secured to the series of cylinders, a rotary valve in said casing, transverse passages through said valve for controlling the flow of gas to the cylinders, an oil passage extending longitudinally of the crank casing and perforated at suitable intervals to spray oil upon the crank shaft, a longitudinal oil passage through the valve, an oil conduit connecting the passage in the casing with the passage in the valve and means for forcing oil through said passages.

7. A reciprocating engine comprising a series of cylinders, a valve casing common to the cylinders, a rotary valve extending through said casing and having passages controlling the supply of gas to the cylinders, hollow trunnions on the valve, a worm wheel on one of said trunnions, a worm meshing with said worm wheel, a housing surrounding said worm and worm wheel, and means for forcing oil through said valve and housing and withdrawing it therefrom.

8. A combustion engine of the class described, comprising a plurality of cylinders, a valve casing mounted above the same, a pair of rotary valves mounted in said casing and extending over the cylinders of said row and provided with transverse passages for controlling respectively the inflow and outflow of gases with respect to said cylinders, worm-wheels connected to the respective valves, a worm intermediate and meshing with said worm-wheels, a crank chamber, gearing within the crank chamber and a hollow shaft connecting the worm and said gearing.

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