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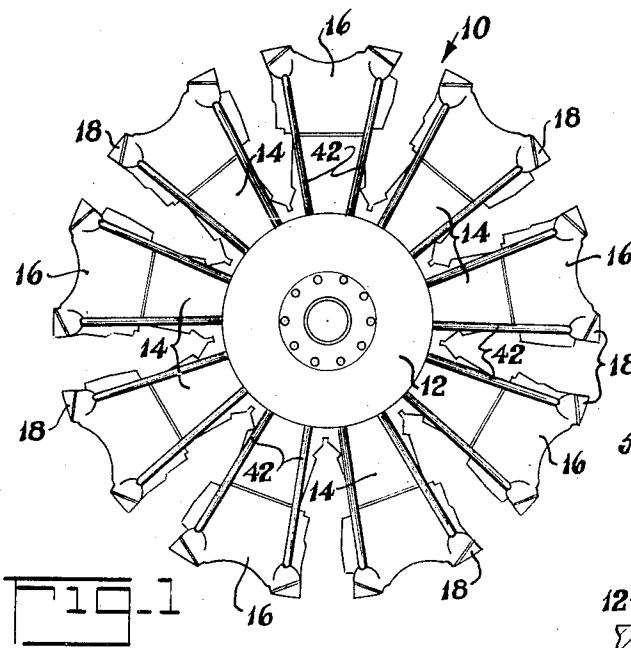
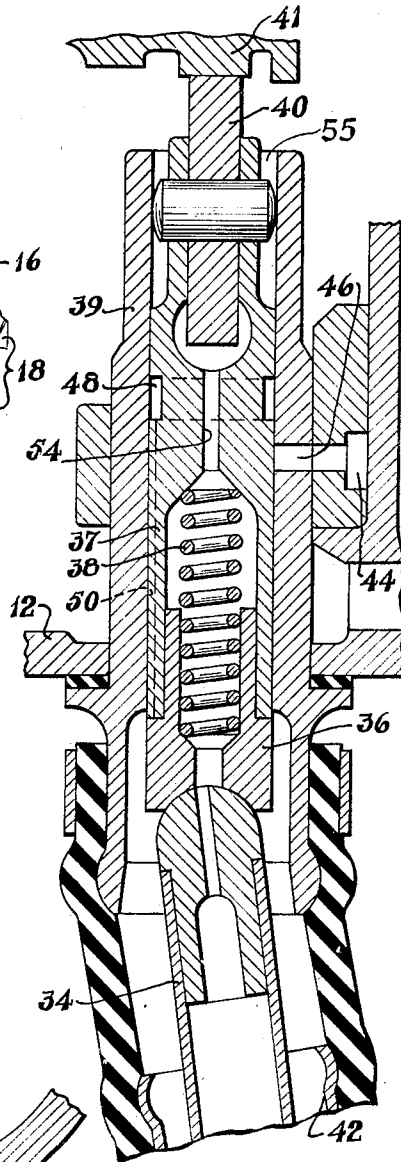
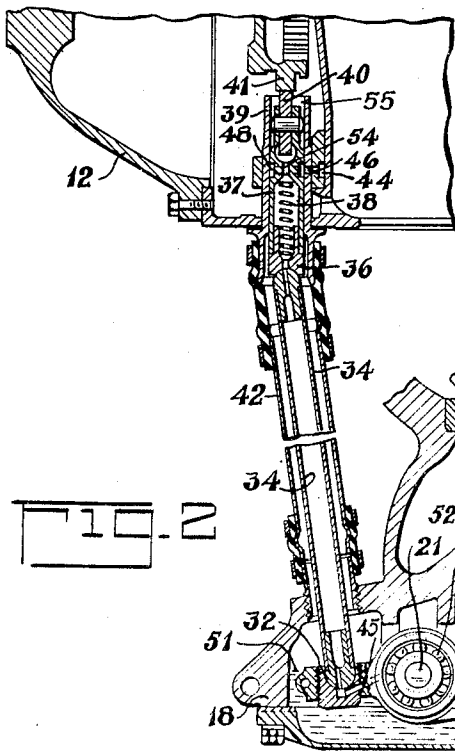
G. B. DU BOIS ET AL

2,502,933

ROCKER BOX LUBRICATION SYSTEM

Filed June 26, 1944

2 Sheets-Sheet 1



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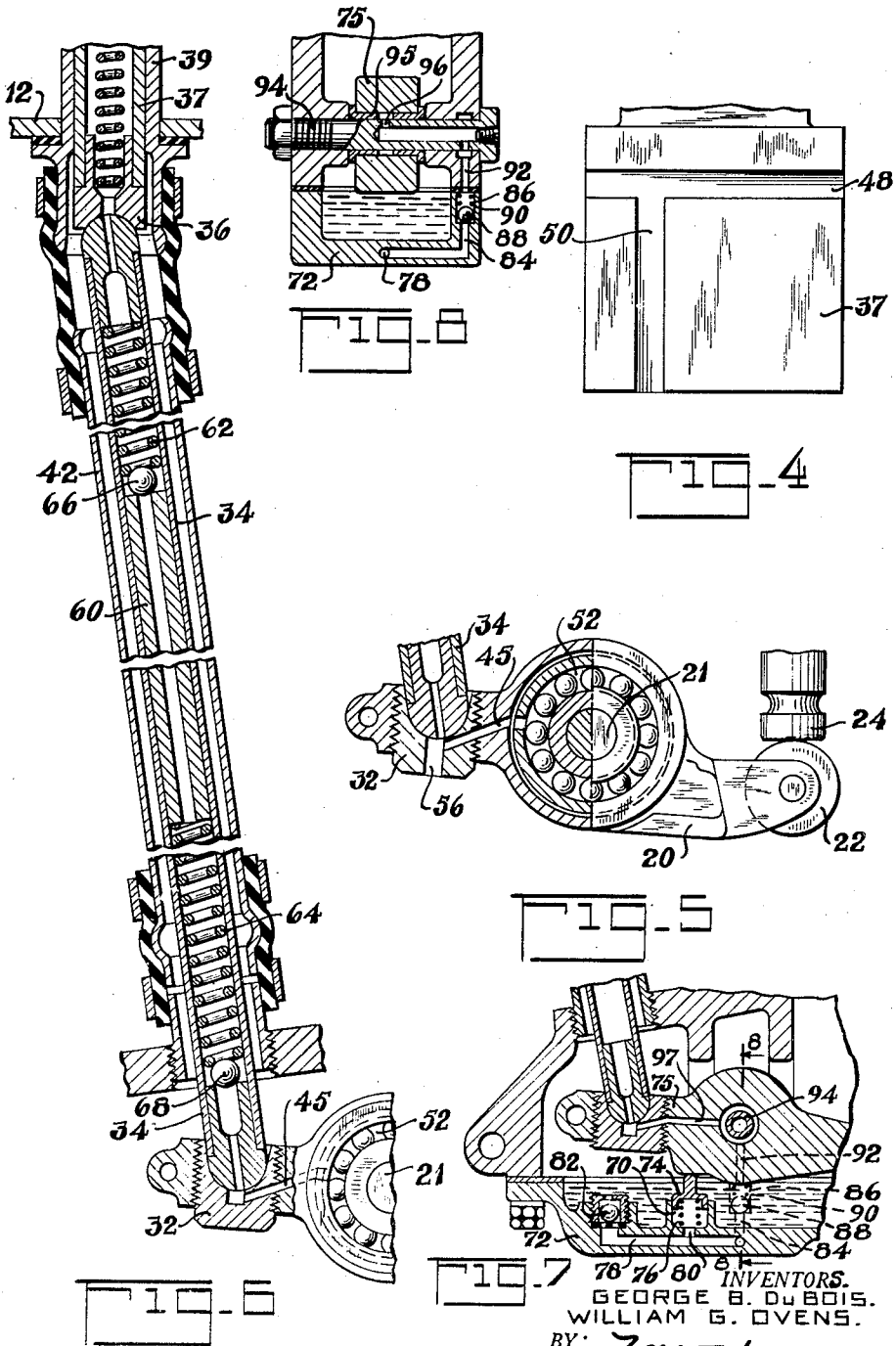
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ROCKER BOX LUBRICATION SYSTEM

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12 Claims. (Cl. 184—6)

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This invention relates to valve gear lubrication, and is particularly directed to means for lubricating the valve gear of the lower cylinders of a radial cylinder engine.

The valve gear for each cylinder valve of a radial cylinder engine generally comprises a rocker arm, pivotally mounted on the cylinder head and disposed within a rocker box, the rocker arm having its one end operatively engaging a valve stem and its other end operatively engaging a hollow push rod, reciprocated by an engine driven cam. The valve gear for the valves of the upper engine cylinders are generally pressure lubricated by metered quantities of oil fed through the hollow push rod, the oil draining by gravity back into the engine crank case from the rocker box through a tubular housing surrounding the push rod. Obviously, such a gravity return oil circulating system cannot be used for lubricating the valve gear of any of the lower engine cylinders. The valve gear of these lower engine cylinders are conventionally lubricated by allowing a limited quantity of oil to drain into the rocker boxes, and therefore, there is no circulation of oil through such valve gear. Accordingly, it is an object of this invention to provide a new and improved method and means for lubricating the valve gear of the lower cylinders of a radial cylinder engine. It is a further object of this invention to provide a new lubrication system for the valve gear of the lower engine cylinders whereby oil is circulated through such valve gear and their associated rocker boxes.

Specifically, the invention comprises means to supply lubricating oil directly to the rocker box housing through the annular passage between the push rod and the usual tubular casing surrounding the push rod. With this arrangement, oil accumulates within the rocker box, and by providing a bleed opening in the valve tappet at the upper end of the push rod, the gas pressure within the rocker is effective to force the oil into the rocker arm bearing, through the oil passages in the rocker arm and push rod and out into the engine crank case through the aforementioned bleed opening. It is also an object of this invention in an alternative proposal to utilize the reciprocal movement of the valve gear for operating a pump to help remove the oil from the rocker box.

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Other objects of this invention will become apparent upon reading the annexed detailed description in connection with the drawing in which:

5 Figure 1 is a schematic front view of a radial cylinder engine;

Figure 2 is a sectional view through the valve gear of a lower cylinder of the engine and embodying the invention;

10 Figure 3 is an enlarged view of the valve tappet embodied in Figure 2;

Figure 4 is a development of the exterior of a portion of the valve tappet;

15 Figure 5 is a view illustrating a modification of a portion of Figure 2;

Figure 6 is a view similar to Figure 2 of a modification;

Figure 7 is a sectional view of a further modification; and

20 Figure 8 is a sectional view taken along line 8—8 of Figure 7.

Referring to the drawing, a conventional radial cylinder internal combustion engine 10 is provided with a crank case 12 about which a plurality of radially disposed cylinders 14 are mounted. Each cylinder is provided with a cylinder head 16, and a pair of rocker boxes 18 are integrally formed therewith for the cylinder intake and exhaust valves. In each rocker box, a 30 rocker arm 20 is pivotally mounted about a rocker arm bolt 21, carried by the walls of the rocker box. One end of each rocker arm is provided with a roller 22, adapted to engage the end of a valve stem 24 of a valve 26. The valve 26 is 35 slidably mounted within a valve guide 28 in the cylinder head and is urged toward closed position by spring means 30.

The other end of the rocker arm is provided with an adjusting nut 32 having a spherical bearing seat adapted to engage the outer end of a hollow push rod 34. The other end of the push rod is engaged by the spherical seat formed at one end of a hollow valve tappet comprising hollow interfitted members 36 and 37 urged apart by 40 a spring 38. The valve tappet 36, 37 is slidably mounted within a valve tappet guide 39 carried by the engine crank case 12. The other end of the valve tappet 36, 37 is provided with cam follower roller 40, which is arranged for engagement 45 by engine driven cam means 41. A tubular cas-

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ing 42 is disposed about the push rod 34 and is secured at one end to the valve tappet guide 39 and at its other end to its associated rocker box. The structure so far described is quite conventional.

In the conventional lubricating arrangement, the supply of oil for the rocker boxes of the lower cylinders consists of the oil which leaks outward between the valve tappet socket and valve guide parts, there being no other passages for either supply or return of oil. In such an arrangement, the supply of oil can be controlled only by indirect means, and there is no circulation and return of oil from these lower rocker boxes.

In the present invention, oil for lubricating the valve gear of the lower engine cylinders is supplied under pressure to the passage 44 formed in the crank case supporting structure about each valve tappet guide 39. Each valve tappet guide 39 is provided with a radial opening 46 communicating with the supply passage 44, and during engine operation, an annular groove 48 about the exterior surface of the valve tappet member 37 is periodically brought into alignment with this opening 46. The valve tappet member 37 is also provided with an axially extending flat or groove 50 on its exterior surface, establishing communication between the groove 48 and the interior of the tubular casing 42. Thus, when the annular groove 48 is in communication with the opening 46, oil is fed therethrough to the flat 50, tubular casing 42, and thence into the rocker box connected thereto. With this construction the axial position of the annular groove 48 about the valve tappet determines the length of time the groove is in communication with the passage 46 during each tappet actuation, thereby controlling the quantity of oil metered to the rocker box.

In Figure 2, the valve tappet 36, 37 is shown in its valve opening or actuated position, and accordingly, the annular groove 48 is in communication with the passage 46, while in the enlarged view of Figure 3 the valve tappet is shown in its non-actuated position. The relative disposition of the annular groove 48 and the groove or flat 50 is best seen in the development of the exterior surface of the tappet member 37 in Figure 4.

The push rod 34 is hollow, and its lower end communicates with a passage 45 leading to the rocker arm roller bearing 52, while its upper end communicates with the hollow valve tappet 36, 37 which is provided with a hole 54 communicating with the interior of the crankcase around the roller 40 and through the open inner end 55 of the tappet guide 39. The hole 54 is disposed at the inner end of the tappet member 37 directly under the cam follower roller 40. That is, the passage 45, the hollow push rod, the hollow valve tappet, and hole 54, together define a vent passage establishing communication between a point within the rocker box and the crank case. Therefore, with an excess quantity of oil supplied to the rocker box, the rocker box will fill with oil approximately to the level indicated at 51 in Figure 2, at which level the rocker box end of the vent passage is submerged in the oil. The gas pressure within the rocker box will prevent the oil from rising appreciably beyond this level, by forcing the oil out into the crank case through this vent passage.

If the valve 26 is an exhaust valve, there will always be a substantial gas pressure within the rocker box, because there always is a tendency

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for the transmission of the engine exhaust pressure into the rocker box through the space between the valve stem and valve guide. Similarly, if the valve 26 is an intake valve and the engine is provided with a supercharger maintaining a manifold pressure above atmospheric pressure, there always is a tendency for the transmission of this manifold pressure into the rocker box through the space between the valve stem and its guide. The provision of such a supercharger is general practice on aircraft engines.

With the above described arrangement, although the groove 48 is positioned so as to meter a surplus quantity of oil to the rocker box, the gas pressure within the rocker box prevents the rocker box from filling up completely by forcing the excess oil out through a discharge passage into the crank case. In other words, there is a continual circulation of oil through the rocker box flood lubricating the rocker arm bearing, and in addition, the rocker box does not fill up with oil.

By discharging the oil through the valve tappet opening 54 into the crank case, the valve tappet guide 39 provides a stand pipe extending into the crank case, thereby preventing drainage of crank case oil back into the rocker box. Also, if desired, an oil passage 56 may be provided through the back of the rocker arm adjusting nut 32 as illustrated in Figure 5. This latter arrangement facilitates the return of oil to the crank case by by-passing the passage 45 in the rocker arm.

Figure 6 illustrates a further modification in which an inertia pump is incorporated within the push rod in order to help remove the oil from the rocker box. This pump comprises a hollow spring balanced plunger member 60 slidably disposed within the push rod and urged to an intermediate position therein by springs 62 and 64, respectively disposed between the plunger and the two ends of the push rod. A ball-type check valve 66 is disposed between the one end of the spring 62 and the adjacent end of the plunger 60, and a second ball-type check valve 68 is disposed between one end of the spring 64 and the adjacent end of the push rod. With this arrangement, the inertia plunger 60 tends to stand still while the push rod reciprocates and therefore, on the downstroke of the push rod, oil is drawn into the lower or outer end of the push rod and is forced out of the upper or inner end of the push rod, while on the upstroke of the push rod, oil is displaced through the plunger 60 from its lower end to its upper end. Except for the provision of the inertia pump in the hollow push rod, the modification of Figure 6 is similar to Figure 2 and like parts have been designated by like reference numerals.

Instead of providing an inertia-type pump within the push rod as illustrated in Figure 6, a conventional piston-type pump may be disposed within the rocker box for pumping the rocker box oil back of the crank case through the hollow push rod. Such an arrangement is illustrated in Figures 7 and 8 in which a pump cylinder 70 is carried by the rocker box cover 72, and a piston 74 disposed within the cylinder 70 is urged outwardly against the rocker arm 75 by a spring 76. A passage 78 formed within the rocker box cover opens into the pump cylinder through opening 80 and into the rocker box through a check valve 82. If desired, a light spring (not shown) may urge the valve 82 upwardly against its seat. The passage 78 also communicates with a passage 84 extending up

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one side wall on the rocker box cover. The side wall passage 84 is counterbored at 86 for receiving a check valve 88 urged downwardly against its seat by a spring 90. The passage 84 communicates with a passage 92 in the side wall of the rocker box proper which leads up into communication with a hollow rocker arm bolt 94 and a radial opening 96 establishes communication between the hollow rocker arm bolt and the rocker arm bearing 95 as best seen in Figure 8. A passage 97 extends from the rocker arm bearing 95 to the hollow push rod as in the previous modifications.

With the construction of Figures 7 and 8, upon reciprocation of the rocker arm, the pump piston operates to pump oil out through the check valve 88 to the rocker arm bearing and through the rocker arm passage 97 and the hollow push rod into the engine crank case. During the downstroke of the piston 74, the check valve 82 closes, while the piston forces the oil within the cylinder 70 up through the check valve 88 and thence through the rocker arm passage 97 and the hollow push rod into the engine crank case. On the spring return stroke of the piston 74, the check valve 88 closes to prevent the return of oil back into the rocker box from the push rod, while the check valve 82 opens to permit the pump cylinder 70 to refill with oil. As illustrated, the rocker arm 75 is provided with a plane bearing 95, which type of bearing has much less end leakage than the roller bearings illustrated in Figures 2 and 6. If a roller bearing were provided in Figures 7 and 8, it might be necessary to provide bearing end seals in order to limit the leakage of oil out through the bearing ends.

In all modifications, lubricating oil enters the rocker boxes for the lower cylinders to lubricate the rocker arm bearing, and the oil level in these rocker boxes rises until it closes the lower or outer end of the escape passage of the rocker box gases through the associated hollow push rods. The escaping rocker box gas pressure, either alone or assisted by pumps, prevents the oil from rising above this level by forcing the surplus oil up through the push rods into the crank case. In this way the rocker arm bearings for the lower cylinders are flood lubricated, and yet the rocker box does not fill up with oil, the surplus oil returning to the engine crank case through the hollow valve operating push rods.

While we have described our invention in detail in its present preferred embodiment, it will be obvious to those skilled in the art, after understanding our invention, that various changes and modifications may be made therein without departing from the spirit or scope thereof. We aim in the appended claims to cover all such modifications and changes.

We claim as our invention:

1. In an internal combustion engine, a valve, a rocker arm operatively engaging said valve, a housing enclosing said arm, a hollow push rod mounted for reciprocation by said engine and operatively engaging said arm, a tubular casing surrounding said push rod, means for supplying lubricating oil to said housing through said tubular casing, and means disposed within said hollow push rod and responsive to reciprocation thereof for removing lubricating oil from said housing through said push rod.

2. In an engine having a crank case, a valve, a valve gear for operating said valve comprising a rocker arm and a hollow push rod, a housing

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for said rocker arm into which the stem of said valve projects for operative engagement by said rocker arm, said push rod being mounted for reciprocation by said engine and extending in a direction downwardly from the engine crank case into said housing into operative engagement with said rocker arm, a tubular casing surrounding said push rod, means to supply lubricating oil to said housing through the annular passage within the tubular casing about the push rod, and pump means responsive to operation of said valve gear for removing lubricating oil from said housing through said push rod.

3. In an internal combustion engine having a crankcase, a valve, a valve operating mechanism, a housing for said mechanism, a push rod extending in a direction downwardly from said crankcase to said housing and operatively engaging said valve operating mechanism for operating said valve, a tubular casing surrounding said push rod and extending in a direction downwardly from said crankcase to said housing but terminating short of the bottom end of said push rod means for supplying lubricating oil to said housing through the annular passage within the tubular casing about the push rod, and means for returning oil from said housing to said crankcase, said last mentioned means including an oil passageway extending longitudinally through said push rod and communicating at its upper end with the interior of said crankcase and communicating at its lower end with the interior of said housing.

4. In an internal combustion engine having a crankcase, an engine cylinder valve, a housing into which the stem of said valve projects, a rocker arm within said housing operatively engaging said valve stem, a valve operating push rod extending in a direction downwardly from said crankcase into said housing and operatively engaging said rocker arm, a tubular casing surrounding said push rod and extending in a direction downwardly from said crankcase to said housing but terminating short of the bottom end of said push rod, means for supplying lubricating oil to said housing through the annular passage within the tubular casing about the push rod, and means for returning oil from said housing to said crankcase, said last mentioned means including an oil passageway extending longitudinally through said push rod and communicating at its upper end with the interior of said crankcase and communicating at its lower end with the interior of said housing.

5. In an internal combustion engine having a crankcase, an engine cylinder valve, a housing into which the stem of said valve projects, a rocker arm within said housing operatively engaging said valve stem, a valve operating push rod extending in a direction downwardly from said crankcase into said housing and having one end operatively engaging said rocker arm, a valve tappet slidably supported by said crankcase and operatively engaging the other end of said push rod, a tubular casing surrounding said push rod and extending in a direction downwardly from said crankcase to said housing but terminating short of the bottom end of said push rod, means for supplying lubricating oil to said housing through the annular passage within the tubular casing about the push rod, and a passageway for returning oil from said housing to said crankcase, said passageway including a passage extending longitudinally through said push rod and a passage extending through said tappet and

communicating with said push rod passage; said tappet projecting a substantial distance into said crankcase with the discharge end of said tappet passage opening into the crankcase adjacent the inner end of said tappet.

6. In an engine having a crankcase; a valve; a housing; valve operating mechanism within said housing operatively connected to said valve; a valve-operating push rod mounted for reciprocation by said engine and extending in a direction downwardly from said engine crankcase into said housing into operative engagement with said mechanism, said push rod being hollow to form at least a portion of a passage between said housing and crankcase; a tubular casing surrounding said push rod to form an annular space about said push rod; means for supplying lubricating oil to said housing through said annular space, said housing being subjected to a gas pressure, during engine operation, in excess of the pressure within said crankcase, the arrangement being such that the pressure differential between said housing and crankcase urges oil from said housing through said passage when the oil within said housing covers the housing end of said passage.

7. In an internal combustion engine having a crankcase; a valve; valve operating mechanism connected to said valve; a housing for said mechanism; a hollow push rod mounted for reciprocation by said engine and having one end operatively engaging said mechanism for operating said valve; means for supplying lubricating oil to said housing; and pump means disposed within said hollow push rod and responsive to reciprocation thereof for removing lubricating oil from said housing through said rod.

8. In an internal combustion engine having a crankcase; a valve; valve operating mechanism connected to said valve; a housing for said mechanism, said mechanism and its housing being disposed below said crankcase; a hollow valve operating push rod mounted for reciprocation by said engine and disposed between said crankcase and housing and having one end operatively engaging said mechanism; a tubular casing surrounding said push rod; means for supplying lubricating oil to said housing through the annular space within the tubular casing about the push rod; and pump means disposed within the hollow push rod and responsive to reciprocation of said rod for removing lubricating oil from said housing through said rod.

9. In an internal combustion engine having a crankcase; a valve; valve operating mechanism connected to said valve; a housing for said mechanism, said mechanism and its housing being disposed below said crankcase; a push rod disposed between said crankcase and housing and having one end operatively engaging said mechanism for operating said valve in response to reciprocation of said rod; a sleeve carried by said crankcase; a valve tappet slidably supported by said crankcase within said sleeve and operatively engaging the other end of said push rod for reciprocating said rod; a tubular casing surrounding said push rod and having one end forming a continuation of said sleeve and having its other end opening into said housing, said sleeve and tappet having a passage therebetween communicating with the annular space within said tubular casing about said push rod; an oil supply passageway intermittently communicating with said passage during reciprocation of said tappet whereby lubricating oil is supplied to said hous-

ing from said passage and through said annular space; and a passageway extending longitudinally through said push rod for returning oil from said housing to said crankcase.

10. In an internal combustion engine having a crankcase; a valve; valve operating mechanism connected to said valve; a housing for said mechanism, said mechanism and its housing being disposed below said crankcase; a push rod disposed between said crankcase and housing and having one end operatively engaging said mechanism for operating said valve in response to reciprocation of said rod; a sleeve carried by said crankcase; a valve tappet slidably supported by said crankcase within said sleeve and operatively engaging the other end of said push rod for reciprocating said rod; a tubular casing surrounding said push rod and having one end forming a continuation of said sleeve and having its other end opening into said housing, said sleeve and tappet having a passage therebetween communicating at one end with the annular space within said tubular casing about said push rod; an oil supply passageway intermittently communicating with the other end of said passage during reciprocation of said tappet whereby lubricating oil is supplied to said housing from said passage and thence through said annular space; and a passageway for returning oil from said housing to said crankcase, said passageway including a passage extending longitudinally through said push rod and a passage extending through said tappet and communicating with said push rod passage, said tappet projecting a substantial distance into said crankcase with the discharge end of said tappet passage opening into the crankcase adjacent the inner end of said tappet.

11. In an engine having a crankcase, a valve, a housing into which the stem of said valve projects, valve operating mechanism within said housing operatively engaging said valve stem, a valve-operating push rod mounted for reciprocation by said engine and extending in a direction downwardly from said engine crankcase into said housing and into operative engagement with said mechanism, said push rod being hollow to form at least a portion of a passage between said housing and crankcase, a tubular casing surrounding said push rod, means for supplying lubricating oil to said housing through the annular space within the tubular casing about the push rod, said housing being subjected to a gas pressure during engine operation in excess of the pressure within said crankcase, the arrangement being such that the pressure differential between said housing and crankcase urges oil from said housing through said passage when the oil within said housing covers the housing end of said passage.

12. In an engine having a crankcase, an engine exhaust valve, a housing into which the stem of said valve projects, valve operating mechanism within said housing operatively engaging said valve stem, a valve-operating push rod mounted for reciprocation by said engine and extending in a direction downwardly from said engine crankcase into said housing and into operative engagement with said mechanism, said push rod being hollow to form at least a portion of passage between said housing and crankcase, a tubular casing surrounding said push rod and extending in a direction downwardly from said crankcase to said housing but terminating short of the bottom end of the push rod, means for

supplying lubricating oil to said housing through the annular space within the tubular casing about the push rod, said housing being subjected to a gas pressure during engine operation resulting from leakage of engine exhaust gases therein 5 from around said valve stem, the gas pressure differential between said housing and crankcase urging oil from said housing through said passage when the oil within said housing covers the housing end of said passage.

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