July 12, 1938. A. V. D. WILLGOOS 2,123,681

INTERNAL COMBUSTION ENGINE-ROCKER ARM LUBRICATION

Filed Sept. 25, 1935 3 Sheets-Sheet 1

Fig. 1

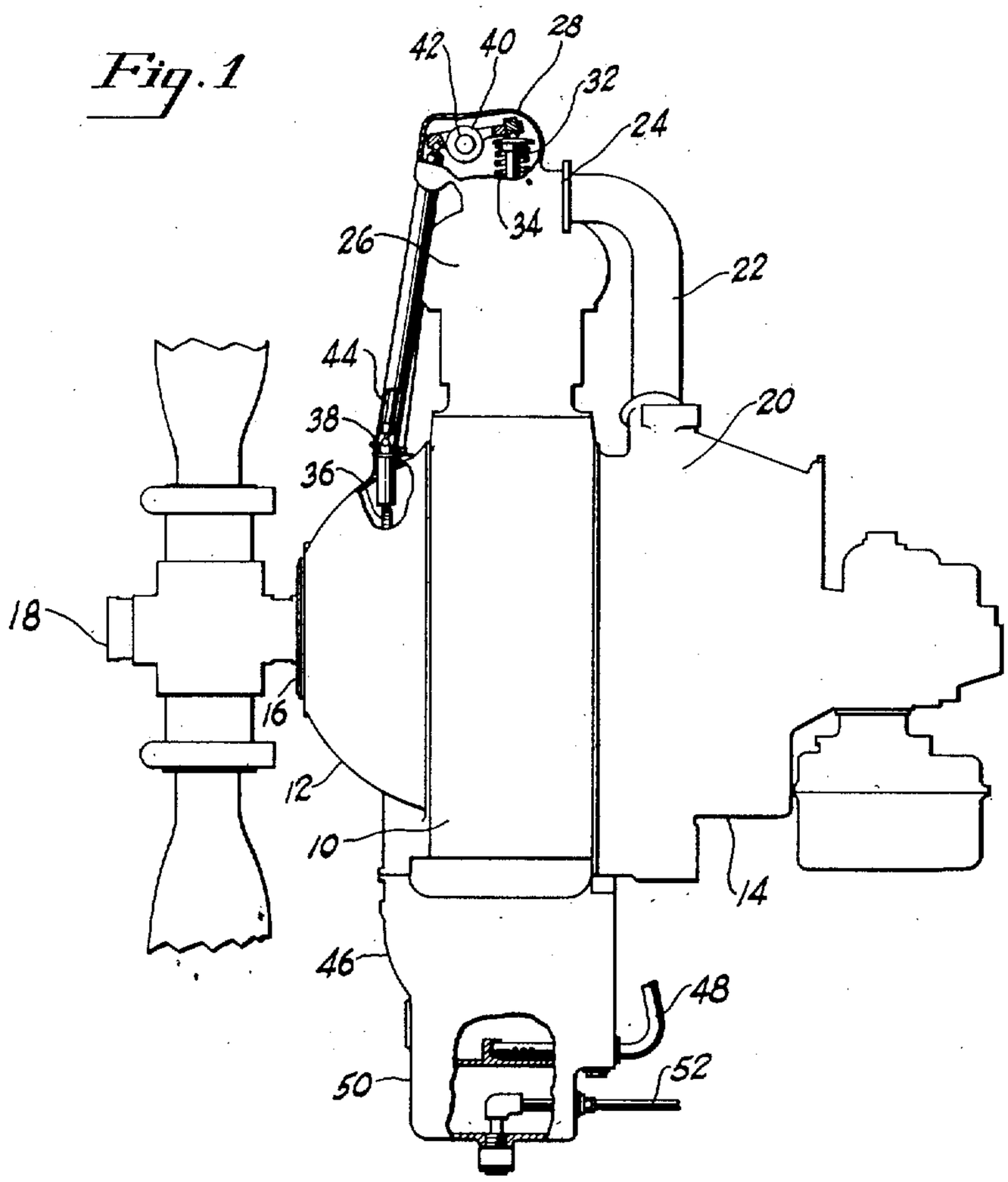

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Fig. 2

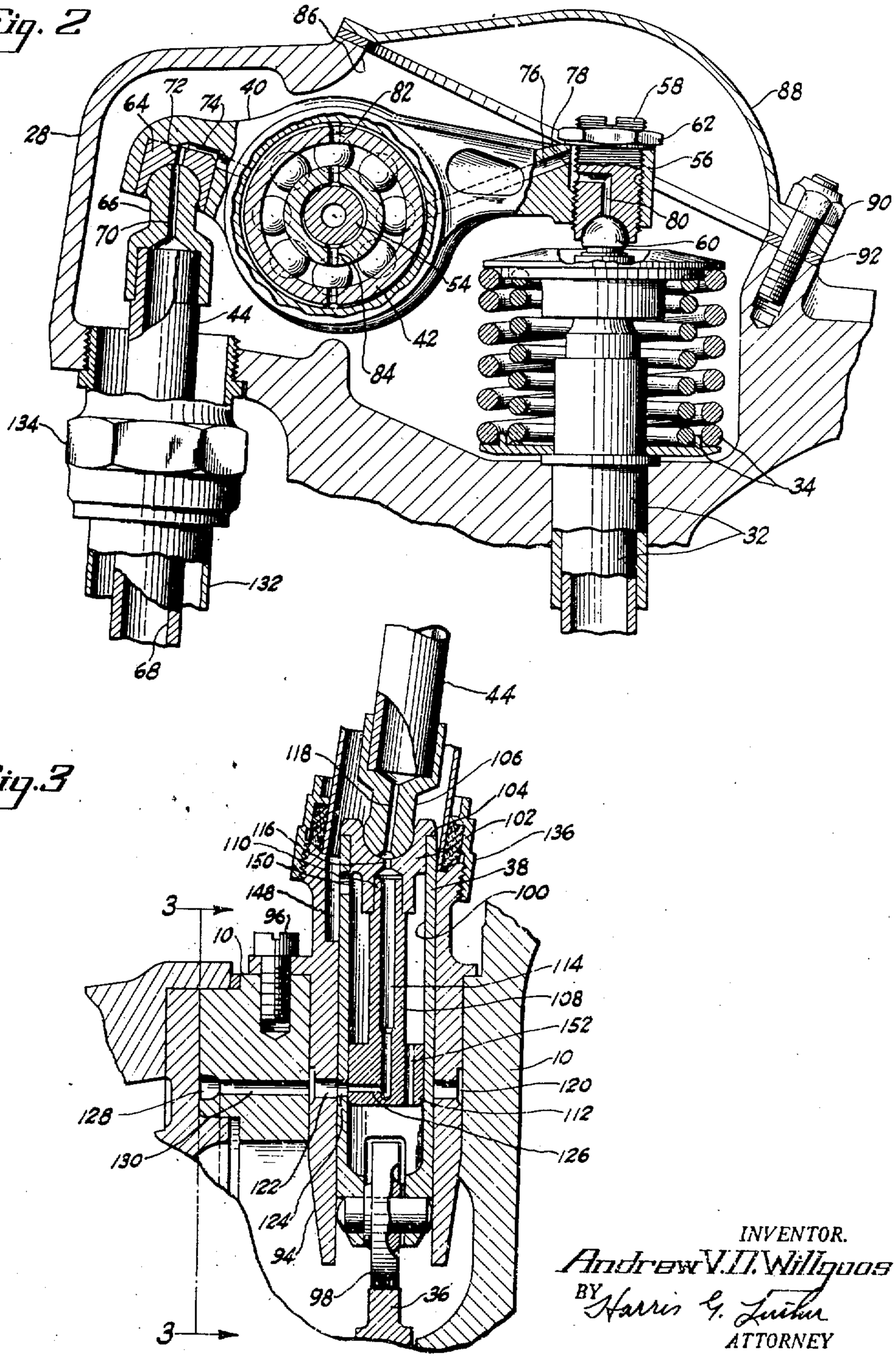

Fig. 3

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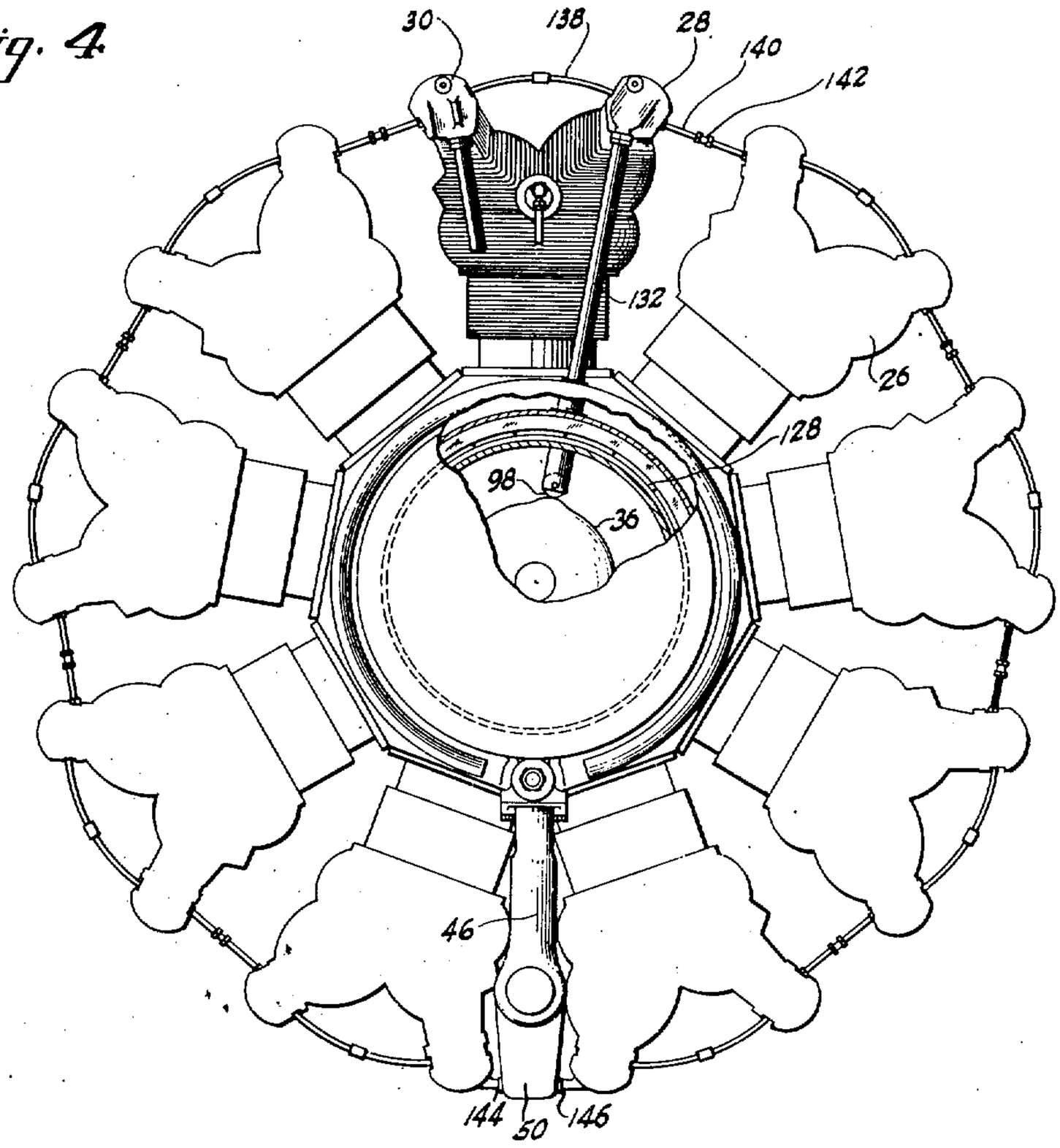
Fig. 4



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Patented July 12, 1938 2,123,681

UNITED STATES PATENT OFFICE

2,123,681

INTERNAL COMBUSTION ENGINE—ROCKER ARM LUBRICATION

Andrew V. D. Willgoos, West Hartford, Conn., assignor to United Aircraft Corporation, East Hartford, Conn., a corporation of Delaware

Application September 25, 1935, Serial No. 42,005

8 Claims. (Cl. 184—6)

This invention relates to improvements in internal combustion engines and has particular reference to improved means for lubricating the valve operating mechanism of such an engine.

One object of the invention resides in the provision of means for supplying lubricant from the engine lubricating system to the valve operating mechanism.

A further object resides in the provision of means for definitely limiting the amount of lubricant supplied to the valve operating mechanism and for removing the lubricant therefrom and returning the same to the engine lubricating system so that the valves will not be flooded by an excessive quantity of lubricant.

Other objects and advantages will be hereinafter pointed out or will become apparent as the description proceeds.

In the accompanying drawings, in which like reference numerals are used to designate similar parts throughout, there is illustrated a suitable mechanical embodiment of what is now considered to be the preferred form of the invention. The drawings, however, are for the purpose of illustration only and are not to be taken as limiting the invention, the scope of which is to be measured entirely by the scope of the appended claims.

In the drawings, Fig. 1 is a side elevational view of an internal combustion engine such as an air-cooled radial engine conventionally used to furnish power for aircraft, certain portions of the engine being broken away to illustrate the application of the idea of the invention thereto.

Fig. 2 is a sectional view on an enlarged scale showing a fragmentary portion of the engine illustrated in Fig. 1 and a portion of the valve operating mechanism including the valve rocker arm in its operative position in such fragmentary portion of the engine.

Fig. 3 is a sectional view on an enlarged scale showing a fragmentary portion of the engine illustrated in Fig. 1 and the valve tappet and tappet guide in its operative position in such fragmentary portion of the engine.

Fig. 4 is a front elevational view of the engine illustrated in Fig. 1 showing means for returning oil from the vicinity of the engine valves back to the engine lubricating system and also showing in a broken away portion of the engine, means for supplying oil from the engine lubricating system to the valve operating mechanism.

Referring to the drawings in detail, in Fig. 1 there is illustrated an air-cooled radial internal combustion engine having a crankcase 10 to which is attached a front section 12 and a rear section 14. The front section 12 is provided with a central aperture 16 through which projects a power shaft, not illustrated, upon the projecting end of which is mounted a propeller generally indicated at 18. The rear section is provided with a fuel distributing chamber 20 from which manifolds 22 lead to the intake ports 24 of the cylinders 26 radially secured upon the substantially annular crankcase 10. The cylinders are also provided with exhaust ports, not illustrated, in the conventional manner. Each cylinder 26 is provided with a pair of valve rocker arm boxes 28 and 30, preferably, though not necessarily, formed integrally with the cylinder heads. The intake and exhaust ports of the cylinders are opened and closed in timed relation to the operation of the engine by suitable valves such as the intake valve indicated at 32 in Fig. 1. These valves are urged toward their closed position by suitable coiled compression springs 34 and are opened at properly timed intervals by suitable valve operating mechanisms including a cam 36 geared to the engine power shaft to be driven at a certain fraction of the power shaft speed, suitable valve tappets as indicated at 38, rocker arms as indicated at 40 mounted in the rocker arm boxes 28 and 30 by means of suitable bearings 42, and push rods, as indicated at 44, interposed between the tappets 38 and the rocker arms 40 to transfer movements of the tappets 38 induced by the action of the cam 36 to the rocker arms 40 and through the rocker arms to the stems of the valves 32 to cause the valves to open and close the intake and exhaust ports in timed sequence to the operation of the engine.

At the bottom of the crankcase 10 there is provided an oil sump 46 into which the oil which has been forced under pressure through the bearings and other working parts of the engine flows under the influence of gravity. The oil is removed from the sump 46 through a suitable conduit 48 and a scavenging pump, not illustrated, and returned to a tank or other suitable reservoir from which it is led to the oil pressure pump and returned under pressure to the lubricating system of the engine.

In accordance with the idea of this invention, a second oil sump 50 is secured to the crankcase 10 directly below the oil sump 46 for a purpose to be presently described. This secondary oil sump 50 is also provided with an outlet conduit

52 leading to a suitable scavenging pump by means of which the oil is returned to the oil tank or reservoir and the sump maintained in a dry condition.

This oil sump 50 has a sufficient capacity below the rocker boxes of the bottom cylinders to receive all of the oil which drains from the rocker boxes of the various cylinders when the engine is stopped so that there is no tendency to flood the bottom cylinders.

Referring particularly to Fig. 2 it will be observed that each rocker arm is a lever of the first order in which the forces are applied to the opposite ends and the bearing 42 intermediate the ends acts as a fulcrum. The bearing 42 is preferably an antifriction bearing such as a ball bearing or roller bearing and is supported upon a pin 54 mounted at its opposite ends in the sides of the rocker arm box 28. At the valve end the rocker arm 40 is provided with a screw threaded aperture 56 within which is inserted an adjustable screw threaded plug 58 having a partly spherical depression in its lower end to receive a spherical flattened ball 60 which slides on the upper end of the stem of the valve 32. This plug 58 is locked in adjusted position by suitable means such as the lock nut 62. At its opposite end the rocker arm is provided with a cylindrical well within which is disposed a block 64 of hardened material provided with a partly spherical depression which receives a partly spherical tip 66 secured upon the upper end of the push rod 44. The push rod is tubular or provided with an axial bore as indicated at 68, and a channel 70 leads from the bore 68 through the tip 66. A corresponding channel 72 leads through the portion of the block 64 overlying the upper end of the tip 68 and communicates with a channel 74 leading through the portion of the rocker arm 40 between the block 64 and the bearing 42. The passage through the rocker arm is continued upon the valve side of the bearing 42 by means of a channel 76 which leads to a slot 78 provided in the screw threaded wall of the aperture 56. From this slot an angular channel 80 leads through the plug 58 to the surface of the tip 60. Suitable branch channels 82 and 84 lead from the channel 74 into the interior of the bearing 42 to provide a supply of lubricant to the interior of the bearing.

From the above description it will be observed that lubricant, such as a suitable engine oil, may flow from the interior of the hollow push rod 44 through the channel 70 to the bearing between the push rod tip 66 and the block 64 to lubricate this bearing and that some of the lubricant will continue to flow through the channels 72, 74, 76, the slot 78 and the channel 80 to the bearing between the plug 58 and the ball 60 on the stem of the valve 32 to lubricate the bearing between the plug 58 and the tip 60, and that another portion of the lubricant will be diverted from the channel 74 through the channels 82 and 84 to the interior of the antifriction bearing 42 to lubricate the elements of this bearing, thus providing complete lubrication for all of the movable elements of the portions of the valve operating mechanisms contained in the rocker arm boxes 28 and 30. Each rocker arm box is provided with an aperture 86 to allow access to the adjustable plugs 58 so that the valve operating mechanisms may be adjusted to provide proper clearance for the valves, and each of these apertures is covered by a suitable curved plate 88 secured to the rocker arm boxes by stud bolts as indicated at 90. Suitable compressible gaskets 92 are interposed between the adjoining surfaces of the rocker arm boxes and the plates 88 to constitute an oil tight seal so that each rocker box is made an oil tight receptacle for receiving the oil flowing from the bearings included therein.

In Fig. 3 there is illustrated the valve operating mechanisms at the lower or inner ends of the push rods 44, such mechanisms include the cam 36 for operating the valve tappets 38. Each valve tappet 38 is slidably mounted in a suitable tappet guide 94 secured to the engine crankcase 10 by screws or stud bolts 96 and is provided with a bifurcated lower or inner end within which is mounted a roller 98 which rolls upon the cam 36. The tappets 38 are hollow members provided with internal bores or recesses as indicated at 100 and have open outer ends. The outer ends of the hollow tappets 38 are closed by push rod cups 102, each having a reduced portion fitting within the open end of the tappet and an annular shoulder 104 resting upon the tappet end. Each of the cups 102 is provided with a partly spherical depression which receives the partly spherical bearing portion of the tip 106 on the lower end of the push rod 44. The tappets 38 may be constructed in several different ways. For instance, the roller 98 may be mounted in the lower portion of the bore 100 as illustrated in Fig. 3, or the bore may be separated from the roller by a partition, thus providing a tappet in the form of a cup having continuous side and bottom walls in which case, lubricant to be fed to the interior of the push rod 44 may be introduced directly into the interior of the hollow tappet. In the form of tappet illustrated, however, it is obvious that unless a definite channel were provided the lubricant would flow out of the tappet through the opening around the roller 98 so, in order to provide a pressure feed of lubricant to the hollow push rod 44, there has been provided within the hollow tappet a plug 108 having a reduced end portion 110 fitting into a well provided in the inner surface of the cup or seat 102 and an enlarged end 112 which forms a seal between the plug and the inner wall of the hollow tappet. The plug 108 is provided with a concentric oil channel 114 which leads from a position adjacent to the inner end of the plug to the exterior of the reduced portion 110 fitting into the well provided in the lower surface of the cup member 102. From this well a channel 116 leads through the intermediate portion of the cup member to the end of a channel 118 which extends through the push rod tip 106 and communicates with the interior of the hollow push rod 44. The tappet guide 94 is provided with an annular channel 120 from which a plurality of radial ports, as indicated at 122, extend through the wall of the guide. A port 124 in the tappet 38 comunicates with one of the ports 122 when the tappet is in the position illustrated in Fig. 2 with the roller 98 riding on the highest portion of the cam 36 and the port 124 communicates through a channel 126 with the lower end of the channel 114. The portion of the engine crankcase overlying the tappets 38 and the tappet guides 94 is provided with an annular manifold 128 which may be a groove or channel cut into the material of the crankcase or may be a separate tubular member attached to the engine structure, depending upon the construction of the engine to which the device of the invention is applied. Headers, as indicated at 130, lead from the manifold 128 to each of the annu-

lar channels 120 provided in the tappet guides 94. At one point in its circumference the manifold 128 is connected with the pressure lubricating system of the engine so that lubricant under pressure is supplied to the manifold. From the manifold the lubricant flows through the various headers 130 to the channels provided in the tappet guides and from these channels through the ports 122 and 124 to the interior of the hollow tappet 38 or the interior of the plug 108, depending upon the type of tappets to which the invention is applied. In the device illustrated the oil flows through the port 124, the channels 126 and 114 and the channel 116 in the push rod seat 102 to the bearing between the push rod seat and the push rod tip 106 and from thence through the channel 118 to the interior of the hollow push rod from whence it flows by means of the channels above described to the various bearings in the valve end of the valve operating mechanism.

It will be observed that the port 122 in the tappet guide and the port 124 in the tappet are so related that a passage for the oil is provided only when the tappet is pushed upwardly or outwardly by the roller 98 riding upon the top of the cam 36. By means of this construction the quantity of oil supplied to the valve operating mechanism is definitely limited so that the flow of oil will not be sufficient to flood the valves and lead to difficulties in valve operation. Also, the oil is supplied to the valve operating mechanism only when all of the bearings of such mechanism are under load and consequently jammed tightly together so that the oil pressure through the valve operating mechanism is maintained and the device does not tend to materially lower the pressure in the engine lubricating system.

As stated above, each of the rocker boxes 28 has an oil tight construction and, in order to provide a closed oil tight system, each of the push rods 44 leading to the various rocker boxes is surrounded by a tubular member as indicated at 132. The upper end of each tubular member 132 is connected to the respective rocker box by means of an oil tight connection 134 and the lower end is connected to the valve tappet guide 94 by means of a similar oil tight connection 136. This construction serves to provide an oil tight casing for the push rods between the respective rocker arm boxes and the crankcase of the engine so that the entire valve operating mechanism is enclosed in an oil tight casing and no substantial quantity of oil can be lost from the engine by forcing the oil to the portions of the valve operating mechanism remote from the crankcase.

Referring to Fig. 4, it will be observed that the two rocker arm boxes on each cylinder are connected together by means of a tubular member as indicated at 138, and adjacent rocker arm boxes of adjacent cylinders are connected together by tubular members as indicated at 140 leading to apertures provided in the walls of the rocker boxes. If desired, the tubular members 138 may be rigid members cast or welded into the cylinder construction, but, in the form of the invention illustrated, both the tubular members 138 and 140 are formed in two sections, the adjoining ends of which are secured together by flexible rubber couplings as indicated at 142. As particularly illustrated in Fig. 4 the tubular members 138 and 140 together with the rocker arm boxes 28 and 30 to which they are terminally secured, constitute a continuous oil channel around the outer circumference of the engine. At the bottom of the engine the opposite ends of this oil channel lead into the sides of the sump 50 as indicated at 144 and 146.

From the above construction, it will be observed that the oil which collects in the rocker arm boxes after passing through the bearings of the valve operating mechanisms will flow through the above described oil return channels back to the sump 50; the oil flowing from the top of the engine downwardly on both sides thereof and through the connections 144 and 146 into the sump.

Means are also provided for draining oil from those rocker arm boxes of the engine which are above a horizontal plane passing through the center of the engine through the tubular members 132 which surround the push rods 44. The tappet guides connected with the inner ends of the tubular members 132 above the aforesaid plane are each provided in their outer ends with an oil receiving slot or channel 148. In the construction illustrated, each of the valve tappets above the aforesaid plane is provided at its upper or outer end with a port 150 leading from the slot or channel 148 into the space between the tappet and the plug 114. The enlarged end of each plug 114 is provided with a channel 152 leading from the space between the plug and the tappet into the space at the lower end of the tappet into which the roller 98 projects so that oil returning from the upper rocker arm boxes through the upper tubular members 132 may flow into the slotted channel 148 and through the port 150 and channel 152 back to the interior of the engine from which it drains into the sump 46. Oil from both of the sumps 46 and 50 is returned by suitable scavenging pumps to a common oil reservoir from which it is again pumped into the pressure lubricating system of the engine.

While the present disclosure shows the oil from the upper rocker arm boxes returning through the interiors of the upper tappets, it is within the scope of the invention to provide suitable channels between the tappets and the tappet guides connecting the annular channels or slots 148 with the interior of the engine so that the oil from the upper rocker arm boxes may return to the interior of the engine without flowing through the interiors of the tappets.

From the above description it will be observed that I have provided means for supplying a definitely limited quantity of oil at predetermined intervals to the valve operating mechanisms of an internal combustion engine and have provided adequate means for returning such oil to the lubrication system of the engine.

While the accompanying drawings illustrate and specifically describe a particular mechanical construction in which the idea of the invention may be embodied, it is to be understood that the invention is not limited to the particular construction so illustrated and described, but that such changes in the size, shape and arrangement of parts may be resorted to as come within the scope of the subjoined claims.

Having now described my invention so that others skilled in the art may clearly understand the same, what it is desired to secure by Letters Patent is as follows.

What is claimed is:

1. In an engine having an oiling system, a plurality of valves and valve actuating mechanisms,

means for supplying oil from said oiling system to said valve actuating mechanisms, and means for limiting the supply of oil to each valve actuating mechanism to those intervals during which the elements of said mechanism are under load.

2. In a radial engine having an oiling system including a sump, a plurality of valves and valve actuating mechanisms, and means separately enclosing each of said valve actuating mechanisms, means for supplying oil to said actuating mechanisms, and a separate dry sump below said oiling system included sump for receiving the oil draining from said mechanisms, said sump having a sufficient capacity to receive the oil collected in all of said valve actuating mechanism enclosing means and maintain the level of said oil below the lowermost of said valves.

3. In a radial engine having an oiling system including a sump, a plurality of valves and valve actuating mechanisms, and means separately enclosing each of said valve actuating mechanisms, means for supplying oil from said oiling system to said valve actuating mechanisms, means for draining oil from the means enclosing said mechanisms, a separate sump connected only with said valve enclosures having a sufficient capacity below the bottom cylinders of said radial engine to receive the oil collected in all of said mechanism enclosing means receiving the oil drained from said enclosing means, and means for maintaining said sump in a dry condition whenever the engine is operating.

4. In combination with an engine having a crankcase, a plurality of cylinders radially disposed around said crankcase, an oil sump on said crankcase between the two bottom cylinders, valves on the outer end of each cylinder, a valve operating mechanism between each valve and said crankcase, and a rocker arm box adjacent to each valve enclosing the valve associated part of said valve operating mechanisms; means for forcing lubricant under pressure through all the elements of said valve operating mechanisms, a separate oil sump on said crankcase below said first mentioned oil sump and extending below the rocker arm boxes on the two bottom cylinders of said engine, and oil conduits interconnecting all of said rocker arm boxes and connecting said rocker arm boxes with said second mentioned oil sump.

5. In combination with an engine having a crankcase, a plurality of cylinders radially disposed around said crankcase, an oil sump on said crankcase between the two bottom cylinders, valves on the outer end of each cylinder, a valve operating mechanism including a rocker arm and a push rod between each valve and the crankcase, a tubular member surrounding each push rod between the associated rocker arm box and the crankcase, a separate oil sump on said crankcase below said first mentioned oil sump, oil conduits interconnecting all of said rocker arm boxes and connecting said rocker arm boxes with said lower oil sump, and means for draining at least a portion of the oil from the rocker arm boxes above a horizontal plane including the axis of said engine through said tubular members and into said first mentioned oil sump.

6. In an engine having a crankcase, a plurality of valves remote from said crankcase, and a valve operating mechanism extending from each valve to said crankcase, each valve operating mechanism comprising a rocker arm, a push rod and a valve tappet, each valve actuating mechanism having an oil passage therethrough from said tappet to said valve; means for supplying oil under pressure to said oil passages, and means associated with each tappet for limiting the supply of oil to those intervals during which the bearings of the respective valve operating mechanism are under load.

7. In an engine having a crankcase, a plurality of valves remote from said crankcase, and a valve actuating mechanism including a valve tappet and a tappet guide and having an oil passage therethrough from said tappet to said valve, extending from each valve to said crankcase; means for supplying oil under pressure to said oil passages, and means comprising a port in said tappet guide and a port in said tappet registering with said first named port only when said tappet is in a predetermined position for limiting the quantity of oil supplied to said valve operating mechanisms and for limiting such restricted supply of oil to those intervals during which the bearings of the respective valve operating mechanisms are under load.

8. In an engine having a crankcase, a plurality of valves remote from said crankcase, a valve operating cam in said crankcase, and a valve operating mechanism between each valve and said cam, said valve operating mechanisms each having an oil passage therethrough and including a hollow valve tappet bearing on said cam and a tappet guide secured in said crankcase, means for supplying oil under pressure to said tappet guides, a port in each tappet guide, a port in each tappet positioned to register with the port in the tappet guide when the tappet is on the high part of the cam, and a plug in each tappet having a channel therein connecting said tappet port with said oil passage.

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DISCLAIMER

2,123,681.—*Andrew V. D. Willgoos*, West Hartford, Conn. INTERNAL COMBUSTION ENGINE—ROCKER ARM LUBRICATION. Patent dated July 12, 1938. Disclaimer filed November 30, 1940, by the assignee, *United Aircraft Corporation*, the inventor, approving and assenting.

Hereby disclaims claims 1, 6, 7, and 8 of said patent.

[*Official Gazette December 17, 1940.*]

means for supplying oil from said oiling system to said valve actuating mechanisms, and means for limiting the supply of oil to each valve actuating mechanism to those intervals during which the elements of said mechanism are under load.

2. In a radial engine having an oiling system including a sump, a plurality of valves and valve actuating mechanisms, and means separately enclosing each of said valve actuating mechanisms, means for supplying oil to said actuating mechanisms, and a separate dry sump below said oiling system included sump for receiving the oil draining from said mechanisms, said sump having a sufficient capacity to receive the oil collected in all of said valve actuating mechanism enclosing means and maintain the level of said oil below the lowermost of said valves.

3. In a radial engine having an oiling system including a sump, a plurality of valves and valve actuating mechanisms, and means separately enclosing each of said valve actuating mechanisms, means for supplying oil from said oiling system to said valve actuating mechanisms, means for draining oil from the means enclosing said mechanisms, a separate sump connected only with said valve enclosures having a sufficient capacity below the bottom cylinders of said radial engine to receive the oil collected in all of said mechanism enclosing means receiving the oil drained from said enclosing means, and means for maintaining said sump in a dry condition whenever the engine is operating.

4. In combination with an engine having a crankcase, a plurality of cylinders radially disposed around said crankcase, an oil sump on said crankcase between the two bottom cylinders, valves on the outer end of each cylinder, a valve operating mechanism between each valve and said crankcase, and a rocker arm box adjacent to each valve enclosing the valve associated part of said valve operating mechanisms; means for forcing lubricant under pressure through all the elements of said valve operating mechanisms, a separate oil sump on said crankcase below said first mentioned oil sump and extending below the rocker arm boxes on the two bottom cylinders of said engine, and oil conduits interconnecting all of said rocker arm boxes and connecting said rocker arm boxes with said second mentioned oil sump.

5. In combination with an engine having a crankcase, a plurality of cylinders radially disposed around said crankcase, an oil sump on said crankcase between the two bottom cylinders, valves on the outer end of each cylinder, a valve operating mechanism including a rocker arm and a push rod between each valve and the crankcase, a tubular member surrounding each push rod between the associated rocker arm box and the crankcase, a separate oil sump on said crankcase below said first mentioned oil sump, oil conduits interconnecting all of said rocker arm boxes and connecting said rocker arm boxes with said lower oil sump, and means for draining at least a portion of the oil from the rocker arm boxes above a horizontal plane including the axis of said engine through said tubular members and into said first mentioned oil sump.

6. In an engine having a crankcase, a plurality of valves remote from said crankcase, and a valve operating mechanism extending from each valve to said crankcase, each valve operating mechanism comprising a rocker arm, a push rod and a valve tappet, each valve actuating mechanism having an oil passage therethrough from said tappet to said valve; means for supplying oil under pressure to said oil passages, and means associated with each tappet for limiting the supply of oil to those intervals during which the bearings of the respective valve operating mechanism are under load.

7. In an engine having a crankcase, a plurality of valves remote from said crankcase, and a valve actuating mechanism including a valve tappet and a tappet guide and having an oil passage therethrough from said tappet to said valve, extending from each valve to said crankcase; means for supplying oil under pressure to said oil passages, and means comprising a port in said tappet guide and a port in said tappet registering with said first named port only when said tappet is in a predetermined position for limiting the quantity of oil supplied to said valve operating mechanisms and for limiting such restricted supply of oil to those intervals during which the bearings of the respective valve operating mechanisms are under load.

8. In an engine having a crankcase, a plurality of valves remote from said crankcase, a valve operating cam in said crankcase, and a valve operating mechanism between each valve and said cam, said valve operating mechanisms each having an oil passage therethrough and including a hollow valve tappet bearing on said cam and a tappet guide secured in said crankcase, means for supplying oil under pressure to said tappet guides, a port in each tappet guide, a port in each tappet positioned to register with the port in the tappet guide when the tappet is on the high part of the cam, and a plug in each tappet having a channel therein connecting said tappet port with said oil passage.

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