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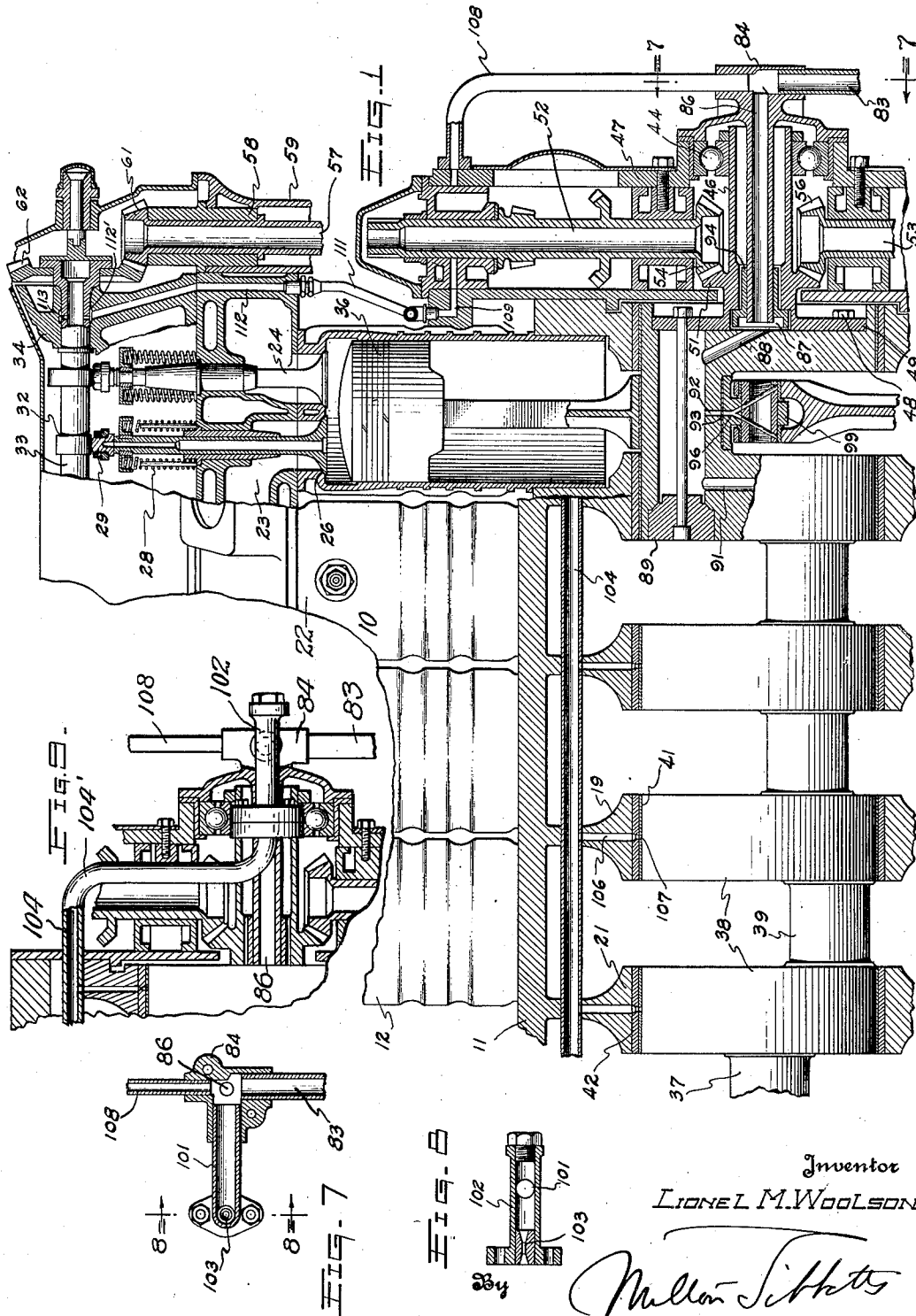
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INTERNAL COMBUSTION ENGINE

Original Filed Oct. 1, 1928

2 Sheets-Sheet 1



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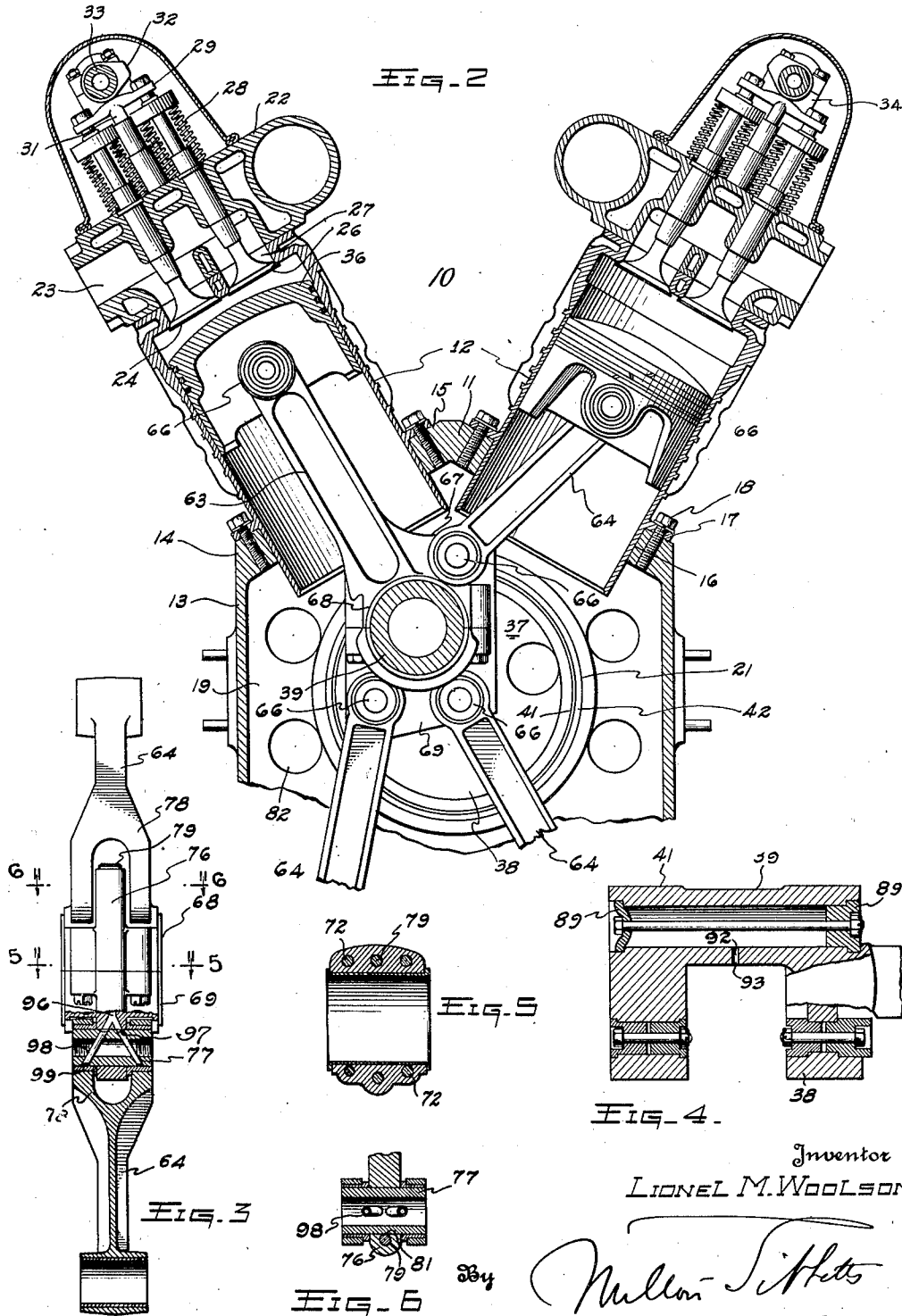
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INTERNAL COMBUSTION ENGINE

Original application filed October 1, 1928, Serial No. 309,631. Divided and this application filed January 18, 1930. Serial No. 421,661.

This application is a division of application Serial No. 309,631, filed October 1, 1928.

The invention relates to internal combustion engines such as are used, for example, in the propulsion of aircraft, and more particularly to the lubrication of such engines.

The principal object of the invention is to provide such an engine with an improved lubricating system for the various bearings of the engine. The inventive concept is capable of expression in a variety of mechanical embodiments, and is capable of use in connection with engines of different specific construction.

Other objects of the invention will appear from the following description taken in connection with the drawings, which form a part of this specification, and in which:

Fig. 1 is a view, partially in side elevation and partially in longitudinal section, through part of an engine embodying this invention;

Fig. 2 is a view in transverse section through part of the engine shown in Fig. 1;

Fig. 3 is an end elevation partially in section, through a connecting rod assembly for the engine shown in Figs. 1 and 2;

Fig. 4 is an enlarged detail section taken longitudinally through one of the cranks of the engine crank shaft;

Fig. 5 is a detail section taken substantially on the line 5—5 of Fig. 3;

Fig. 6 is a detail section taken substantially on the line 6—6 of Fig. 3;

Fig. 7 is a detail section taken substantially on the line 7—7 of Fig. 1, and

Fig. 8 is a detail section taken substantially on the line 8—8 of Fig. 7.

Fig. 9 is a fragmentary view partially in side elevation and partially in longitudinal section showing the connection from the three way fitting to one of the lubricant manifolds.

In order that the lubricating system may be clearly understood, the engine shown in the drawings will first be described in detail, and the lubricating applied thereto will be described thereafter.

Referring to the drawing, at 10 is shown an internal combustion engine having a crank case 11 on which are mounted cylinders 12,

the crank case being in the form of a housing, preferably hexagonal in cross section, having parallel side walls 13 and upper and lower cylinder supporting walls 14, each presenting a pair of inclined faces 15. The walls 14 are provided with holes 16 through which the barrels of the cylinders 12 project, the barrels being provided with integral flanges 17 which contact the faces 15 and are secured to the walls 14 by bolts 18, in the well known manner. The interior of the crank case 11 is provided with transverse internal ribs or webs 19, preferably integral with the crank case and spaced longitudinally thereof between the cylinders 12, and each web 19 is provided at its central portion with a hole 21, which holes are in alignment axially of the crank case to receive the engine crank shaft, as will appear. Such structure, however, is particularly pointed out and claimed in my co-pending applications Serial No. 515,798, filed February 14, 1931, and Serial No. 295,937, filed July 28, 1928.

As shown in Figs. 1 and 2, a plurality of cylinders 12 are arranged in inclined rows or banks above and below the crank case 11. In the present embodiment there are four such banks of six cylinders each, arranged in two upright banks above, and two inverted banks (not shown) below the crank case, in the general form of an X. The cylinder banks are each provided with a head member 22 in which are formed passages 23 for the intake and exhaust of each of the cylinders, these passages being controlled by valves as at 24 having seats 26 formed at ports 27 in the head. These valves are urged to closed position on their seats 26 by valve springs 28. The valves are arranged in pairs connected by a yoke or follower 29 having a guide stem 31 and operated from a cam 32 on a cam shaft 33, supported in suitable bearings 34 on the head member 22, but as mechanism of this type is well known in the art to which this invention relates, further description thereof in unnecessary.

Each of the cylinders 12 is provided with a piston 36 adapted to reciprocate therein in the usual manner, all of the pistons being connected to and adapted to operate a com-

mon crank shaft 37. The crank shaft preferably employed in the present embodiment of the invention is a six-throw shaft, there being four of the pistons 36 connected to each of the cranks thereof. It comprises spaced cylindrical crank arms or cheeks 38 in the form of discs, connected by integral crank pins 39, preferably hollow as shown. The cheeks 38 provide bearing surfaces 41 which constitute the crank shaft journals and on which the crank shaft is rotatably mounted in aligned bearings 42 in the crank case 11. These bearings 42 are preferably integral shells or rings of steel or other suitable material, which may be lined with babbitt or other bearing metal, that are supported in the openings 21 in the crank case webs 19 and are held tightly therein.

The crank shaft 37 is maintained in correct axial position in the crank case by means of a thrust bearing 44 cooperating with a removable axial extension 46 at the rear end of the shaft. This bearing is mounted in a suitable housing 47, removably secured to the rear end of the crank case 11, in which the timing gears of the engine are preferably located.

The axial extension 46 may be conveniently secured to the rear face of the end crank cheek 38 by screws 48 passing through a flange portion 49, and this extension is provided with a gear 51 through which the timing gears are driven. This gearing comprises the vertical aligned shafts 52 and 53 extending above and below the crank shaft and provided with the integral gears 54 and 56 which mesh with and are driven from the gear 51, these gears being preferably bevel gears. The shafts 52 and 53 are provided with suitable gears adapted to drive suitable gears secured to inclined shafts 57, there being one of the shafts 57 for each of the banks of cylinders. These shafts 57 are journaled in bearings 58 in extensions 59 of the housing 47 and they are provided at their outer ends with gears 61 which mesh with and drive gears 62 connected to the ends of the respective cam shafts 33. In this way the four cam shafts are driven in synchronism from the crank shaft 37, the gear reduction being such as to secure the proper half speed for each of the cam shafts.

Each of the crank pins 39 is connected to four of the pistons 36, one in each of the cylinder banks, by a connecting rod assembly, as shown in Figs. 2 and 3, including a master rod 63, and link rods 64, each of which is pivotally connected to its piston by a piston pin 66 in the usual way. The crank shaft end of the master rod 63 is provided with an enlarged portion 67 in which is formed part of the crank pin bearing 68, the remainder of this bearing being formed in a cap member 69 which is removably secured to the portion 67. For this purpose

the bearing members are provided with studs or bolts 72, arranged on each side of the bearing and set in as close to the bearing as possible. They are adapted to pass through and connect lugs in the cap members 69 to lugs on the bearing members, so that the cap member may be clamped to the portion 67, and the halves of the bearing 68 positioned upon the crank pin 39.

The portions 67 and 69 are also provided with integral flange members 76 disposed in the median plane of the bearing 68, in which axially disposed tubular pins 77 are mounted to pivotally engage forked ends 78 on the link rods 64. These forked ends are adapted to straddle the flange members 76 as clearly shown in Figs. 1 and 3. The pins 77 are preferably locked in position in the flange members 76 by bolts 79, one on each side of the bearing 68, which pass through the cooperating flange members 76 parallel to the studs 72, and engage notches 81 in the pins 77. These bolts 79 assist the studs 72 to clamp the members 67 and 69 in operative position. The pins 77 are preferably threaded internally for engagement with the threaded end of a suitable bar (not shown) by which they may be inserted or withdrawn through axially disposed holes 82 arranged in the crank case webs 19, after removal of the bolts 79.

The lower end of the shaft 53 is connected to and drives the engine pump assembly, comprising pumps for the fuel, cooling and lubricating systems of the engine. As combined pump units of this nature are well known in the art the pumps have not been illustrated in the drawings, but it is to be understood that the water pumps are adapted to supply cooling water to the jackets of each of the banks of cylinders, and that the lubricating pumps serve to scavenge or remove oil from the crank case and the camshaft housings as well as to supply oil under pressure for the various engine bearings.

The outlet of the oil pressure pump is connected to a conduit 83 through which it delivers oil under pressure to a fitting 84. From this fitting part of the oil passes to a tube or nozzle 86 which is supported on the housing 47 and projects through the hollow crank shaft extension 46 into a pressure chamber 87 in the inner end thereof. From this chamber a passage 88 leads to the inside of the rear crank pin 39. Each of the hollow crank pins is closed at the ends by suitable plugs 89, and the chambers thus formed are connected by passages 91, forming a continuous conduit through the crank shaft supplied with oil under pressure from the tube 86. A passage 92 is formed in each of the crank pins 39 which passage terminates at the bearing surface in a port 93, through which oil flows under pump pressure to the crank pin bearings, escaping at the ends

thereof into the crank case in the usual way.

Loss of oil between the tube 86 and the crank shaft is prevented by a bushing 94, having a tight fit on the tube and a relatively loose fit in the crank shaft extension. This bushing has a flanged end located in and contacting the wall of the pressure chamber 87, in which position it is retained by the pressure of the oil in the chamber, thus effectively sealing possible leakage at this point, and permitting slight variations in axial alignment between the tube and the shaft.

Passages 96 are also provided in each of the cap and the bearing portions of the master connecting rods, terminating in ports 97 at the bearing surface, which register once per engine revolution with the ports 93, receiving therefrom a measured charge of oil. This oil is conducted from passage 96 through branch passages 98 to the link pin bearings through ports 99, whereby these passages are lubricated.

The lubrication of the main bearings is preferably effected by a low pressure system connected to the fitting 84. It has been discovered that bearings which have a large diameter in proportion to their width, and a relatively large clearance, offer very little resistance to the flow of lubricating oil and in fact frequently have a pumping action which increases the flow of oil through them. For this reason the high pressure under which oil is fed to the connecting rod bearings is not desirable at the main bearings, since it causes the circulation of an unnecessarily large quantity of oil which must be removed by the scavenging pumps, and requires a large circulation pump to maintain the pressure. This invention provides for the supply to the main bearings of oil under a lower pressure. To this end high pressure oil from the fitting 84 is conducted through a branch pipe 101 to a reducing chamber 102 having a pressure reducing passage 103, Fig. 8. From this chamber oil at a reduced pressure is conducted through a pipe 104' to a manifold 104 extending longitudinally of the crank case 11 and supported from the webs 19 thereof. A passage 106, formed in each of the webs 19, conducts the low pressure oil from the manifold 104 to an orifice 107 of the bearing surface, thus providing ample lubrication for these bearings without excessively reducing the pressure in the remainder of the lubricating system.

Oil from the fitting 84 is also supplied by a pipe 108 to the upper bearing of the shaft 52, and thence through a passage 109 to a branched pipe 111 which leads to each of the heads 22. These heads are provided with passages 112, communicating with the pipes 111, by which the oil is conducted to an annular groove 112' in the rear camshaft bearing 34, and thence through ports 113 to the

interior of the hollow camshaft. From the camshaft the oil is distributed through suitable ports and passages (not shown) to the other bearings 34, and the cams and cam followers, in the well known manner. Oil is supplied in a similar way to the camshafts of the lower cylinder banks through pipes (not shown) connecting with the pump conduit 83.

It will be evident that this invention provides a very efficient lubricating system for internal combustion engines of the character designated, which avoids the unnecessary circulation of oil, and the consequent overloading of the oil return system, while insuring an ample supply of lubricant to all of the engine bearings.

While a specific embodiment of the invention has been herein described, which is deemed to be new and advantageous and may be specifically claimed, it is not to be understood that the invention is limited to the exact details of the construction, as it will be apparent that changes may be made therein without departing from the spirit or scope of the invention.

The internal combustion engine herein described is not claimed per se in this application, since the same forms the subject matter of application Serial No. 309,631, filed October 1, 1928, of which this application is a division.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. The combination in an internal combustion engine having pistons, of a crank shaft having cylindrical crank cheeks forming journals and having crank pins between the journals, bearings for said journals, connecting rods connecting the pistons to said crank pins, and a lubricating system including means to deliver oil under high pressure to the crank pin bearings and to deliver oil under low pressure to the journal bearings.
2. The combination in an internal combustion engine of a crank shaft having journal bearings of relatively large diameter, connecting rods having bearings of relatively small diameter, and means to supply oil under pressure to said bearings including pressure reducing means for the oil supply to said journal bearings.
3. The combination in an internal combustion engine of a crank shaft having large main bearings and relatively small crank pin bearings, a source of oil under pressure means to conduct oil from said source to the crank pin bearings, a manifold connected to each of the crank shaft bearings, and pressure reducing means connecting said conducting means to said manifold.
4. The combination in an internal combustion engine having a pressure oil supply means, of a crank shaft having main bearings

of large diameter, other smaller bearings, a manifold on said engine connected to said main bearings, distributing means including conduits connecting the smaller bearings to
5 said oil supply means, and pressure reducing means connecting said distributing means to said manifold.

5. The combination in an internal combustion engine of a crank shaft comprising a
10 cylindrical cheek forming a journal and a crank pin cooperating with said cheek, and having an oil conduit extending through the pin and the cheek longitudinally of the shaft, means to supply oil under pressure to said
15 conduit, means including a passage to conduct oil from the conduit to the surface of the crank pin, and separate means including a passage having a restricted portion to conduct oil from said conduit to the journal
20 surface.

6. A lubrication system for internal combustion engines having crank shaft bearings and connecting rod bearings, comprising a
25 pump to supply oil under pressure, a conduit formed partly in the crank shaft to conduct oil from said pump to the connecting rod bearings, and means including a branch passage having pressure reducing means to supply oil from the conduit at a reduced pressure to said crank shaft bearings.
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7. The combination in an internal combustion engine, of bearings having a high resistance to the flow of lubricant, other bearings having a lower resistance to the flow
35 of lubricant, means to supply lubricant to said high resistance bearings under considerable pressure, and means associated with said first means to supply lubricant to the low resistance bearings under a lower pressure.
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8. The combination in an internal combustion engine, of bearings having high resistance to the passage of lubricant, other bearings having little or no resistance to the passage of lubricant, and a lubricating system
45 including means to supply lubricant under considerable pressure directly to said high resistance bearings, and means to supply lubricant to said other bearings under reduced pressure.
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9. The combination in an internal combustion engine of a crank shaft having bearings adapted to facilitate the flow of lubricant therethrough, other bearings having relatively high resistance to the passage of lubricant, means to supply lubricant to said high
55 resistance bearings at high pressure, and means connecting said supply means to said crank shaft bearings including a pressure reducing device.
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In testimony whereof I affix my signature.
LIONEL M. WOOLSON.