

May 23, 1933.

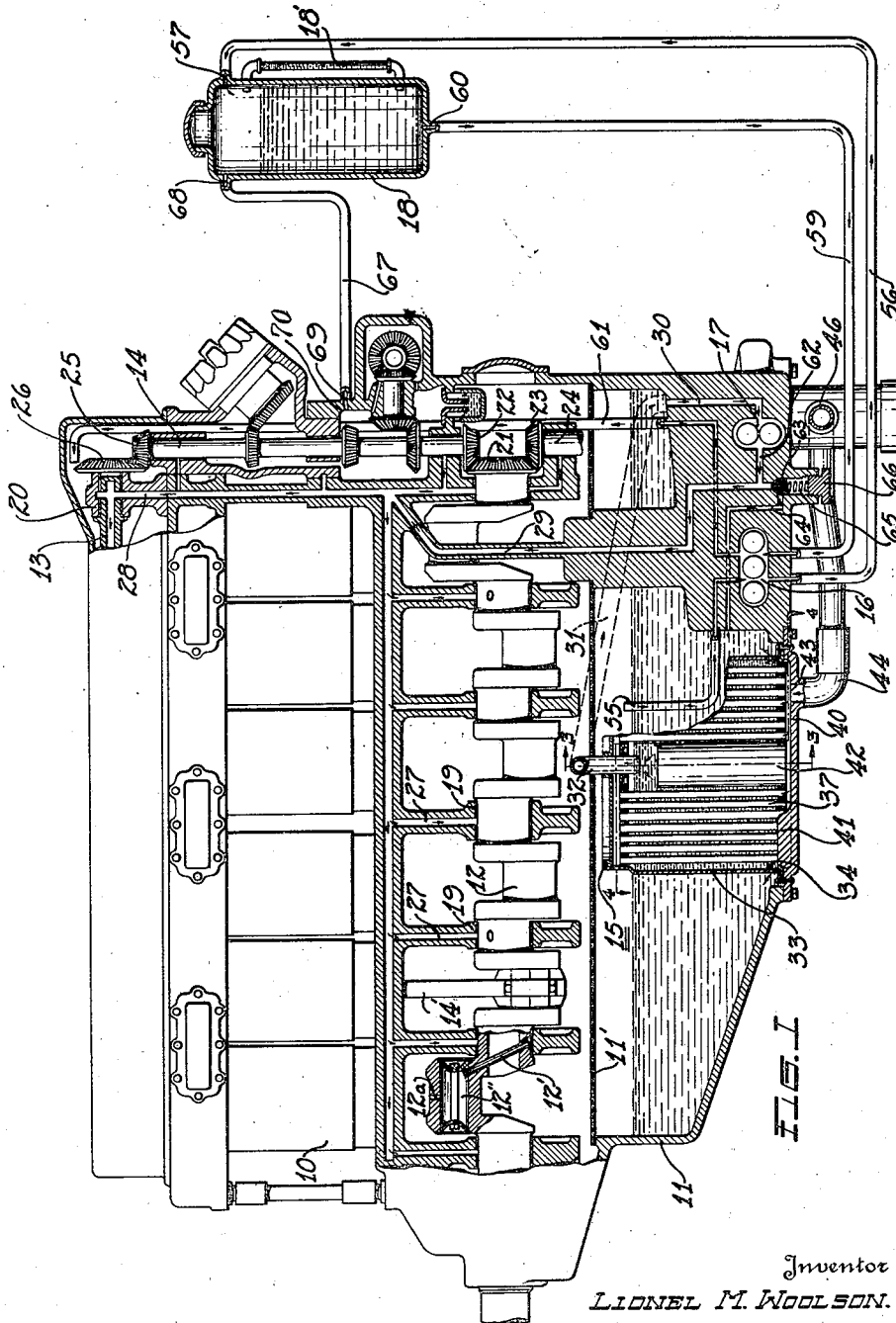
L. M. WOOLSON

1,910,375

INTERNAL COMBUSTION ENGINE

Filed June 3, 1927

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FIG. 2

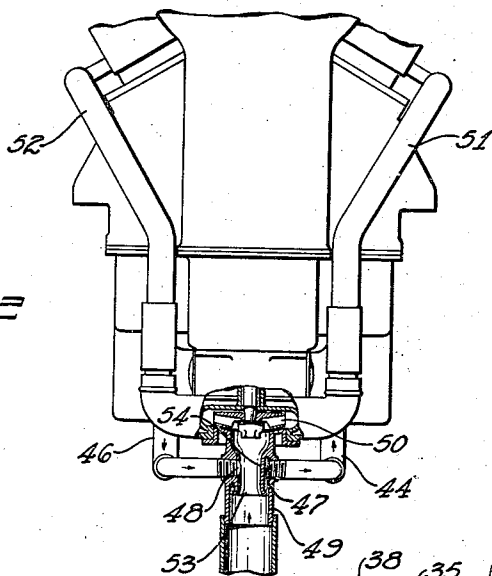


FIG. 3

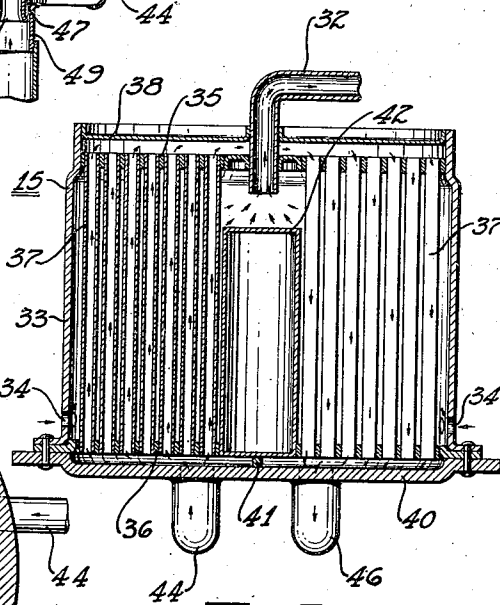
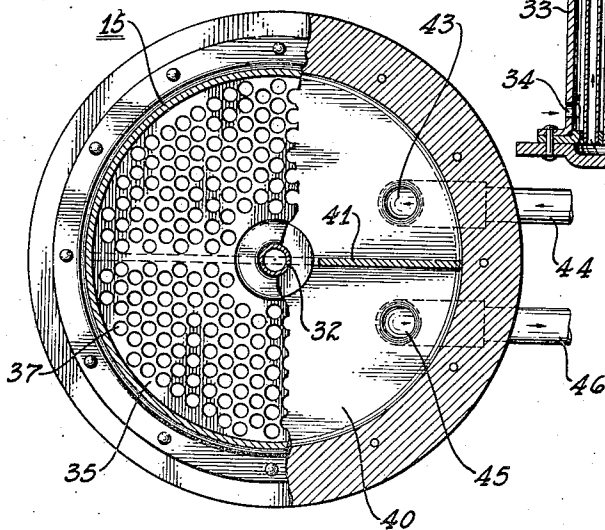


FIG. 4



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INTERNAL COMBUSTION ENGINE

Application filed June 3, 1927. Serial No. 196,157.

This invention relates to internal combustion engines, and more particularly to lubricating mechanisms therefor.

It is found desirable to cool the lubricant supplied to the bearings of internal combustion engines, particularly airplane engines, because such engines are likely to be operated at maximum load and at high speed over long periods of time. It is also desirable to automatically maintain a constant supply of oil to the engine crankcase and to automatically replenish this supply as it is diminished during operation in order that long non-stop flights may be made.

The supply of lubricant may be maintained by a make-up pump connected to an oil reservoir, and the level of the oil may be determined by a standpipe having an inlet opening in the crankcase, and connected to a scavenging pump having an outlet conduit extending to an oil reservoir external to the crankcase. The scavenging and make-up pumps are of small capacity since they are required to supply only small quantities, hence a pressure pump of relatively large capacity must be provided. Heretofore, when oil coolers have been provided, it has been the practice to locate them externally of the engine crankcase, and to circulate the oil supplied to the bearings through the cooler, hence large, heavy, cumbersome pipes of considerable length, have been required. Such pipes have the great disadvantage, particularly on airplane engines, that they increase the weight of the engine and the space occupied thereby and also are liable to break and cut off the engine oil supply.

An object of the present invention is to lubricate the moving parts of an internal combustion engine.

A specific object is to cool the lubricant supplied to the moving parts of an engine.

An additional object is to reduce the size and weight and to otherwise simplify the

lubricating mechanism of an internal combustion engine.

A feature of the invention is a lubricant cooler located in the crankcase of an engine closely adjacent to the oil pump and parts to be lubricated.

Another feature is an arrangement of oil cooling and oil pumping facilities adapted to maintain a supply of cool oil at a constant level in the crankcase of an internal combustion engine.

Other features and objects of the invention will appear from the following description taken in connection with the accompanying drawings, wherein like reference characters have been used to indicate like parts and wherein:

Fig. 1 is a side elevation, partly in section, of an internal combustion engine embodying this invention;

Fig. 2 is a fragmentary end view in elevation, partly in section of the engine of Fig. 1;

Fig. 3 is a view in section on line 3—3 of Fig. 1, and

Fig. 4 is a view in section on line 4—4 of Fig. 1.

The engine shown in Fig. 1 includes a cylinder block 10, crankcase 11, crankshaft 12, camshaft 13, and driving shaft 14, and connecting rods 14' only one of which is shown, adapted to connect with respective pistons not shown. The crankcase contains a horizontal filtering screen 11', an oil cooler 15, and associated oil pumps, including a combined scavenging and make-up pump 16, and a pressure pump 17; the pump 16 being connected to an oil tank or reservoir 18, external to the crankcase.

The crankshaft 12 is journaled in suitable bearings 19 in the cylinder block 10 and the camshaft 13 is mounted in bearings 20 only one of which is shown. The right hand end of the crankshaft is provided with a bevel gear 21 meshed with a gear 22 on the end of the vertical shaft 14, and also meshed

with a second gear 23 on the end of a second shaft 24. The shaft 14 has a bevel gear 25 on its upper end meshed with a bevel gear 26 on the end of the camshaft. The crankshaft is therefore adapted to drive the camshaft and also to drive the shaft 24 as a means of operating the pumps 16 and 17 in any suitable manner; for example, as shown and described in my Patent No. 1,698,044, dated January 8, 1929.

The crankshaft and camshaft bearings and the several gears just mentioned require lubrication and for this purpose ducts 27 extending to the various crankshaft bearings and a duct 28 extending to the camshaft bearings are provided and are connected to a main duct 29 extending to the outlet port of the oil pressure pump 17. The crankshaft 12 is provided with ducts 12' adapted to communicate during each revolution with the respective ducts 27. The ducts 12' extend up the crank arms and communicate with recesses 12'' in the cranks which are adapted to supply oil to the several connecting rod bearings through radial ducts 12a.

The oil ducts and the oil pumps 16 and 17 are shown more or less diagrammatically in order to simplify the explanation of the invention. The pumps 16 and 17 may be ordinary gear pumps or any other suitable type. The inlet port of the pump 17 is connected by a duct 30 and a conduit 31 to the oil cooler 15. A duct 62 normally closed by a spring pressed relief valve 63 is adapted to communicate upon opening of the valve with a duct 64 extending to the inside of the crankcase.

The oil cooler, which is positioned substantially in the middle of the crankcase, includes a casing 33 having a circumferential row of inlet openings 34 near the bottom thereof. The upper and lower ends of the casing are closed by circular plates 35 and 36 respectively, Figs. 3 and 4, having a plurality of holes or perforations in which are inserted the opposite ends of a corresponding plurality of pipes or flues 37. The plates 35 and 36 are joined to the casing and to the flues 37 by welding or in any other suitable manner so as to provide an oil and water tight closure. An outer, circular end-plate 38 is positioned at the upper end of the casing and is separated somewhat from the plate 35 to provide a passage for water between the flues on either side of the baffle 41. The plate 38 is likewise attached by an oil and water tight joint to the casing and is provided with a hole at its center through which the pipe 32 passes. The joint between the plate 38 and the pipe 32 is rendered oil and water tight in any suitable manner for example by welding. A solid bottom plate 40 is attached to the casing 33 at the lower end thereof to provide a water and oil tight closure and is spaced a distance

from the end plate 36 to allow for the passage of water into the flues 37 on one side of the baffle 41 and out of the flues on the other side thereof. The baffle 41 consists of an integral diametral flange on the plate 40 which extends entirely across the plate and engages at its upper edge the bottom of the plate 36 and also the bottom of the cylindrical baffle 42 which is inserted through a hole in the center of this plate and welded or otherwise attached thereto to provide an oil and water tight joint. The plate 40 includes a water inlet port 43 connected to an inlet conduit 44 and a water outlet port 45 connected to an outlet conduit 46. The conduits 44 and 46 extend to respective outlet and inlet ports 47 and 48 in a main cooling water supply line 49, Fig. 2, including a water pump 50 and a conventional radiator, not shown, adapted to supply cooling water by means of conduits 51 and 52 to the water jackets of the engine cylinders. Inside of the pipe 49 is an integral tube 53 having a restricted neck portion 54 constituting a Venturi tube.

The scavenging portion of the oil pump 16 includes an inlet port connected to a stand pipe 55 in the crankcase, the opening of the stand pipe being located as near as possible to the middle of the crankcase and at the level at which it is desired to maintain the oil in the crankcase. An outlet port of the pump 16 is connected by a conduit 56 to an inlet opening 57 at the top of a reservoir or oil tank 18. The make-up portion of the pump includes an inlet port connected by a conduit 59 to an outlet opening 60 in the bottom of the tank 18 and also includes an outlet port connected to a pipe 61 extending vertically adjacent to the shaft 14, its upper end being open and above the gear 26. An overflow conduit 67 has one end connected to a port 68 at the top of the tank 18 and its other end connected to a port 69 opening into the drive shaft housing 70, whereby foam and excess oil may be drained into the crankcase, and air may be admitted and expelled from the tank as the oil level therein rises or falls. The crankcase is of course open to atmospheric pressure via the usual filling conduit not shown. The tank 18 is provided with an oil level gauge 18' which may be of the boiler gauge type, for enabling the oil level to be observed at all times.

In the operation of the cooling and lubricating system of this invention, oil from the crankcase 11 enters the casing 33 of the cooler 15 through the ports 34 and passes between the flues or pipes 37 as indicated by the arrows in Fig. 3. Under the suction of the pump 17, the oil in the cooler flows through the outlet pipe 32, the direction of flow being determined by the cylindrical baffle 42, which serves to effect an even distribution of the oil through the cooler, whereby

most efficient operation of the cooler is secured. The oil passes through the conduit 31 and the duct 30 into the pump 17. From the outlet port of this pump, the oil is forced up through the duct 29 into the ducts 27 and 28, and thence to the bearings 19 and 20, and via the ducts 12', 12'' and 12a to the connecting rod bearings. The pressure of oil supplied by the pump 17 is determined by the relief valve 63 in accordance with the tension of the spring 65 which may be adjusted by turning the threaded plug 66. When the pressure of oil exceeds the force of the spring 65, the valve 63 opens and the excess oil passes out through the duct 64 which empties into the crankcase.

The make-up portion of the pump 16 receives oil from the tank 18, via conduit 59, and pumps this oil through conduit 61. This fresh oil flows down over the camshaft and driving shaft gears into the crankcase and replenishes the oil therein. The make-up pump is preferably designed to supply oil approximately at the rate at which it is consumed or in a volume slightly greater than this rate. When the oil in the crankcase rises above the opening of the stand pipe 55 it is drawn through this pipe into the scavenging portion of pump 16 and is forced back via conduit 56 into the supply tank 18. The scavenging pump preferably has a slightly greater capacity than the make-up pump so that should the make-up pump supply oil faster than it is consumed the oil in the crankcase will nevertheless always be maintained at the level of the opening of the stand pipe.

The oil in the crankcase becomes heated by contact with the bearings and other hot parts of the engine and this oil is cooled, before being re-supplied to the bearings, by contact with the flues 37 of the cooler 15, in which water is circulated as follows: Referring to Fig. 2, the water flowing through the main engine cooling line 49, under the action of pump 50, passes through the Venturi tube 53, and in accordance with the well known action of such tubes, a difference in pressure is produced between the branch outlet opening 47 and the branch inlet opening 48, such that water is forced out of the outlet opening and is drawn in through the inlet opening. The outlet opening 47 communicates with the conduit 44, whereas the inlet opening communicates with the conduit 46. Water flowing from the outlet opening passes through conduit 44 into the inlet port 43 of the cooler and is directed by the baffle 41 up through the flues at one side of the baffle and down through the flues on the opposite side thereof, out through the outlet port 45 and, via the conduit 46, to the inlet port 48 of the Venturi tube, where it merges with the stream in the main line. A sufficient vol-

ume of water is forced through the flues to maintain the oil in the cooler at a suitable operating temperature, the volume being determined by the size of the conduits, the Venturi tube and the water pump, and the rate of flow in the water in the main line.

By virtue of the fact that the cooler 15 is positioned within the crankcase 11 closely adjacent to the pump 17 and the engine parts to be lubricated, the conduit 31 connecting this cooler to the pressure pump 17 may be relatively short and no additional conduit connecting the crankcase to the inlet openings of the cooler is required, hence the weight of the mechanism and the space occupied thereby are reduced so that a compact structure results and the danger of failure of the oil supply to the bearings caused by breakage of the pipes is minimized. Moreover, in this location, the oil in the cooler is quickly warmed in cold weather by heat transmitted thereto from the combustion chamber by conduction through the metal of the engine and also by the water circulation through the flues of the cooler which is warmed by passage through the water jackets of the cylinders and is not reduced to a low temperature in the radiator, and the danger of an inadequate oil supply when starting cold, because of clogging of the oil pipes, is avoided.

Since the volume of oil delivered by the pressure pump 17 may be of the order of 10 gallons per minute, whereas the volume delivered by the scavenging pump and the make-up pump need only be of the order of 10 gallons per hour, the pipes 56 and 59 may be very small so that no serious disadvantage results from extending these pipes a considerable distance to the oil tank 18, because a supply of oil is always present in the crankcase and no considerable weight or added space is involved. The oil tank 18 may therefore be located at a distance from the engine in a position free from material vibration and where the oil supply can be constantly observed. The tank 18 may, of course, if desired, be mounted on the engine itself.

The present invention has the further advantage that an airplane engine constituting a complete operative unit is provided capable of operation for a considerable period of time without the necessity of manually adding oil.

The oil cooler has been shown preferably connected to the intake line of the force pump, but instead it may also be included in the intake line of either one of the other pumps.

Although this invention has been described in connection with certain specific embodiments, the principles involved are susceptible of other applications that will readily occur to persons skilled in the art,

hence the invention is to be limited only as indicated by the scope of the appended claims.

What is claimed is:

- 5 1. A lubricating system for an internal combustion engine including an oil-containing crankcase, comprising an oil reservoir, means for circulating oil from said reservoir to said crankcase and from said crankcase
10 to said reservoir, means including a force pump for supplying oil to moving parts of said engine, and an oil cooling device in the crankcase through which oil is drawn by said force pump from the crankcase.
- 15 2. The combination with an internal combustion engine including a cylinder block, a crankcase connected to said cylinder block, a crankshaft enclosed by said crankcase, a camshaft and a driving connection between
20 said crankshaft and said camshaft, of means for supplying lubricating oil to said crankshaft and camshaft and for maintaining a substantially constant level of oil in said crankcase comprising an oil cooling device
25 positioned in said crankcase, a pressure pump connected between said device and said shafts for supplying lubricating oil thereto, and a combined scavenging and make-up pump having a capacity materially
30 less than said force pump, an oil reservoir external to said crankcase and conduits connecting said make-up and scavenging pumps to the bottom and top respectively of said
35 reservoir, a stand pipe in said crankcase connected to said scavenging pump and an outlet conduit from said make-up pumps, said conduit having an outlet opening positioned above said camshaft and at a level
40 above the level of oil of said reservoir.
- 45 3. A lubricating system for internal combustion engines, comprising a crankcase arranged to receive oil draining from lubricated parts of the engine, an oil cooler within the engine crankcase through which oil
45 passes, a pump within the engine, and connections within the engine leading from the pump to the cooler and the engine parts requiring lubrication, said pump circulating
50 oil from the crankcase through the cooler to the engine parts requiring lubrication.
- 55 4. A lubricating system for internal combustion engines, comprising a crankcase arranged to receive oil draining from lubricated engine parts, an inclosed oil cooler submerged in and in open communication with the oil in the crankcase, means for maintaining
60 a predetermined level of oil in the crankcase, conduit means within the engine leading from the cooler to the engine parts to be lubricated, a pump within the engine for conducting oil from the cooler through the conduit means, and a pressure relief for the conduit means.
- 65 5. A lubricating system for internal combustion engines comprising a crankcase arranged to receive oil draining from lubricated engine parts, means for conducting oil from the crankcase to some of the engine parts to be lubricated, a reservoir, means for conducting oil in excess of a predetermined
70 quantity from the crankcase to the reservoir, and means for conducting oil from the reservoir to other of the engine parts to be lubricated.
- 75 6. A lubricating system for internal combustion engines comprising a crankcase arranged to receive oil draining from lubricated engine parts, means for conducting oil from the crankcase to some of the engine
80 parts to be lubricated, a reservoir, means for conducting oil from the crankcase in excess of a predetermined quantity to the reservoir, means for conducting oil from the reservoir to other of the engine parts to be lubricated,
85 and an overflow connection from the reservoir to the engine crankcase.
- 90 7. A lubricating system of the wet sump type for internal combustion engines, comprising a crankcase arranged to receive and contain oil draining from lubricated engine
95 parts, a reservoir, conduit means for conducting oil in excess of a predetermined quantity from the crankcase to the reservoir, conduit means for conducting oil from the reservoir to engine parts to be lubricated,
100 and a conduit extending from the reservoir to the crankcase, said conduit being connected with the upper portion of the reservoir.
- 105 8. A lubricating system for internal combustion engines comprising a crankcase arranged to receive oil draining from lubricated parts of the engine, means for conducting
110 oil from the crankcase to some of the engine parts to be lubricated, a reservoir connected with the crankcase, and means for conducting oil to the reservoir from the crankcase and from the reservoir to other
115 parts of the engine to be lubricated.
- 120 9. A lubricating system for internal combustion engines comprising a crank case arranged to receive oil draining from lubricated parts of the engine, a surplus oil reservoir, a pressure pump adapted to circulate
125 oil from the crank case to some of the points of lubrication, a scavenging pump adapted to force surplus oil from the crank case to said reservoir, and a make-up pump to force oil from the reservoir to one of the points of lubrication, said pressure pump having a large capacity relative to the scavenging
130 and make-up pumps.
- 135 10. A lubricating system for internal combustion engines comprising a crank case arranged to receive oil draining from lubricated parts of the engine, a surplus oil reservoir, a pressure pump adapted to circulate
140 oil from the crank case to some of the points of lubrication, a scavenging pump adapted to force surplus oil from the crank case to said reservoir, a stand pipe to determine the

circulation of the scavenging pump, and a make-up pump to supply oil at a low rate from the reservoir to a high point of lubrication on the engine.

- 5 11. An oiling system of the wet sump type, for an internal combustion engine, comprising engine cooling fluid means within the engine to cool the oil, means within the engine including a pump to urge cooled
10 oil towards the engine parts to be lubricated, means within the engine for conducting used oil to the cooler, means within the engine tending to add an excess of oil to the sump, and means within the engine tending to
15 maintain a constant level of oil in the sump.

In testimony whereof I affix my signature.

LIONEL M. WOOLSON.

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