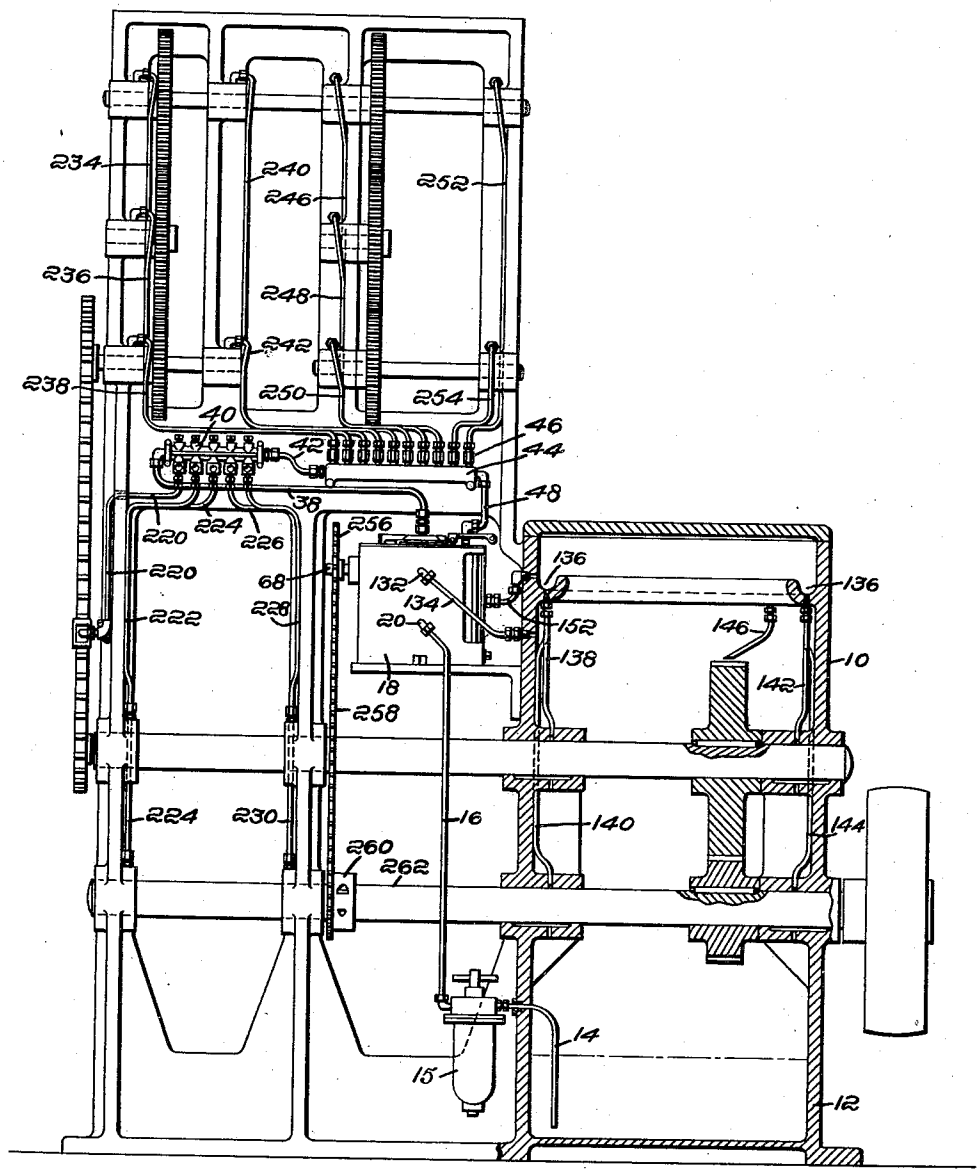
June 20, 1939. F. C. BLANCHARD 2,162,932

LUBRICATION APPARATUS

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Fig. 1.



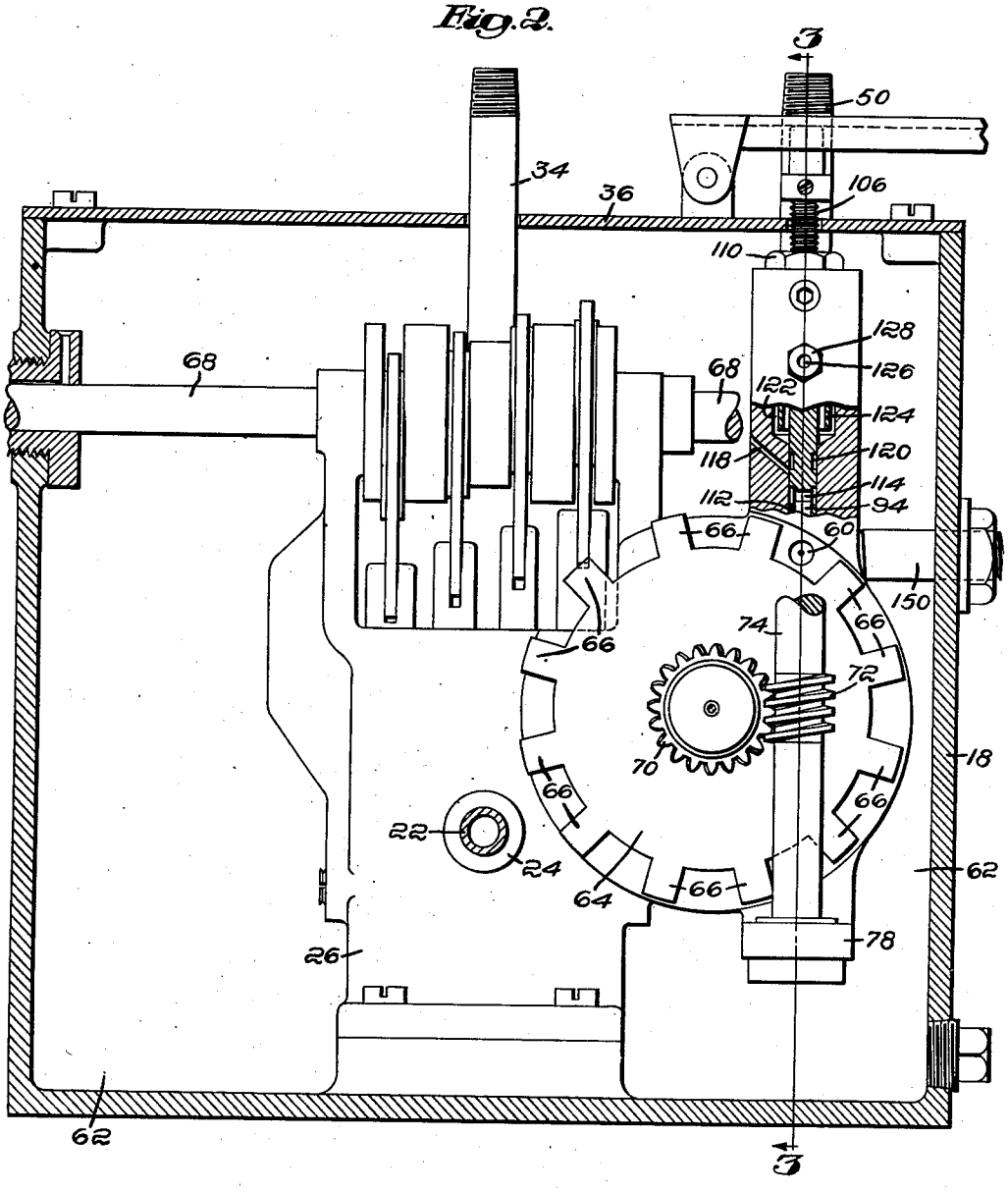
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LUBRICATION APPARATUS

Filed Jan. 18, 1937 4 Sheets-Sheet 2

Fig. 2.



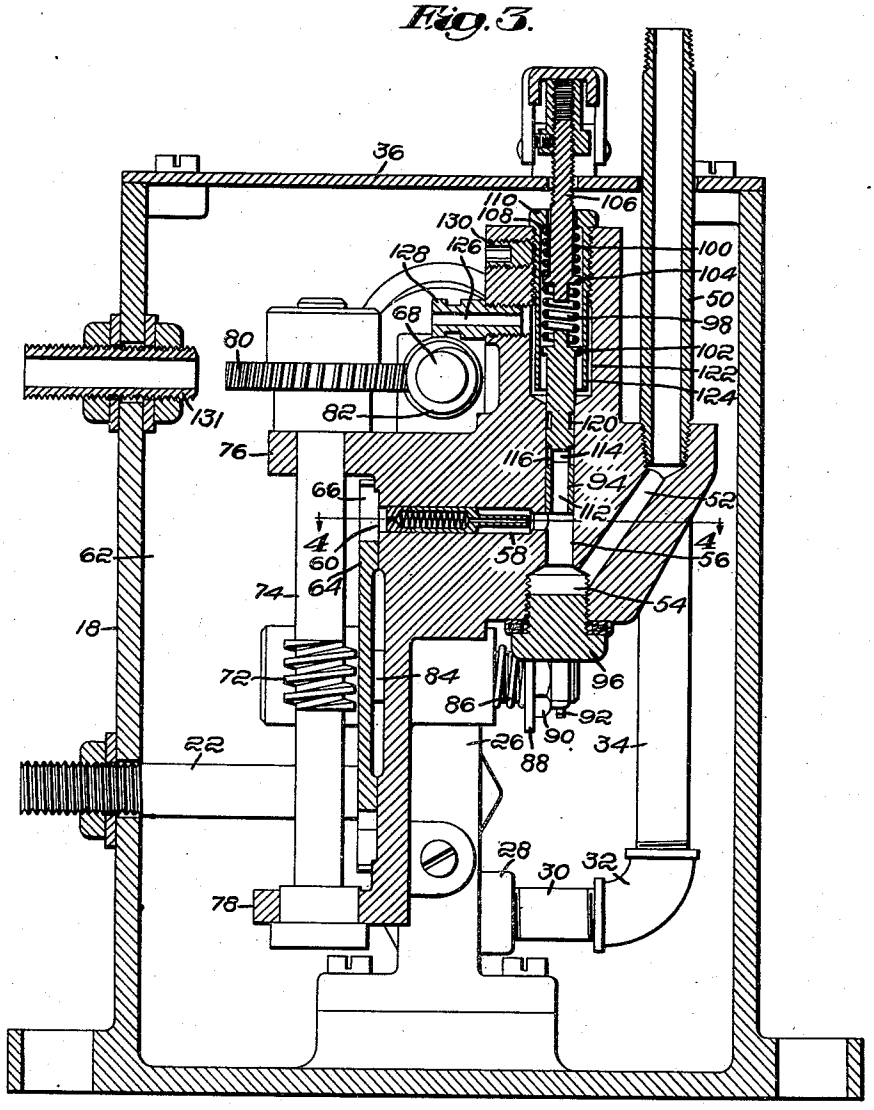
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LUBRICATION APPARATUS

Filed Jan. 18, 1937 4 Sheets-Sheet 3

Fig. 3.



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LUBRICATION APPARATUS

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Fig. 4.

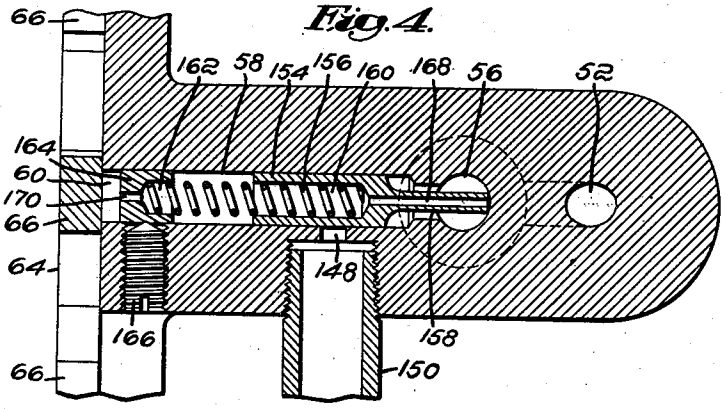


Fig. 5.

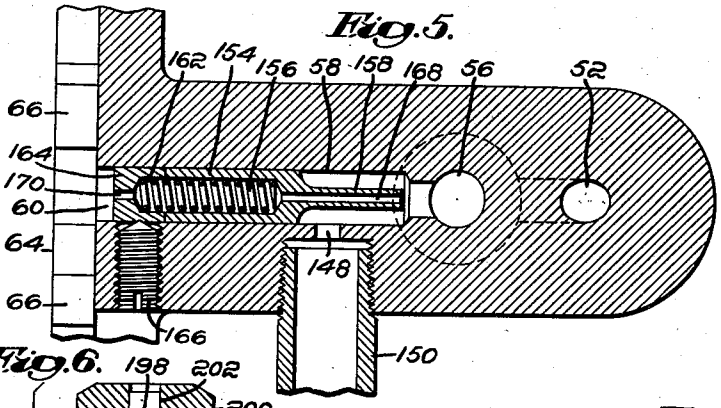


Fig. 6.

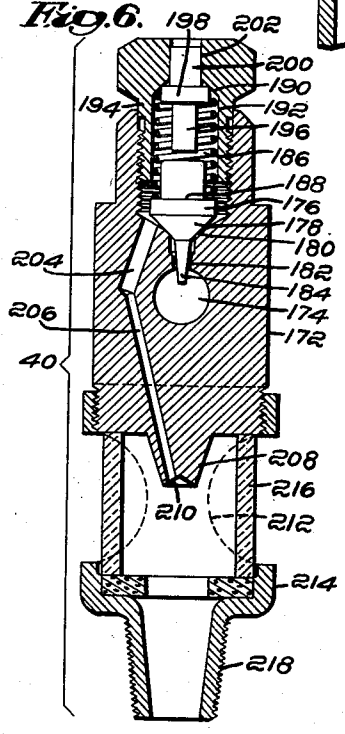
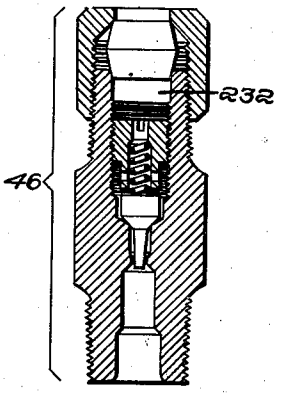


Fig. 7.



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Patented June 20, 1939 2,162,932

UNITED STATES PATENT OFFICE

2,162,932

LUBRICATION APPARATUS

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Application January 18, 1937, Serial No. 121,071

20 Claims. (Cl. 184—7)

This invention relates to lubrication apparatus, and is more especially concerned with interconnected dual systems, one of which serves one or more working parts requiring a continuous supply of oil, and the other of which serves one or more working parts requiring only an intermittent supply of oil. Sometimes, as in the present example, the working parts requiring a continuous supply of oil are enclosed within a housing whose lower portion constitutes a sump to which oil is returned, while the parts requiring only an intermittent supply of oil are extraneous to the housing and no oil is returned from them to the source of supply.

In the present example, the sump is common to both systems, and there is a pump also common to both and drawing oil from the sump and supplying oil to both systems, the pump inlet being connected to the sump, and the pump outlet being connected to one or more feeders serving the extraneous working part or parts. In the present example, the system extraneous to the housing includes a loop line or conduit to which oil is supplied by the pump in excess of the requirements of the feeder or feeders, and the excess oil is returned to a reservoir within which the pump is located.

Furthermore, in the present example, pressure pulsations are created in the loop line or conduit by a power driven valve which opens and closes the return end or outlet of the loop line to the reservoir. The pulsations thus impressed upon the oil in the loop line cause the feeder or feeders to respond, the feeders opening when the pressure rises due to the closing of the return end of the loop line, and closing when the pressure drops due to the opening of the return end. The maximum pressure in the loop line is predetermined by a pressure limiting or relief valve which discharges oil into the reservoir. The oil returned to the reservoir, whether by the relief valve or by the power driven valve, creates in the reservoir a body of oil whose level is maintained by a drain conduit leading from the reservoir and discharging to the sump. The pump is submerged in this body of oil and its working parts are thus lubricated.

In the present example, moreover, oil is taken from the circulating column in the pulsating system and is utilized to lubricate the working part or parts within the hereinbefore mentioned housing, the latter to this end being provided with a reservoir, herein conveniently in the form of a gutter having an outlet or outlets to the working part or parts within the housing. The supply of oil to this gutter is under the control of an automatic, pressure-responsive valve responding to the pressure fluctuations in the circulating column. When the power driven valve closes the return end of the loop line or conduit and thus raises the pressure in the latter, this pressure responsive valve closes and stops the discharge of oil to the gutter. When, on the other hand, the power driven valve opens the return end of the loop line and thus lowers the pressure in the latter, this pressure responsive valve opens the loop line to the gutter, thus maintaining in the latter a supply of oil which gravitates to the working part or parts within the housing.

Thus it is evident that the dual systems, each operating in its own way, have much that is common to both, such as the sump, the pump and the reservoir in which the pump is submerged in oil. A filter between the sump and the pump inlet filters the oil over and over again during the circulation common to both systems.

The invention will best be understood by reference to the following description when taken in connection with the accompanying drawings illustrating one specific embodiment of the invention, while its scope will be pointed out more particularly in the appended claims.

In the drawings:

Fig. 1 is a vertical, sectional view of a machine equipped with lubrication apparatus embodying the invention;

Fig. 2 is a vertical, sectional view illustrating the pumping unit with its pump and reservoir;

Fig. 3 is a vertical, sectional view on line 3—3 of Fig. 2;

Fig. 4 is a horizontal, sectional view on line 4—4 of Fig. 3 but with the pressure responsive valve closed;

Fig. 5 is a horizontal, sectional view like Fig. 4 but with the pressure responsive valve open;

Fig. 6 is a vertical, sectional view of a pressure responsive feeder of one type serving extraneous bearings; and

Fig. 7 is a vertical, sectional view of a pressure responsive feeder of another type serving other extraneous bearings.

Referring to the drawings and to the embodiment of the invention illustrated therein by way of example, and having reference at first to Fig. 1, there is shown a housing 10 presenting a sump 12 serving as a primary reservoir from which oil is drawn and to which oil is returned and subsequently re-used. In other words, this primary

reservoir is a part of a circulatory system. A part of this circulatory system is an intake pipe 14 having an inlet near the bottom of the reservoir and leading to the inlet of an appropriate filter 15 (for example the commercially known filter known as the Cuno and manufactured under U. S. Letters Patent No. 1,414,120).

From the filter outlet, a pipe 16 leads upwardly and is connected to the inlet of an appropriate pump such as that which is disclosed in U. S. Letters Patent No. 2,047,352 issued to me July 14, 1936, to which reference may be had for such details as are not shown and described herein. As shown in that patent, the pump inlet is provided with a strainer through which oil is drawn from a reservoir within a casing which houses the pump. In the present invention, however, although there is a similar casing 18 and although it provides a reservoir, as will hereinafter appear, nevertheless the pipe 16 does not communicate with the reservoir but leads directly to the pump inlet whose strainer, shown in the patent, is omitted.

The pipe 16 is attached to an elbow 20 (see Fig. 1) which, in turn, is attached to a pipe 22 (see Fig. 3) which extends through the adjacent wall of the casing 18 and is connected to the inlet 24 (see Fig. 2) of a pump 26 like that disclosed in the aforesaid patent, subject to certain changes hereinafter to be noted. The pump has an outlet 28 (see Fig. 3) discharging through a pipe 30, elbow 32 and pipe 34, the latter leading upwardly through a cover 36 at the top of the casing 18, as shown in Fig. 2. This pipe (see Fig. 1) is connected by a pipe 38 to one or more, herein a gang of pressure responsive feeders 40 hereinafter described, and from this gang of feeders a pipe 42 leads to a header or manifold 44 which supplies one or more pressure responsive feeders 46 hereinafter described.

A pipe 48 leads from the header or manifold 44 and is connected to the upper end of a return pipe 50 (see Fig. 3) which discharges oil through a passage 52 to a chamber 54. Communicating with the upper end of this chamber is a cylinder 56 which, in turn, communicates with a passage 58 having an outlet 60 adapted to discharge part of the returning oil into a secondary reservoir 62 within the casing 18. When this outlet is open, oil drawn from the sump passes through the pump and loop line or conduit including the pipes 38, 42 and 48 and a small proportion of the oil is delivered into the reservoir 62 which may be considered a secondary reservoir. The remainder is delivered to a tertiary reservoir as will appear hereinafter. When the outlet 60 is open, as stated, the pressure in the loop line or conduit is relatively low (as 5 to 10 pounds, for example) and is insufficient to cause the feeder or feeders to respond.

When this outlet is closed as by a valve 64, presently to be described, the pressure in the conduit rises abruptly to a relatively high value (as one hundred and fifty pounds, for example) which is more than sufficient to make the feeders respond and open. The degree of pressure developed in the system when the valve 64 closes the outlet 60 is determined by a pressure relief valve presently to be described.

In the present example, the valve 64 is a slowly rotating plate having a series of spaced lobes 66 (see Fig. 2) which successively close the outlet 60. This plate is power driven as by appropriate mechanism connecting the same to a pump driving shaft 68, the driving mechanism (see Fig. 2) in the present example comprising a worm gear 70 which meshes with and is driven by a worm 72 suitably formed on or secured to a vertical shaft 74 which is mounted in upper and lower bearings 76 and 78. To the upper end of this shaft is secured a worm gear 80 which meshes with and is driven by a worm 82 suitably formed on or secured to the pump driving shaft 68. The plate valve 64 is maintained in firm engagement with the adjacent face of the pump body as by securing the plate valve and the worm gear 70 to a shaft 84 which extends through the pump body and is encircled on the opposite side of the latter by a spring 86 which rests at one end against the pump body and at its other end against a washer 88 held in place on the shaft by a nut 90 threaded onto the latter and held in place by a cotter pin 92. This spring therefore constitutes an automatic take-up which prevents leakage of the valve when the latter is closed.

When the return end outlet 60 of the system is closed by one of the lobes 66 on the plate valve 64, there is produced in the system a comparatively high pressure for a brief interval of time, the pressure being of sufficient intensity to cause the feeder or feeders to respond. The intensity of this pressure is limited by a relief valve 94 which is movable vertically in the cylinder 56 and has its lower end exposed to the pressure within the chamber 54 whose lower end is closed by a threaded plug 96. The relief valve is suitably spring loaded as by two springs 98 and 100. The lower end of the spring 98 rests upon an abutment 102 near the upper end of the relief valve, and at its upper end by an abutment 104 presented by a plunger 106. The lower end of the spring 100 rests against the abutment 104, while its upper end is adapted to engage an abutment 108 presented by a plug 110 which is threaded into the pump body.

The spring loading on the relief valve is such that during the periods of high pressure the valve is lifted, at first, without resistance because the upper spring 100 has not yet engaged the abutment 108, and upon further movement of the relief valve a compression of the springs 98 and 100 occurs and the lower end of the relief valve uncovers the adjacent end of the passage 58, thus allowing oil returning from the incoming end of the conduit system to escape through the passage 58 to the reservoir.

The relief valve is provided with a vertical passage 112 extending from its lower end upwardly and communicating with a horizontal passage 114 which in turn communicates with an annular groove 116. The relief valve rises until its annular groove registers with a relief port 118 (Fig. 2) leading to the reservoir 62, and permits the escape of sufficient oil to limit the pressure in the system to that which is desired (for example, one hundred and fifty pounds) the pressure being predetermined by the spring loading on the relief valve.

Although the relief valve is provided with an annular oil sealing groove 120 to prevent excessive leakage of oil about the relief valve, there is nevertheless some leakage of oil into an annular chamber 122 (Fig. 3) about a depending skirt 124 on the plug 110 and from this chamber a small amount of oil is conducted through a passage 126 in a nozzle 128. Oil from this nozzle drips onto the worm 68 and lubricates the latter and the worm gear 80. The load of the springs 98 and 100 may be varied by turning the plug 110. A set-screw 130 preserves the adjust-

ment. Oil escaping into the reservoir 62 is maintained at a high level predetermined by an overflow, herein comprising a pipe 131 extending through the wall of the casing 18 and connected (see Fig. 1) by an elbow 132 and a pipe 134 to the interior of the housing 10, whence the oil is returned to the sump or primary reservoir 12.

From the system thus described, oil is taken to supply the other system which lubricates a working part or parts within the housing 10, the the latter, in this example, being provided with a tertiary reservoir conveniently in the form of a gutter 136 from which one or more conduits herein a plurality of conduits 138, 140, 142, 144 and 146 lead to working parts to lubricate them. This diversion of oil from the first system to the second system is conveniently accomplished by a pressure responsive valve, presently to be described, whose mode of operation is such that when the return outlet 60 is closed to create high pressure in the first system, the valve automatically moves and stops discharge of oil to the gutter 136. On the other hand, when the return outlet 60 is opened to cause a low pressure in the first system, the pressure responsive valve now to be described automatically opens the passages 58 and 148 to the gutter 136.

The valve by which this is accomplished will now be described, reference being had to Figs. 4 and 5. Leading from one side of the passage 58 is a port 148, and communicating with the port is a pipe 150 which as shown in Fig. 2 extends through the wall of the casing 18 and as shown in Fig. 1 is connected to an exterior pipe 152 leading to the gutter 136. Returning now to Figs. 4 and 5, the passage 58 constitutes a cylinder, within which is a piston valve 154 arranged to open and close the lateral port 148.

When the pump is at rest and when, consequently, there is no pressure in the system, a suitably arranged spring 156 urges the piston valve toward the right (see Fig. 4) and the valve 154 covers the port 148. Movement of the valve under the influence of the spring is suitably limited as by providing the valve with a slim stem whose extremity engages the far side of the cylinder 56. In the example shown, one end of the spring is seated at the inner end of a chamber 160 within the valve, and the other end of the spring is seated within a chamber 162 within a plug 164 secured in place as by a set-screw 166.

The piston valve 154 is provided with a longitudinal passage 168 and the plug 164 is provided with a longitudinal passage 170, the cross-sectional area of each being much less than that of the lateral port 148. When the pump starts, pressure quickly develops because the lateral port 148 is closed, and the pressure moves the valve to the position shown in Fig. 5, thus opening the port 148 and causing the delivery of oil through the port and to the gutter. This is because the passages 168 and 170 are so small in comparison with the port 148.

When, however, during the rotation of the plate valve 64 a lobe 66 on the latter closes the outlet opening 60 (see Fig. 4) pressure becomes equalized on opposite ends of the piston valve 154, the spring 156 asserts itself and moves the piston valve to the position first described, i. e., across the port 148, and a high pressure develops in the system so that surplus oil released by the pressure relief valve 94 escapes through the relief port 118 (see Fig. 3) into the reservoir 62 within the casing 18. This surplus oil accumulates in the reservoir 62 until the overflow level determined by the overflow pipe 131 is attained, and further excess oil drains out through the elbow 132 (see Fig. 1) and pipe 134 to the sump 12.

As already indicated, the pressure pulsations produced by the opening and closing of the outlet 60 are utilized to operate one or more pressure responsive feeders such as the feeders 40 and 46 for the extraneous working part or parts. The feeder 40 is fully shown and described in the aforesaid patent but will be described here, reference being had to Fig. 6. The feeder comprises a body or casing 172 provided with a supply passage 174 communicating with the pipes 38 and 42 shown in Fig. 1 forming a part of the system. Within the body 172 is a member 176 having a conical portion 178 constituting the valve proper and cooperating with a seat 180. Between the valve seat and the supply passage 174 there is a metering orifice 182 which is controlled by a metering pin 184. This pin has a very slight taper as compared with the valve 178.

In the lowermost position of the valve and metering pin, the latter clears the metering orifice 182 by a slight space which permits the lower end of the valve to be subjected to the pressure of the oil in the supply passage 174, thereby to lift the valve from its seat and to retract the metering pin within the orifice when the pressure rises high enough to overcome the loading of a spring now to be described.

The valve is arranged to respond to a predetermined pressure in the supply passage 174 as by being loaded by a spring 186 whose lower end rests against an abutment 188 on the valve, and whose upper end rests against an adjustable abutment 190 at the upper end of an axial chamber 192 in a screw 194 which is threaded into the valve casing 172. The spring is made the desired strength to hold the valve on its seat until the desired opening pressure occurs. The amount which the valve will open and the consequent effective area of the metering orifice is determined by an appropriate stop, herein a pin 196, having a body 200 which is tightly fitted into an axial hole 202 drilled in the screw 194. By rotating the screw in the proper direction the gap between the lower end of the stop pin 196 and the upper end of the valve member 176 may be varied to predetermine the rate of feed.

In this feeder, the valve and its seat are above the supply passage 174 and when the valve opens oil is permitted to flow upwardly past the valve into the chamber above the valve seat and the oil then gravitates through passages 204 and 206 to a nozzle 208 presenting an outlet 210. The rate of feed is observable through openings 212 in a casing 214 which is threaded onto the valve casing 172 and holds a glass tube 216, and presents a threaded nipple 218. In the example shown (see Fig. 1) the nipples of the several feeders are connected by pipes 220, 222, 224, 226, 228 and 230 which deliver oil at intervals to corresponding working parts of the machine shown.

The feeder 46 shown in Fig. 7 is generally similar to the feeder 40 just described, but instead of having a gravity outlet has a pressure outlet 232 from which oil is delivered under pressure and can therefore be used in situations calling for the delivery of oil to working parts above the feeder. Such an example is shown in Fig. 1 in which several feeders are connected to pipes 234, 236, 238, 240, 242, 246, 248, 250, 252 and 254 leading to corresponding working parts of the machine shown.

While the pump might be driven by a motor or other separate source of power, in the example shown it is driven by the machine itself and it starts and stops with the machine. To this end, it is conveniently driven from the machine as by a sprocket wheel **256** on the pump shaft **68**, and connected by a chain **258** to a sprocket wheel **260** secured to a shaft **262** of the machine.

While the general operation of the lubrication apparatus should be understood from the foregoing description, it will be reviewed briefly. Except for the fact that there is a permanent loss of oil at the extraneous working parts which require only slight, occasional oiling, and except that some oil is always maintained in the primary reservoir (sump), secondary reservoir (about the pump) and tertiary reservoir (gutter), all oil in the apparatus is continually, though not continuously, in circulation. The pump intake draws oil directly from the primary reservoir (sump) and forces it out under pressure which rises and falls as the power driven plate valve opens and closes. The pressure pulsations are applied to the pressure responsive feeders which open and close and feed oil to the extraneous working parts. Also, as the pressure rises and falls, the pressure fluctuations are utilized to operate the pressure responsive piston valve to take oil from the pulsating column and to keep the secondary reservoir (about the pump) supplied with oil, and also to keep the tertiary reservoir (gutter) supplied with oil. The surplus oil from the secondary reservoir returns directly to the sump. The oil which passes to the tertiary reservoir (gutter) is delivered by the latter to the working part or parts within the housing **20**, and the oil draining therefrom gravitates to the primary reservoir (sump), thus completing the cycle. As the filter is between the sump and the pump inlet all oil is filtered before being supplied to the working parts.

It should now be evident that the dual systems are interdependent, that they have the primary reservoir and the pump in common, and that they are coordinated by the described arrangement including the pressure responsive piston valve which not only causes the gutter to be supplied but which also assures an adequate supply of oil for the maintenance of a body of oil about the pump to lubricate its working parts. Of course, it is true that when no lobe of the rotating plate valve covers the outlet **60**, the latter discharges oil into the secondary reservoir, but that oil is supplemented by the discharge of oil by the pressure relief valve to the secondary reservoir, so that ample oil is supplied to the secondary reservoir for the maintenance of the desired body of oil to keep the pump submerged. It is apparent, from the foregoing, that the two systems are not only interconnected by the parts which they have in common, but that they are coordinated and interrelated so that two classes of lubrication are effected with but little more expense and complication than a single system of the type employing pressure responsive feeders.

Having thus described one embodiment of the invention, but without limiting myself thereto, what I claim, and desire, by Letters Patent, to secure is:

1. Lubrication apparatus comprising, in combination, first and second lubrication systems, a reservoir common to both systems and to which oil from both returns, a pump drawing oil from said reservoir and supplying oil to the first system, means to cause feeding and non-feeding periods in the first system, and means to cause oil to be taken from the first system during said non-feeding periods and supplied to the other.

2. Lubrication apparatus comprising, in combination, first and second lubrication systems, a reservoir common to both systems, and to which oil from both returns, a pump drawing oil from said reservoir and supplying oil under pressure to the first system, means to cause alternating high and low pressures in the first system, and means including a valve responsive to said pressures to cause oil to be taken from the first system during the period of low pressure therein and supplied to the second system.

3. Lubrication apparatus comprising, in combination, primary and secondary lubrication systems, said primary system including a pressure responsive feeder, a reservoir common to both systems and to which oil from both returns, a pump drawing oil from said reservoir and supplying oil under pressure to said primary system, means for causing in said primary system a high pressure to which said feeder responds and opens, and a low pressure, to which said feeder does not respond, and a valve responsive to said high and low pressures and causing oil to be taken from said primary system during said low pressure and supplied to said secondary system.

4. Lubrication apparatus comprising, in combination, two lubrication systems, one of which includes a pressure responsive feeder, a reservoir common to both systems and to which oil from both returns, a pump drawing oil from said reservoir and supplying oil under pressure to the system which includes said feeder, means to cause high pressure to which said feeder responds and opens and low pressure to which said feeder does not respond, and a valve responding to said low pressure and causing oil to be taken from the system which includes said feeder and supplied to the other systems, and responding to said high pressure and shutting oil off from said other system.

5. Lubrication apparatus comprising, in combination, two lubrication systems, one of which includes a pressure responsive feeder, a reservoir common to both systems and to which oil from both returns, a pump drawing oil from said reservoir and supplying oil under pressure to the system which includes said feeder, means to cause high pressure to which said feeder responds and opens and low pressure to which said feeder does not respond, a cylinder having a lateral port connected to the system which does not include said feeder and having a connection to the system which includes said feeder, a piston valve working in said cylinder across said port and subject to the pressure in the system which includes said feeder, and a spring which yieldingly resists uncovering of said port by said valve, said valve having a passage therethrough of smaller cross-sectional area than said port and through which passage oil pressure on opposite ends of said valve is equalized during said high pressure, thereby permitting said spring to assert itself to move said valve to a position in which it closes said lateral port.

6. Lubrication apparatus comprising, in combination, two lubrication systems, one of which includes a pressure responsive feeder, a reservoir common to both systems and to which oil from both returns, a pump drawing oil from said reservoir and supplying oil under pressure to the system which includes said feeder, means to cause high pressure to which said feeder responds and opens and low pressure to which said feeder

does not respond, a cylinder having an outlet from the system which includes said feeder, and having a lateral port connected to the system which does not include said feeder, means to open and close said outlet and to cause alternately high and low pressures in the system which includes said feeder, a pressure responsive piston valve working in said cylinder across said port and having one end subject to said high and low pressures, and a spring which yieldingly resists uncovering of said port by said valve and which yields to said low pressure and allows said valve to uncover said port, said valve having a passage therethrough of smaller cross-sectional area than said port and through which passage oil flows from the system which includes said feeder to said outlet, and through which passage oil pressure on opposite ends of said valve is equalized when said outlet is closed, thereby to permit said spring to assert itself to move said valve to a position in which it closes said lateral port.

7. Lubrication apparatus comprising, in combination, two lubrication systems, a primary reservoir common to both systems and to which oil from both returns, a pump common to both systems, drawing oil from said reservoir and supplying oil to both systems, and a secondary reservoir about said pump, receiving oil from one system and discharging surplus oil to said primary reservoir.

8. Lubrication apparatus comprising, in combination, two lubrication systems, a primary reservoir common to both systems and to which oil from both returns, a pump drawing oil from said reservoir and supplying oil to one system, means to cause oil to be taken from the one system and supplied to the other, and a secondary reservoir about said pump, receiving oil from the one system and discharging surplus oil to said primary reservoir.

9. Lubrication apparatus comprising, in combination, first and second lubrication systems, a primary reservoir common to both systems and to which oil from both returns, a pump drawing oil from said reservoir and supplying oil under pressure to the first system, a secondary reservoir about said pump and having an outlet to said primary reservoir, means to cause alternately high and low pressures in the first system, means including a valve responsive to the pressure in the first system to cause oil to be taken from the first system during the periods of low pressure and supplied to the second system, and means to cause oil to be taken from the first system and supplied to said secondary reservoir.

10. Lubrication apparatus comprising, in combination, first and second lubrication systems, the first system including a pressure responsive feeder, a primary reservoir common to both systems and to which oil from both returns, a pump drawing oil from said reservoir and supplying oil under pressure to the first system, a secondary reservoir about said pump and having an outlet to said primary reservoir, means for causing alternating high and low pressures to which said feeder responds, means to limit said pressure and to supply oil to said secondary reservoir, and a valve responsive to said pulsations and causing oil to be taken during periods of low pressure from the first system and supplied to the second system.

11. Lubrication apparatus comprising, in combination, two lubrication systems, one of which includes a pressure responsive feeder, a primary reservoir common to both systems and to which oil from both returns, a pump drawing oil from said reservoir and supplying oil under pressure to the system which includes said feeder, a secondary reservoir about said pump and having an outlet to said primary reservoir, means to cause high pressure to which said feeder responds and opens and to cause low pressure to which said feeder does not respond, means to determine the maximum pressure and to supply oil to said secondary reservoir, and a valve which responds to said low pressure and causes oil to be taken from the system which includes said feeder and supplied to the other system, and which valve responds to said high pressure and shuts off oil to said other system.

12. Lubrication apparatus comprising, in combination, two lubrication systems, one of which includes a pressure responsive feeder, a primary reservoir common to both systems and to which oil from both returns, a pump drawing oil from said reservoir and supplying oil under pressure to the system which includes said feeder, a secondary reservoir about said pump and having an outlet to said primary reservoir, means to cause high pressure to which said feeder responds and opens and to which said feeder does not respond, means to determine the maximum pressure and to supply oil to said secondary reservoir, a cylinder having an outlet from the system which includes said feeder to said secondary reservoir, and having a lateral port connected to the system which does not include said feeder, means to open and close said outlet and to cause alternately high and low pressures in the system which includes said feeder, a pressure responsive valve working in said cylinder across said port and having one end subject to said high and low pressures, and a spring which yieldingly resists uncovering of said port by said valve and which yields to said low pressure and allows said valve to uncover said port, said valve having a passage therethrough of smaller cross-sectional area than said port and through which passage oil flows from the system which includes said feeder to said outlet to said secondary reservoir, and through which passage oil pressure on opposite ends of said valve is equalized when said outlet is closed, thereby to permit said spring to assert itself to move said valve to a position in which it closes said port.

13. Lubrication apparatus comprising, in combination, a sump, a gravity type system from which oil returns to said sump, a reservoir having an outlet to said sump, a pressure type system including a conduit having two outlets, one to said gravity type system and the other to said reservoir and including also a pressure responsive feeder supplied by said conduit, a pump within said reservoir and having its inlet connected to said sump and its outlet connected to said conduit, means alternately to open and close said conduit outlet to said reservoir thereby to raise and lower the pressure in said conduit and to cause alternate feeding and non-feeding intervals of said feeder, and means operated by rise of pressure in said conduit to close said outlet to said gravity type system and operated by lowering of pressure in said conduit to open said outlet to said gravity type system.

14. Lubrication apparatus comprising, in combination, a sump, a gravity type system from which oil returns to said sump, a reservoir having an outlet to said sump, a pressure type system including a conduit having two outlets, one to said gravity type system and the other to said reservoir, and including also a pressure responsive feeder supplied by said conduit, a pump within said reservoir and having its inlet connected to said sump and its outlet connected to said con-

duit, means alternately to open and close said conduit outlet to said reservoir thereby to raise and lower the pressure in said conduit and to cause alternate feeding and non-feeding intervals of said feeder, a pressure limiting valve which limits pressure in said conduit by releasing oil therefrom to said reservoir, and means operated by rise of pressure in said conduit to close said outlet to said gravity type system and operated by lowering of pressure in said conduit to open said outlet to said gravity type system.

15. Lubrication apparatus comprising, in combination, a sump, a gravity type system from which oil returns to said sump, a reservoir having an outlet to said sump, a pressure type system including a conduit having two outlets, one to said gravity type system and the other to said reservoir, and including also a pressure responsive feeder supplied by said conduit, a pump within said reservoir and having its inlet connected to said sump and its outlet connected to said conduit, means alternately to open and close said conduit outlet to said reservoir thereby to raise and lower the pressure in said conduit and to cause alternate feeding and non-feeding intervals of said feeder, and means operated by rise of pressure in said conduit to close said outlet to said gravity type system and operated by lowering of pressure in said conduit to open said outlet to said gravity type system, the last-mentioned means including a valve, and a spring which tends to close said valve and is overcome by the lower pressure in said conduit.

16. Lubrication apparatus comprising, in combination, a sump, a gravity type system from which oil returns to said sump, a reservoir having an outlet to said sump, a pressure type system including a conduit having two outlets, one to said gravity type system and the other to said reservoir, not including also a pressure responsive feeder supplied by said conduit, a pump within said reservoir and having its inlet connected to said sump and its outlet connected to said conduit, means alternately to open and close said conduit outlet to said reservoir thereby to raise and lower the pressure in said conduit and to cause alternate feeding and non-feeding intervals of said feeder, and means operated by rise of pressure in said conduit to close said outlet to said gravity type system and operated by lowering of pressure in said conduit to open said outlet to said gravity type system, the last-mentioned means including a valve, and a spring which tends to close said valve and is overcome by the lower pressure in said conduit, said valve having a pressure equalizing passage which equalizes oil pressures on opposite ends of said valve when said conduit outlet to said reservoir is closed.

17. Lubrication apparatus comprising, in combination, two lubricating systems, a reservoir common to both systems, and to which oil from both returns, a pump drawing oil from said reservoir and supplying oil to the first system under pressure, means to cause alternately high and low pressures in the first system, and a control valve having two positions, one in which, during each period of high pressure in the first system, the supply of oil to the second system is cut off, and the other in which, during each period of low pressure in the first system, oil is supplied from the first system to the second system.

18. Lubrication apparatus comprising, in combination, two lubricating systems, a reservoir common to both systems, and to which oil from both returns, a pump drawing oil from said reservoir and supplying oil to the first system under pressure, means to cause alternately high and low pressures in the first system, a control valve having two positions, one in which, during each period of high pressure in the first system, the supply of oil to the second system is cut off, and the other in which, during each period of low pressure in the first system, oil is supplied from the first system to the second system, and means to cause said valve to occupy said positions in alternation.

19. Lubrication apparatus comprising, in combination, a pressure type system, a gravity type system, a sump which receives oil from said gravity type system, a pump drawing oil from said sump and supplying oil under pressure to said pressure type system, and means intermittently to cause oil to be taken from said pressure type system at predetermined intervals and delivered to said gravity type system and to said sump in alternation, said means including a power-driven valve.

20. Lubrication apparatus comprising, in combination, a pressure type system, a gravity type system, a sump which receives oil from said gravity type system, a pump drawing oil from said sump and supplying oil under pressure to said pressure type system, a reservoir associated with said pump and having an outlet to said sump, and means intermittently to cause oil to be taken from said pressure type system at predetermined intervals and delivered to said gravity type system and to said reservoir in alternation, said means including a power driven valve.

FREDERICK C. BLANCHARD.

CERTIFICATE OF CORRECTION.

Patent No. 2,162,932. June 20, 1939.

FREDERICK C. BLANCHARD.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 6, first column, line 40, claim 16, for the word "not" read and; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 22nd day of August, A. D. 1939.

Leslie Frazer

(Seal) Acting Commissioner of Patents.