June 9, 1959 J. W. MAKI 2,889,821

ENGINE LUBRICATING SYSTEM

Filed Oct. 7, 1953 2 Sheets-Sheet 1

Fig. 1

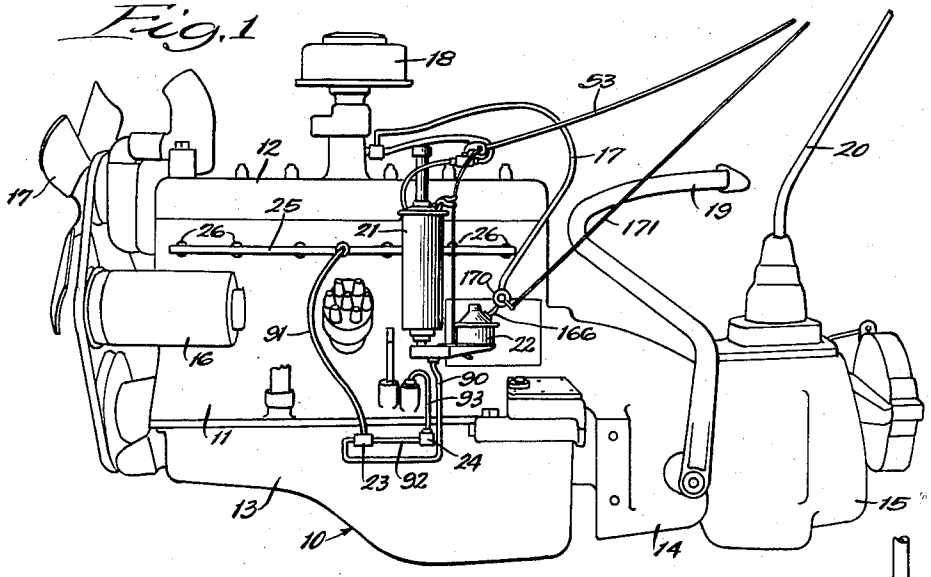
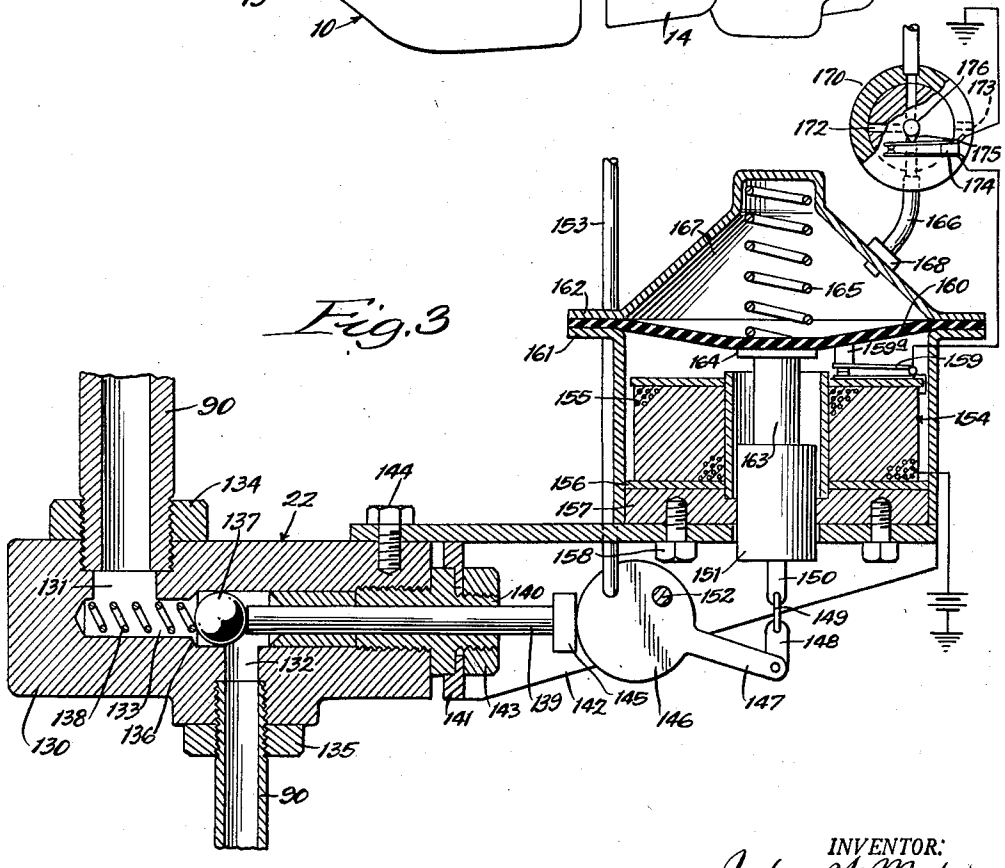


Fig. 3



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Filed Oct. 7, 1953 2 Sheets-Sheet 2

Fig. 2

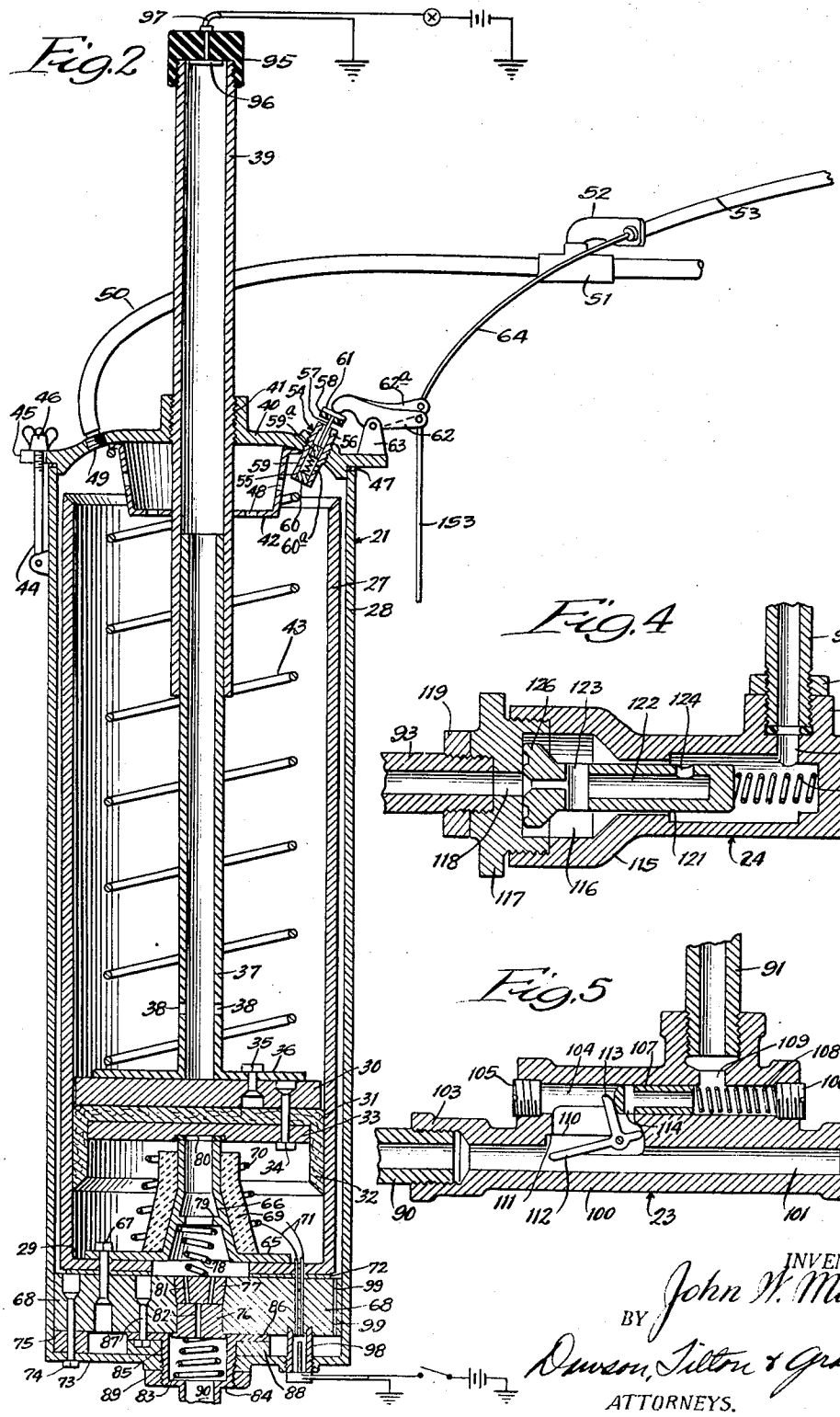


Fig. 4

Fig. 5

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United States Patent Office 2,889,821 Patented June 9, 1959

2,889,821

ENGINE LUBRICATING SYSTEM

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Application October 7, 1953, Serial No. 384,635

6 Claims. (Cl. 123—196)

This invention relates to a lubricating system and, more particularly, to an auxiliary lubricating system adapted for use with internal combustion engines such as those that are found in automobiles, trucks, etc.

It is well known that during initial starting or cranking of an internal combustion engine that a great amount of wear occurs at the bearing surfaces because of the lack of adequate lubrication at this time. The reason that there is not sufficient lubrication when an engine is first started is that the oil pump is actuated by the engine itself and therefore is not operating at a sufficiently high rate of speed during the cranking to maintain adequate oil pressure and therefore adequate lubrication. This condition is especially serious during cold weather because the oil becomes thick when it is cold and it is therefore difficult to force it through the lubrication conduits and ports, etc., and a much longer period results before proper lubrication of the engine takes place. It would be desirable, then, to provide a pre-oiler that would be operative to supply oil to the bearing surfaces of an internal combustion engine, etc. during the cranking or starting thereof. Even more desirable would be a pre-oiler in which the oil was heated prior to being distributed to the bearing surfaces for in this way the severe wear that occurs in cold weather would be, to a great extent, avoided.

It is also known that after an engine is operating and is slowed down, that the oil pressure in the engine decreases seriously. For example, in an automobile when waiting for traffic or a stop light, etc., the engine is normally idled and it is readily observed that the oil pressure decreases considerably at this time. It would be advantageous to provide a lubrication system in which the oil pressure remained relatively constant under substantially all operating conditions, and oil pressure-compensating means would therefore be desirable.

There has long been a need for a practicable means for supplying pre-heated oil under pressure to an internal combustion engine prior to the initial starting or cranking thereof and for maintaining the oil pressure more constant under all operating conditions. I have provided such a means.

It is accordingly an object of this invention to provide apparatus for supplying heated lubricant to an internal combustion engine prior to the initial starting thereof. Another object of the invention is to provide apparatus for heating lubricant outside of an internal combustion engine so that heated lubricant may be supplied thereto prior to cranking of the engine. Still another object is to provide apparatus for maintaining the oil pressure of an internal combustion engine more constant under all operating conditions.

Still a further object is in the provision of an accumulator operatively arranged with an engine for receiving oil therefrom during the normal operation of the engine and for providing the engine with oil during the starting thereof; the accumulator being able to maintain heated oil received therein at an elevated temperature for relatively long periods and being equipped with means for heating oil that is stored therein. Still a further object is to provide pump means in such an accumulator for forcing oil into an engine both during initial starting thereof and after the engine is operating, but when the oil pressure thereof drops below a predetermined value whereby a relatively constant engine oil pressure is maintained under all operating conditions. Yet a further object is to provide control apparatus in conjunction with said accumulator to enable the results indicated above to be achieved. Additional objects and advantages will appear as the specification proceeds.

An embodiment of the invention is illustrated in the accompanying drawing, in which—

Fig. 1 is a side view in elevation of an internal combustion engine having my oil pressure system incorporated thereon; Fig. 2 is a vertical sectional view taken through substantially the center of the accumulator; Fig. 3 is a longitudinal sectional view of the shutoff valve used in the system; Fig. 4 is a longitudinal sectional view of the flow limit valve used in the system; and Fig. 5 is a longitudinal sectional view of the diverter valve used in the system.

Illustrated in Fig. 1 is an internal combustion engine designated generally with the numeral **10**. The engine **10** is one that is customarily found in trucks or automobiles, etc., and includes a block **11**, head **12**, pan **13**, clutch assembly **14**, and transmission **15**. The engine **10** may also include the customary generator **16**, fan **17**, carburetor **18**, clutch lever **19**, and gear shift **20**. The engine **10** is wholly conventional and while parts normally carried thereby and operative therewith are illustrated, it is believed unnecessary to describe these parts and the parts already set out in more detail since these engines are very well known.

It is an engine of this character with which my invention is particularly adapted for use. These engines provide an oiling or lubrication system, but the system operates effectively only when the engine is operating at normal speeds and not during the initial cranking or starting thereof. The conventional lubrication system found in such engines also does not maintain a constant oil pressure because the pressure provided by the oil pump is dependent upon the operating speed of the pump which is driven by the variable speed sngine. Such an engine is also difficult to start in cold weather, for one reason because the oil becomes thick and retards normal rotation and movement of the engine parts and, further, the thick lubricant does not properly lubricate the bearings, etc, and the frictional resistance to movement is therefore fairly high.

Also shown in Fig. 1 is the auxiliary lubricating system that I provide. The system includes generally an accumulator **21** having at the bottom end thereof a shutoff or stop valve **22** connected through suitable conduits to a diverter valve **23** and a flow limit valve **24**. The accumulator is also connected through these valves to a distribution manifold **25** equipped with a plurality of outlets **26** that project through the wall of the engine block **11** and into the interior thereof. It is seen that the flow limit valve **24** is also connected to the interior of the engine through a conduit and this conduit (which will be described in detail and numerically designated subsequently) should be coupled to the high-pressure side of the engine lubricating system and serves as a tap to withdraw oil therefrom for the auxiliary lubricating system, all as will be described in detail as the specification develops.

The general operation of the system is such that oil flows from the engine through the valve **24**, valve **23** and valve **22** and into the accumulator **21** while the engine is operating, and during starting of the engine

oil flows in a reverse manner from the accumulator **21**, through the valve **22** and valve **23** and into the manifold **25**. The outlets **26** of the manifold are connected to appropriate bearing parts or wearing parts of the engine that require lubrication and the oil from the accumulator **21** is therefore directed to and toward these parts to provide lubrication while the engine is being cranked.

Referring now to Fig. 2, which is a sectional view of the accumulator **21**, it is seen that the accumulator has an inner cylinder **27** and spaced therefrom and surrounding the same an outer cylinder or jacket **28**. At its lower end the cylinder **27** is turned inwardly to provide a cylinder bottom wall **29** having a central annular opening therethrough. Slidably mounted within the cylinder **27** is a piston **30** having secured to the bottom thereof a piston cup or seal member **31** with depending side walls **32** that slidably and sealingly engage the inner surface of the cylinder **27**. A cup retainer or seal retainer **33** is mounted below the horizontal top wall of the seal **31** and a bolt **34** secures the retainer, seal, and piston together.

Upon the top surface of the piston **30** is secured, by means of a bolt **35**, an annular flange member **36** formed integrally with an elongated tube forming a lower piston guide **37**. Preferably, the guide **37** is equipped with ports **38**. At its upper end the piston guide **37** is telescopically received within an upper piston guide **39** that is rigidly secured to the cover or top closure **40** of the accumulator by means of the threaded section **41**. Rigidly carried on the under surface of the closure **40** is a spring seat **42** that receives thereabout a helical spring **43** seating at one end upon the spring seat **42** and at its other end upon the annular flange **36**. The spring **43** is operative to bias the piston downwardly and toward the bottom wall **29** of the cylinder **27**. The cap or closure **40** may be secured to the jacket **28** in any suitable manner and, preferably, a plurality of swing bolts **44** are provided that are pivotally mounted at one end upon the jacket **28** and are received within bifurcated ears **45** provided by the closure **40**. Wing nuts **46** are used to tighten the closure member **40** downwardly into sealing engagement with the jacket **28**. If desired, a gasket **47** may be employed between the jacket and closure member to insure a fluid seal therebetween. The spring seat **42** is cup-shaped and depends from the closure member **40** and is preferably equipped with a plurality of apertures **48** therethrough.

The closure **40** is equipped at one side with a threaded port **49** that threadedly receives therein the threaded end of a conduit **50** equipped with an on-off valve **51** and that is adapted to be connected to a vacuum source such as the intake manifold of the engine **10**. An exemplary connection for the conduit **50** is illustrated in Fig. 1. The valve **51** is equipped with a valve handle **52** adapted to be swung between an off and on position and a cable **53** is rigidly secured at one end to the handle **52** and is adapted at its other end to be brought into the compartment of the truck or automobile so that it can be manipulated by the driver.

Opposite the port **49** the closure member **40** is equipped with an opening that is threaded and threadedly receives therein a poppet or relief valve **54**. The function of the valve **54** is to normally vent the interior of the cylinder **27** to atmosphere while permitting the interior of the cylinder to be closed during periods when this is desired.

The poppet valve **54** includes a tube **55** having a top closure **56** equipped with a passage therethrough that slidably receives the valve stem **57** of the valve **58**. The valve **58** is biased normally away from the top wall **56** by a coil spring **59** but is adapted to seat thereagainst in sealing relation. The bottom of the tube **55** is closed by a plug **60** that is threadedly received within the tube and adjustment thereof will regulate the biasing force of the spring **59**. The upper end of spring **59** abuts spring seat **59***a* which also serves to prevent the valve stem **57** from being ejected through the top wall **56**. A port **60***a* is provided adjacent the lower end of the tube **55**. At its outer end the stem **57** is provided with a wear-plate member **61** that is adapted to be engaged by a pair of cams **62** and **62***a* pivotally mounted upon a bifurcated ear **63** carried by the closure member **40**. A draw cable **64** is connected to the outer end of the cam **62***a* and is preferably secured to the handle **52** and cable **53** so that the cam **62***a* is operated therewith. The cable **53** may extend into the compartment of the automobile so that it can be manually manipulated therein. The cams or levers **62** and **62***a* operate independently of each other in a manner to be described subsequently.

Rigidly secured to the lower wall **29** of the inner cylinder **27** is the annular flange **65** of the piston stop **66**. If desired, bolts **67** extending through the flange **65**, bottom wall **29**, and which are threadedly received within a base plate **68**, may be used to rigidly connect the piston stop member **66** to the wall **29** of the cylinder. Received about the stop member **66** is an electric insulating member **69** having mounted thereon an immersion-type heating coil **70**. The coil **70** is operative to heat oil contained within the accumulator and for this purpose an electric circuit is provided for the coil **70** to energize the same and electric leads **71** that extend through the bottom wall **29** and base plate **68** provide the energizing means for the heating coil.

Preferably, a gasket **72** is interposed between the wall **29** and the base plate **68** to insure a seal therebetween. The base plate in turn is rigidly secured to the bottom wall **73** of the jacket **28** by means of bolts **74**. Spacers **75** are interposed between the base plate **68** and bottom wall **73** to raise the base plate slightly above the bottom wall of the jacket. The base plate **68** has a central opening therethrough that is substantially cylindrical at the bottom half thereof and slidably receives therein a lower insulating stopper member **76**. The upper portion of the passage is tapered slightly and slidably receives therein the frusto-conical upper insulating stopper member **77**. The stopper member **77** is biased downwardly within the passage by a spring **78** that seats at one end upon the member **77** and at its other end upon an annular flange **79** that projects inwardly from the wall of the stop member **66**. The flange **79** has a central opening therethrough so that fluid may flow freely through the entire stop member **66**. Similarly, the upper end of the member **66** is equipped with a central opening **80** so that fluid may flow therethrough in a manner that will be subsequently described.

It is noted in Fig. 2 that the upper stopper member **77** is equipped with a pair of inclined passages **81** and that the lower stop member **76** is equipped with a central flow passage **82** therethrough that is out of register with the inclined passages **81**. At its lower end the stopper member **76** is enlarged slightly and provides a shoulder portion that seats against the lower surface of the base plate **68**. A spring **83** urges the lower stopper member **76** upwardly and seats thereagainst at one end and at its other end seats against a shoulder **84** provided by a tube **85**. At its upper end the tube **85** has an outwardly-extending flange portion **86** that is secured to the bottom of the base plate **68** by a plurality of bolts **87**. A gasket **88** is interposed between the bottom wall **73** of the jacket member and the flange **86** and provides a seal. The tube **85** is threadedly received within the wall **73** and a nut member **89** secures the tube tightly and in sealing relation within the jacket member and lower wall **73** thereof.

The tube **85** is equipped at its lower end with a conduit **90** through which oil enters and also leaves the accumulator **21**. The conduit **90**, as can be seen best by referring to Fig. 1, is connected at its opposite end to the diverter valve **23** and from there to the manifold **25** through conduit **91** and to the high-pressure side of the lubricating system of the engine **10** through the short

conduit 92, valve 24, and conduit 93. The conduit 93 is simply a tap into the engine oil system and has the sole function of taking out some of the oil therein when the engine is operating normally and under certain conditions for filling the accumulator 21. It is believed that before describing the remainder of the structure in detail, the disclosure of the invention will be more understandable to first describe the operation of the accumulator 21.

Normally the piston 30 is in the lower portion of the cylinder 27, as is indicated in Fig. 2, and rests upon the upper end of the piston stop member 66. When oil under pressure flows through the conduit 90 and into the tube 85 about the spring 83, it flows upwardly through the passage 82 and exerts a force against the upper frusto-conical member 77. The pressure of the oil is sufficient to raise the stopper member 77 slightly and the oil flows upwardly through the inclined passages 81 and fills the interior of the piston stop member 66 and eventually exerts an upward force against the cup retainer member 33 through the central opening 80 of the member 66. The oil pressure forces the piston 30 to rise in the cylinder 27 and the piston continues to be forced upwardly against the biasing action of the spring 43 until the force upon the piston, etc. created by the oil pressure is equal to the biasing force of spring 43. Normal oil pressure of the engine 10 is sufficient to cause the piston 30 to rise a considerable distance within the cylinder 27.

When the oil pressure of the engine decreases, as when the engine is being idled or prior to starting thereof, the pressure within the conduit 90, etc. is quite low and the force exerted by the spring 43 drives the piston 30 downwardly and the oil within the cylinder 27 is forced through the aperture 80 of the stop member 66 and downwardly through the inclined passages 81 where the oil is forced against the upper surface of the stopper member 66 and moves it downwardly until the oil flows through the central passage 82 and then downwardly and out through the conduit 90. The piston 30 will continue to move downwardly until the cylinder 27 has been emptied and the retainer cup 33 abuts the stop member 66 or until the pressure of the oil within the conduit 90 creates a sufficient force upon the piston assembly to cause it to reach a state of equilibrium at some point above the stop member 66.

During normal operation of the accumulator 21, the relief valve 54 is open to permit the portion of the cylinder above the piston 30 to be vented to atmosphere. Opening of the relief valve 54 is accomplished by pivoting the cam 62 away from the plate 61. The cam 62*a* will normally be biased away from the plate 61 by a spring or other appropriate means. When the valve is open, air may enter the interior of the valve tube 55 through the port 60*a* and flow in or out thereof through the passage about the stem 57 where it projects through the top closure 56 of the valve tube.

It is desirable at times to fill the accumulator 21 with a greater volume of oil than that which will ordinarily fill the cylinder 27 due to the normal oil pressure in the line or conduit 90. This can be accomplished by closing the relief valve 54 so that the cylinder 27 is no longer vented to atmosphere and at the same time opening the valve 51 in the vacuum line conduit 50. Both of these operations are accomplished by tensioning the draw cable 53 which opens the valve 52 and closes the relief valve 54 (through the pivotal action of lever 62*a*). A partial vacuum is then created within the interior of the cylinder 27 since the conduit 50 is connected to a source of vacuum or negative pressure. The vacuum established in the upper portion of the cylinder 27 is operative in combination with the oil pressure within the line 90 to move the piston 30 upwardly to its uppermost position. More oil will therefore be drawn into the accumulator 21. The uppermost position of the piston 30 is indicated when the upper end of the piston guide 37 abuts the stop member 95 carried by the upper end of the outer piston guide 39. A switch 96 is provided by the stop member 95 and when the switch is engaged by the guide 37 an electric circuit through the conduit 97 is established and preferably the circuit has a visible indicator that is actuated by the tripping of switch 96. When the operator sees that the piston has reached its uppermost position he can release cable 53 to close valve 51. Preferably the cable 53 or valve handle 52 or alternatively the lever 62*a* is spring loaded so that the cable 53 is automatically retracted upon its release. Prior to this, however, the stop valve, shown in Fig. 3 in detail and in Fig. 1 and which has heretofore been given the numeral 22, is closed in a manner hereinafter described and the oil within the accumulator remains there until its release is later desired.

By referring to Fig. 2, it will be seen that the walls of cylinder 27 and jacket 28 are spaced apart and the space between these members is in open communication with the upper portion of the accumulator 21. Thus, when a negative pressure is created in the cylinder 27 the same negative pressure or partial vacuum is established between the walls of cylinder 27 and jacket 28. Thus the vacuum in combination with the spaced walls provides an insulated reservoir for the oil and it is seen that the accumulator operates somewhat as a thermos bottle and provides an insulation for the oil within the cylinder 27 that tends to keep it warm for relatively long periods. This is desirable because it is much better to lubricate the engine initially with warm oil if it is at all possible to do so. If desired, insulation may be provided around the outer surface of jacket 28 to provide further insulation for the oil within cylinder 27.

In the event it is desired to heat the oil that is stored within the accumulator as, for example, when the oil has been in the accumulator for a considerable period and the heat of the oil has been materially dissipated, the circuit for the immersion heater 70 may be energized and the current flow through this coil will heat the oil within the accumulator. The circuit for the coil 70 is conventional and it is believed unnecessary to illustrate it in its entirety and to provide a detailed description thereof. It is seen that the leads 71 forming a part of the heater coil circuit extend into the interior of the cylinder 27 through the base plate 68, etc. and, preferably, an insulating tube 98 encloses the leads where they pass through the jacket 28. Preferably the insulator tube 98 is sealed to both the jacket 28 and base plate 68 so that there is no loss of vacuum when the upper portion of the cylinder 27 is partially evacuated. It will be seen in Fig. 2 that the space between the cylinder wall and the jacket wall communicates through a passage 99 with the space about the insulator tube 98.

Since the accumulator receives oil from the engine 10 during certain stages of its operation and supplies oil to the engine through the manifold 25 at other times, it is desirable to provide a valve structure that regulates the flow of fluid through the conduit 90. Such a valve structure has been hereinbefore designated with the numeral 23 and is illustrated in detail in Fig. 5. The diverter valve structure 23 will now be described.

The valve 23 includes a valve body 100 provided with a longitudinally-extending bore 101 therethrough and having a threaded portion 102 at one end that threadedly receives the conduit 92 and a threaded portion 103 at its other end that threadedly receives the conduit 90. It should be understood that suitable fittings or couplings, etc., may be used to connect the conduits 90 and 92 to the valve body 100. The body 100 is enlarged on one side and provides a longitudinally-extending passage 104 therethrough that is threaded on each end and is closed by plugs 105 and 106. Slidably mounted within the passage 104 is a plunger 107 that is spring-biased to the left by a coil spring 108. Adjustment of the closure member 106 will determine the biasing force that the spring 108 exerts against the plunger 107. Projecting laterally from the passage 104 and in open communica-

tion therewith is a short passage portion 109 that is enlarged at its outer end and threaded and is adapted to threadedly receive the conduit 91. The longitudinally-extending passages 101 and 104 are also in communication through a port 110 that provides a valve seat 111 therein. Pivotally mounted within the port area 110 is a valve 112 adapted to close the port selectively or to open it, and which is equipped with a laterally-extending finger 113 adapted to be engaged by the head of the plunger 107.

The diverter valve 23 operates as follows. When the engine 10 is operating and the oil system thereof is providing an oil pressure, the oil flows from the engine and through conduit 92 and into the passage 101. The pressure of the oil is sufficient to force the valve 112 substantially against the seat 111 in opposition to the force of spring 108 and the oil is therefore free to flow completely through the passage 101 and outwardly therefrom and into the conduit 90 and eventually into the accumulator. On the other hand, when the engine is turned off so that the oil pressure within the conduit 92 is substantially zero, the spring 108 pushes the finger 113 to swing the valve 112 across the passage 101, as is partially indicated in Fig. 5. Thus when the valve 112 is open and the piston 30 within the accumulator forces oil therefrom and into the conduit 90, the oil from the conduit 90 entering the passage 101 is directed through the valve port 110, into the passage 104, and through ports 114 in plunger 107 and through the central passage provided by the plunger and from there into the conduit 91 that is connected with the distribution manifold 25. Thus it is seen that the diverter valve 23 is operative to direct oil from the accumulator 21 and into the distribution manifold 25 when the engine is being started, but while the engine is operating the diverter valve permits the free flow of oil from the engine to the accumulator, or from the accumulator to the pressure side of the engine lubricating system. That is to say, the spring 108 is only strong enough to open valve 112 when the pressure within passage 101 is substantially zero.

It is also desirable in this system to prevent too rapid a flow of oil from the engine and into the accumulator at certain times. For example, if the accumulator should be substantially empty and the engine 10 is idling, a rapid acceleration of the engine would increase the oil pressure of the lubrication system considerably, and to relieve the pressure the oil might flow in large amounts through the conduit 93 and from there into the accumulator 21. This would be undesirable for it would reduce the engine oil pressure quickly at a time when it should be high and injury to the engine might take place. To prevent such occurrence, I provide a flow limit valve 24 that is illustrated in detail in Fig. 4. The details of flow limit valve 24 will now be set out.

The valve 24 includes a valve casing 115 providing a chamber 116 therein. At one end the casing 115 is threaded and threadedly receives a plug closure member 117 having a flow passage 118 therethrough. At its outer end the flow passage 118 is enlarged and threaded and threadedly receives the conduit 93. If desired, a lock nut 119 may be provided to secure and seal the conduit 93 within the enlargement of passage 118. The opposite end of the casing 115 is closed and provides a seat for one end of a helical coil spring 120 that bears at its opposite end against a plunger 121 equipped centrally with a passage 122 that communicates adjacent one end through passage 123 with the chamber 116 and through a port 124 at its opposite end with the spring chamber 125. The plunger 121 is also provided with a seat member 126 adapted to abut normally the inner surface of the closure plug 117. Spring 120 biases the plunger in this position. The casing 115 has a laterally-extending boss 127 projecting therefrom that is provided with a flow passage 128 therethrough that is threaded at its outer end and threadedly receives conduit 92. Lock nut 129 secures the conduit 92 in position within boss 127.

In operation of this structure, the spring 125 seats the member 126 against the inner surface of closure plug 117 and high-pressure oil flowing through conduit 93 must flow through the passage 122 extending longitudinally of the plunger member and outwardly therefrom through port 124 and then through passage 128 into conduit 92. Eventually the pressure of the oil is sufficiently high to force the plunger rearwardly against the action of spring 120 and larger amounts of oil may readily flow through the valve structure from conduit 93 to conduit 92. When the oil pressure in conduit 93 is relatively low the plunger 121 moves into the position illustrated in Fig. 4. If at this time the engine 10 is accelerated rapidly, only a small amount of oil may flow through the restricted portion of passage 122 and there will not be a serious pressure drop in the lubricating system of the engine 10.

It has been brought out before that it is desirable to provide a stop valve to prevent the flow of oil from the accumulator 121 after it has been filled and while the engine is shut off. The valve I prefer to use to accomplish this result has been designated with the numeral 22 and is shown in detail in Fig. 3. This valve 22 will now be described.

The valve 22 is interposed in the conduit 90 and includes a casing 130 having a laterally-extending passage 131, a laterally-extending passage 132 spaced therefrom, and a central longitudinally-extending passage 133 in open communication with both passages 131 and 132. One portion of conduit 90 that leads to the accumulator 21 is threaded into an enlarged threaded portion of passage 131 and is locked in position with nut 134. The section of conduit 90 leading to the diverter valve 23 is threaded into the threaded end portion of passage 132 and secured in position with lock nut 135. The passage 133 is equipped intermediate the ends thereof with a valve seat 136 adapted to be sealingly engaged by a ball valve 137 that is normally biased away from seat 136 by coil spring 138. The ball valve 137 is secured to valve stem 139 that is freely slidable within the rear end portion of passage 133 and is sealed therein by appropriate packing material. To properly align the stem 139 a plug 140 threaded into the rear end portion of passage 133 is provided and the plug is held in alignment by its connection with a flange 141 provided by a bracket member 142. If desired, a nut 143 may be employed to tighten the member 140 to the flange 141. The casing 130 may also be rigidly secured to the bracket member 142 by means of a cap screw 144 that extends through the upper wall portion of the bracket member.

The outer end of the stem 130 has rigidly secured thereto a head member 145. The head 145 is adapted to be engaged by a cam 146 equipped with an elongated arm 147 that is pivotally secured at its outer end to links 148 and 149 which in turn are connected to a plunger arm 150 carried by solenoid plunger 151. Since the cam 146 has an off-center pivotal mounting 152, it is apparent that movement of the plunger 151 will cause the stem 139 and valve 137 carried thereby to be moved between the open and closed position. A rod 153 is also connected at one end to the cam 146 and at its other end to the lever 62 controlling the poppet valve 62 so that opening of passage 133 by movement of cam 146 automatically opens poppet valve 54.

The solenoid plunger 151 is part of solenoid 154 which is provided with the usual electromagnetic coils 155. The coils 155 are secured to plate 156 which in turn is carried by mounting member 157 rigidly secured by bolts 158 to the bracket member 142. In series with the electric magnet or coils 155 is a switch 159 that is adapted to be closed by engagement with block 159*a* carried by

flexible diaphragm 160. Diaphragm 160 is locked between laterally-extending flange portions provided by the lower solenoid casing 161 and upper casing 162. It is seen in Fig. 3 that the plunger 151 is equipped with an extension 163 that is rigidly connected through integral flange 164 with the central portion of diaphragm member 160.

The upper casing portion 162 is imperforate and sealingly engages the diaphragm 160. A coil spring 165 bearing against the upper portion of the member 162 and at its other end against the diaphragm 160 biases the central portion of the diaphragm in a downward direction and thereby causes the plunger 151 to be normally positioned in the bottom portion of the solenoid. A conduit 166 is in open communication with the vacuum chamber 167 provided by the diaphragm 160 and member 162 and is sealed to the member 162 by a collar 168. The conduit 166 is in open communication at its opposite end with a source of vacuum which may be the intake manifold of the engine 10. A valve 170 is interposed in conduit 166 and is equipped with a handle and actuating rod 171 (seen in Fig. 1) for manual operation. The valve 170 is shown open in Fig. 3 and it is seen that it is provided with bleeder passages 172 and 173 for venting chamber 167 to atmosphere when the valve is closed. Fig. 3 also shows that the valve 170 has a switch 174 actuated by a cam 175 carried on the valve shaft 176. The switch 174 is in series with switch 159 and coils 155 and is open when the valve is closed and closed when the valve is open. Thus when the engine is operating a vacuum is provided within the chamber 167. It should be understood that a suitable electric circuit is provided for the coils 155 and that this circuit includes in series the switches 159 and 174. The circuit is completely conventional and it is not believed that a detailed description thereof would add to an understanding of the invention and is therefore not set out.

The operation of the stop valve structure 22 is as follows. Normally when engine 10 is operating it is desired to have passage 133 open so that oil may readily flow from the engine and through passage 133 and conduit 90 and into the accumulator. The valve will be moved to the right in the illustration shown in Fig. 3 to open passage 133 by the force of spring 138 when cam member 146 is pivoted by raising the arm 147. It is also desired to have these passages open when the engine is initially started so that oil can be ejected from the accumulator and into the engine 10. On the other hand, it is desired to have the passage 133 closed when the engine is shut off and the accumulator 21 is full of oil so that the accumulator will remain full of oil until the engine is again started.

When the engine is initially started, then, the valve 170 is manually opened, closing switch 174 and energizing the circuit through coils 155. This is readily accomplished for at this time the flexible diaphragm 160 will be moved downwardly and against the pivotal arm of switch 159 to close the switch contacts. When the solenoid is energized the plunger 151 is drawn upwardly and forces with it the diaphragm 160. Thus the cam 146 is pivoted, the valve 137 is free to open, and relief valve 54 is opened through movement of the rod 153 and lever 62. Once the engine is up to operating speed a sufficient vacuum is created within vacuum chamber 167 to maintain the diaphragm 160 in raised position even though the solenoid 154 may be de-energized. It is desired at such time to de-energize the solenoid and this is accomplished since the diaphragm block 159*a* will be lifted off of switch 159, thereby breaking the circuit, and coil 155 will then be deactuated.

When the engine is to be shut off the operator may release the linkage 171 which will close valve 170 and vent the vacuum chamber 167, and open switch 174 to insure that the solenoid circuit remains de-energized. Spring 165 will press down upon diaphragm 160 and down against pivot arm 147 through the connecting plunger and linkage and thereby rotate the cam 146 into tight engagement with the head 145 of the valve stem and thus move the valve 137 into closed position.

Operation

Although in the specification as set out so far the operation of the individual valves and the accumulator has been discussed, it is believed that a brief summation of the operation that ties all of the operative structure together might be appropriate.

Assuming that the accumulator 21 is filled with oil, the engine has not been started, and that the oil within the accumulator is cold, the operator may energize heating coil 70 to elevate the temperature of the oil within the accumulator. It is noted that the oil is heated outside of the engine and only that amount of oil is heated that is within the accumulator so there will be no great drain on the vehicle battery if this is used as the source of current for the coil 70. It should be understood, however, that an independent power source may be used for heating the coil, such as 110-volt house current. When the oil is warm the operator energizes the solenoid 154 and the valve 137 is opened. Since there is no pressure within the lubricating system of the vehicle, the spring 43 in the accumulator pushes the piston 30 downwardly therein and oil is forced into the engine 10.

The engine may then be cranked and when started the oil pressure will cause the accumulator 21 to again fill and it will remain filled until it is again used in a starting operation or until the engine of the vehicle has idled so slowly that the oil pressure thereof is not sufficient to maintain the piston 30 in raised position. When the engine is operating properly a vacuum will be created within the chamber 167 of the stop valve 22 and the solenoid circuit will be de-energized. When the engine is to be turned off it will be desirable to fill the accumulator to its capacity and this will be accomplished by closing the poppet valve 54 and opening the valve 51 so that a vacuum is created within the accumulator. This will be accomplished by pulling the draw-line 53. When the operator is aware that the accumulator is filled to its capacity by a signal from a visual indicator, he closes the valve 170 in the vacuum line 166 which closes the stop valve 22 by pushing the linkage 153 upwardly to rotate the cam 146 in the appropriate direction. Oil cannot then flow from the accumulator. The relief valve 54 is now held closed by both levers 62 and 62*a*. The operator next releases cable 53 to close valve 51. The vacuum between the walls of the cylinder 27 and jacket 28 will tend to maintain the oil within the accumulator at an elevated temperature for long periods.

The flow limit valve 24 prevents undue loss of pressure in the vehicle lubricating system when the engine 10 is accelerated rapidly from a low idling speed and the diverted valve 23 functions to selectively open and close the port 110 so that oil flows from the engine and to the accumulator when the engine is operating at normal speeds and to permit flow from the accumulator to the engine oil pump when the pressure in the accumulator is greater than the pressure in the engine oil pump, and to direct the flow of fluid from the accumulator and into the distribution manifold 25 when the engine is stopped and is being cranked, and the pressure in the passage 101 is substantially zero. The manifold may be located as desired to provide required lubrication, as for example to spray oil into the cylinders about the piston skirts. Thus it is apparent that the structure I have provided operates as an oil heater and pre-oiler as well as a pressure compensator that tends to maintain the oil pressure of the engine at a relatively constant value for all operating conditions.

While the invention has been described for the most part in structural terms, it will be apparent that the specification also discloses a method of heating oil outside of the engine, for pre-oiling the parts of the engine, and for maintaining a relatively constant engine oil pressure.

While in the foregoing specification an embodiment of

the invention has been set out in method and structural terms in great detail, it will be apparent to those skilled in the art that considerable variation in these details may be made without departing from the spirit and principles of my invention.

I claim:

1. In combination with an internal combustion engine having a self-contained pressure lubricating system capable of developing pressures in excess of a predetermined value when the engine is operating, a lubricant distribution manifold communicating with the interior of said engine at selected locations to provide lubricant thereat, a diverter valve, a flow conduit connecting said diverter valve with said manifold, conduit means connecting said diverter valve with the high pressure side of said lubricating system, and an accumulator communicating with said diverter valve, said diverter valve being equipped with flow selection means automatically operative to selectively connect said accumulator with said manifold through said flow conduit when there is substantially no pressure in said lubricating system and with the high pressure side of the lubricating system through said conduit means when there is pressure within said system.

2. The combination of claim 1 in which a flow limit valve is interposed between said diverter valve and the high pressure side of said lubricating system for limiting the flow rate of lubricant from said system and to said diverter valve.

3. The combination of claim 1 in which said flow selection means comprises a spring biased valve member normally urged toward a position establishing communication between said accumulator and said manifold, the biasing force being preselected to be overcome by a pressure in said lubricating system which is effective to move said valve member to interrupt communication between the accumulator and the manifold and establish it between the accumulator and high pressure side of said lubricating system.

4. In a system for prelubricating a pressure-lubricating-network-equipped internal combustion engine prior to the starting thereof and to supply lubricant under pressure to the engine when the lubricant pressure in said network thereof drops below a predetermined value, a lubricant distribution manifold for supplying lubricant directly to selected locations within the interior of such engine, an accumulator providing a reservoir for the receipt and storage of lubricant therein, means for applying pressure to lubricant contained within said accumulator tending to eject the lubricant therefrom, diverter valve means in communication with said accumulator, a flow conduit connecting said diverter valve with said manifold, and conduit means connected with said diverter valve to pass lubricant between said diverter valve and the high pressure side of such lubricating network, said diverter valve being equipped with flow selection means automatically operative to normally connect the accumulator with the manifold through said flow conduit and to connect said accumulator to the high pressure side of such engine lubricating network through said conduit means whereby lubricant is fed from that network to the accumulator when the pressure in the network exceeds the pressure within the accumulator and vice versa.

5. The system of claim 4 in which stop valve means are interposed between said accumulator and said diverter valve for selectively interrupting the communication therebetween, and in which means are provided for operating said stop valve means.

6. The system of claim 5 in which flow limit means communicate with said diverter valve for inclusion in the connection thereof with the lubricating network of an engine, said flow limit valve means being operative to retard an instantaneous surge of lubricant from such lubricating network towards said diverter valve.

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