June 30, 1942. R. G. DYKEMAN ET AL 2,288,127

VISCOSITY-CONTROLLED UNIT

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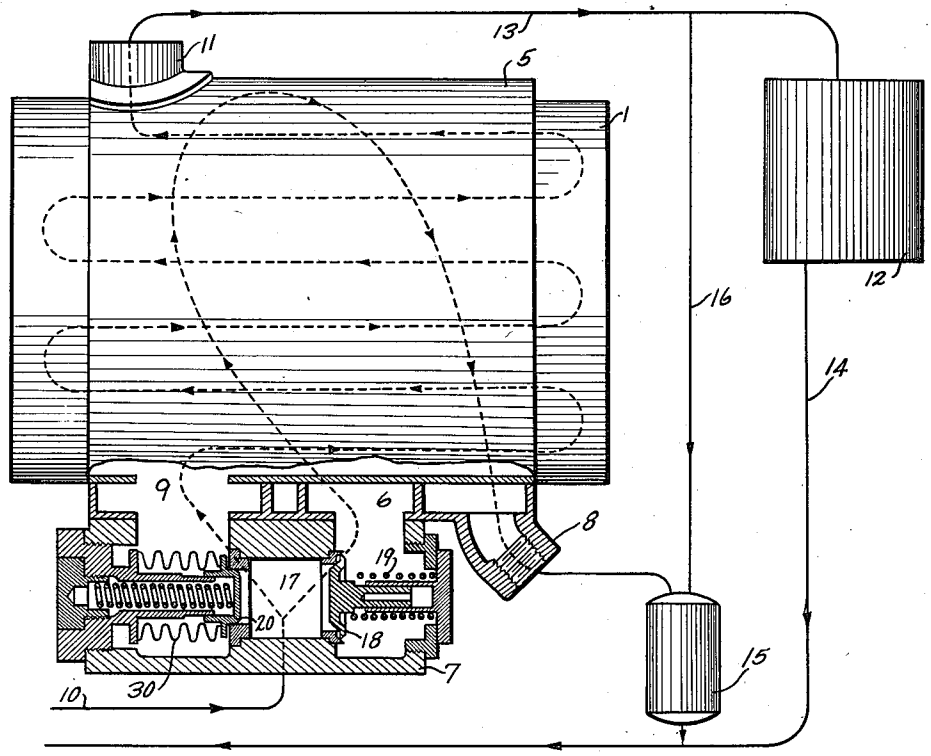


Fig.-1

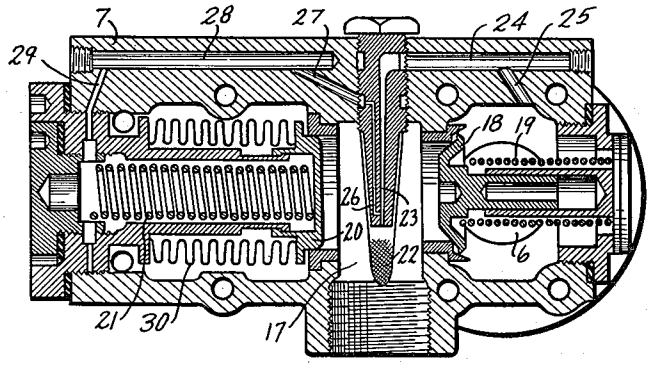


Fig.-2

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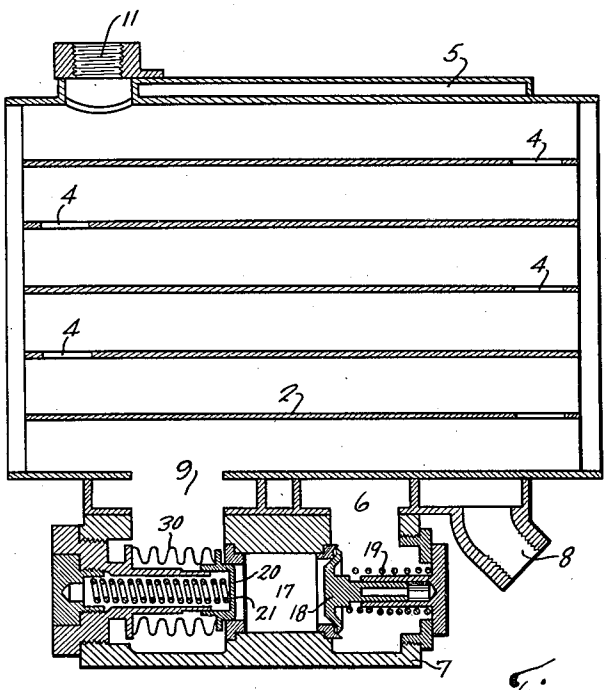


Fig.-3

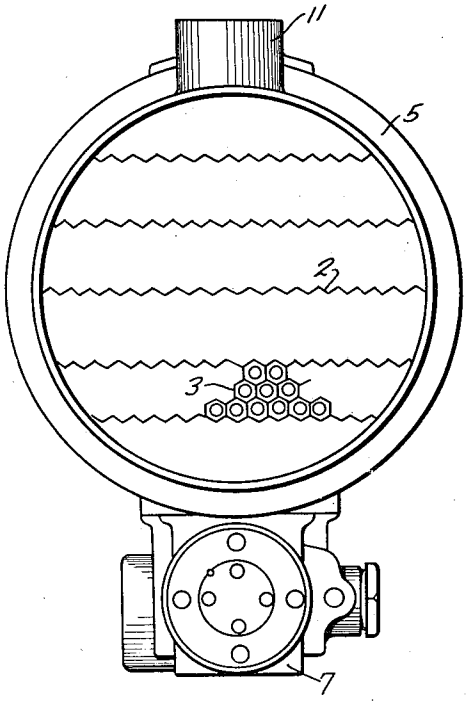


Fig.-4

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UNITED STATES PATENT OFFICE

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VISCOSITY-CONTROLLED UNIT

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14 Claims. (Cl. 184—104)

This invention comprises a lubricant conditioning system and particularly a circulatory system wherein oil is quickly brought to the proper viscosity and thereafter maintained in condition for most efficient and economical functioning and use. The circulating system as herein disclosed embodies a heat exchange unit for rapidly warming the oil and subsequently maintaining it at the proper temperature, and consequently the desired viscosity, wherein the flow control is responsive to the degree of viscosity of the oil in the system.

Due to the development of high speed motors, and especially such as are used in aeroplanes, and more recent types of automobiles and boat motors, it has been found desirable to condition the lubricating oil to the proper viscosity for most efficient and economical functioning and use in the minimum of time. The operating parts of such motors function at a high rate of speed from initial starting, and it is important that all moving parts thereof be properly lubricated from that moment, or as near to such moment as possible. The rate of oil flow to and over the parts to be lubricated is directly proportional to the viscosity of the oil.

Lubricating oils are quite sensitive to thermal change and tend to thicken on congeal throughout the circulatory system when the motor or other apparatus with which the system is used is at rest. The flow of oil at the moment of initial starting of the motor or other apparatus is there fore quite slow, and continues so until the oil in the entire system is brought to the desired temperature and viscosity which heretofore has required considerable time, during which period the lubricating oil does not have the maximum flow and lubricating qualities desired.

The present invention provides an oil circulatory system including a radiator or cooler unit for the circulating oil which embodies two alternative oil flow circuits including a by-pass circuit adapted to initially circulate a small portion of the oil supply through the apparatus to be lubricated over and over again for quickly bringing such small portion of the oil to the desired temperature and viscosity. The main flow circuit includes the radiator or cooling unit through which the oil is automatically deflected as its temperature increases. The system includes automatic control means responsive to the viscosity of the oil for directing the oil through one circuit or the other, or both, as the oil condition dictates.

One object of this invention is to provide an oil conditioning system of simple construction, capable of being economically manufactured, which will be efficient in operation, uniform in action, automatically controlled, and unlikely to get out of repair.

Another object of this invention is to provide an oil conditioning system wherein the circulation of oil is controlled by its degree of viscosity.

A further object of this invention is to provide an oil circulatory system embodying means for rapidly conditioning oil and maintaining it at the proper temperature and viscosity for the most efficient and economic functioning and use.

A further object of this invention is to provide, in combination with viscosity control means for the circulating oil, a suitable heat exchange unit for lubrication systems and to provide means for quickly and automatically thawing congealed lubricant to relieve congestion within the cooling unit, and thereafter maintain a substantially equalized temperature.

A further object of this invention is to provide an oil circulatory system embodying means for initially quickly bringing a small quantity of the oil to the desired temperature and viscosity for efficient lubrication, and then bringing the remainder of the oil in the system to the desired temperature and viscosity gradually, and without affecting the flow and lubrication qualities of the initial oil supply actively in use as a lubricant.

A further object of this invention is to provide an oil circulatory system including alternate flow paths, one of which comprises a by-pass wherein a small quantity of the oil may be used over and over again, until the remainder of the oil supply is brought to the proper temperature and viscosity condition.

A further object of the invention is to provide a suitable heat exchange unit for the oil circulatory system, and to provide means whereby the congealed lubricants therein may be automatically thawed and congestion within the radiator relieved.

A further object of the invention is to provide an automatic by-pass for the liquid oil in the event that the radiator or heat exchange unit is obstructed or the flow of oil therethrough retarded.

A further object of the invention is to utilize the circulation of the small amount of warmed oil used over and over again through the by-pass for relieving the congested condition of the radiator or cooling unit.

A further object of the invention is to provide an automatic flow control means governed by variation in flow resistance.

With the above primary and other incidental objects in view as will more fully appear in the specification, the invention consists of the features of construction, the parts and combinations thereof, and the mode of operation, or its equivalent, as hereinafter described and set forth in the claims.

Referring to the accompanying drawings, wherein is shown the preferred but obviously not necessarily the only form of embodiment of the invention,

Fig. 1 is a diagrammatic view showing a complete oil circulatory system embodying the present invention wherein the flow of oil through the heat exchange unit is controlled by the viscosity of the oil.

Fig. 2 is a sectional plan view of the oil flow controlling unit disclosed in Fig. 1.

Fig. 3 is a sectional view showing the combination of a heat exchange unit and the oil flow control means embodying the present invention.

Fig. 4 is an end view of the heat exchange unit shown in Figs. 1 and 3.

Like parts are indicated by similar characters of reference throughout the several views.

Referring to the drawings, 1 is a radiator or heat exchange unit which may be of any suitable type, but which for illustrative purposes is shown as of a tubular air cooled type such as commonly used in automobile radiators. The radiator consists of a cylindrical shell preferably although not necessarily divided by baffles 2 into a succession of compartments, each filled with parallel tubes 3 (Fig. 4) open at their ends for circulation of air therethrough and spaced apart to afford circulatory passages therebetween for circulation of the oil or other lubricant to be cooled. Intercommunicating ports 4 are provided between the compartments of the radiator through the baffles 2 at alternating ends of the radiator. Obviously, forms of air cooled radiator construction other than the tubular form illustrated may be utilized or for stationary installations, a water cooled or similar type of heat exchange unit may be employed.

Surrounding the radiator or cooler unit is a jacket forming thereabout an annular by-pass through which oil flows under certain predetermined temperature and viscosity conditions as will be hereinafter apparent. The jacket 5 is connected to an inlet chamber 6 of a flow control mechanism 7 and also has an outlet 8 leading therefrom. An inlet port 9 connects the flow control mechanism 7 with the main or baffled passage through the radiator unit. The flow control mechanism is connected with a main or inlet line 10, as shown diagrammatically in Fig. 3. An outlet 11 connects the main baffled passage of the radiator unit to a main supply tank 12 by suitable piping 13. Further piping 14 leads from the main supply reservoir 12 to the mechanism to be lubricated. As also diagrammatically shown in Fig. 3, the outlet 8 of the jacket 5 is connected by suitable piping to an auxiliary reservoir 15 which in turn is suitably connected to the piping 14 to thereby provide a by-pass circulatory system from the mechanism to be lubricated through the radiator unit and back to the such mechanism independently of the main passage through the radiator unit and the main supply tank 12. A vent pipe 16 leads from the auxiliary reservoir 15 to the piping connection 13 between the radiator unit and the main supply reservoir 12 for the purpose of preventing foaming in the auxiliary reservoir 15.

Referring to Figs. 1, 2 and 3, the flow control mechanism 7 includes a main oil inlet chamber 17 connected with the inlet line 10, and two valves one controlling the flow into the inlet 9 and the main passage through the radiator unit and the other controlling the flow to the inlet 6 of the jacket 5. Valve 18 which controls the flow to the jacket 5 is of the type adapted to constant pressure relief and is constantly urged toward or into closed position by means of a spring 19 which surrounds the valve stem and is disposed between the rearward face of the valve and the casing of the flow control mechanism. Thus, the valve 18 will remain closed and prevent flow from the inlet chamber to the jacket 5 so long as the pressure in the inlet chamber is not sufficient to overcome the resistance of the spring 19.

A valve 20 controls the flow from the main inlet chamber 17 to the inlet 9 of the main circulatory baffled passage through the radiator unit and the flow through such radiator unit. The valve 20 is urged toward closed position by a spring 21. Thus, the valve 20 will remain in closed position and prevent flow from the main inlet chamber 17 through the main baffled passage of the radiator unit so long as the pressure in the inlet chamber 17 is less than the resistance of the spring 21 to compression. The spring 21 has a lesser compression resistance value than the spring 19 for obvious reasons. In order that the valves may properly regulate the oil flow through the main or by-pass passages in accordance with the viscosity of the oil, means are provided for supplementing the resistance of the spring 21 to prevent premature opening of the valve 20 as will be hereinafter described.

In an oil circulating system the oil, which is thermally sensitive, becomes more and more viscous as the temperature lowers and it is most important that the temperature of the oil be raised and the viscosity reduced as quickly as possible both for oil flow and lubrication purposes. In the circulatory system here shown, assuming the only oil passage to be from the mechanism to be lubricated through the main baffled oil passage of the radiator unit 1 and thence back to the mechanism to be lubricated, the flow of oil would naturally be retarded, if not blocked all together, by congealed oil in the radiator passage.

In the operation of the circulatory system, and particularly the oil flow control mechanism, oil is circulated through the system by a pump or other suitable pressure producing means, and flows from the mechanism to be lubricated through the piping or conduit 10 into the inlet chamber 17 of the flow control mechanism 7. Then, depending upon the viscosity of the oil, and thereby the pressure built up in the chamber 17, the valve 18 or the valve 20 is selectively opened to permit oil flow through the by-pass or the main circulatory system hereinbefore described.

As shown in Fig. 2, the inlet chamber 17 contains a venturi or an orifice and friction tube assembly surrounded by a screen 22. The main passage 23 of the venturi gradually increases in cross-sectional area from the inlet end and bleeds oil from the inlet chamber 17 to the inlet chamber 6 of the jacket around the main baffled passages of the radiator or cooler unit through suitable conduits 24 and 25. Such passage 23 is continually open. A port and associated conduit 26 which is shown as being relatively small as com-

pared to the main passage 23 of the venturi, leads from a point adjacent the inlet end of the passage 23 through conduits 27, 28 and 29 to a point behind the valve 20 and within a chamber formed by a bellows 30 suitably connected to and disposed rearwardly of the valve 20.

Both of the valves 18 and 20 being normally held closed by the respective compression springs 19 and 21, oil at low temperature and high viscosity, for example 600 Saybolt seconds, entering the chamber 17 under pressure will first by-pass around the valve 18 to the inlet 6 of the jacket 5 surrounding the main baffled passage through the radiator or cooler unit. The oil flow through the passage 23 being necessarily slow, static pressure will be built up in passages 26, 27, 28 and 29 and in the chamber behind the valve 20 formed by the sylphon 30, forming a back pressure against such valve. As oil under pressure from the conduit 10 continues to enter the chamber 17, the pressure in the chamber is built up due to the restricted oil outlet therefrom sufficiently to overcome the resistance of the spring 19 which holds the valve 18 closed. The valve 20 is held closed by its spring 21, which has a lesser compression resistance value than the spring 19, plus the static pressure on the rearward face of the valve through the port and passages 26, 27, 28 and 29.

Upon the pressure of oil within the inlet chamber 17 becoming greater than the resistance of the spring 19, but less than the resistance of the valve 20 to opening, the valve 18 is opened to a degree proportionate with the pressure in the inlet chamber 17 to permit oil flow to the inlet 6 of the jacket or by-pass passage around the radiator or cooler unit. Thus, a closed circuit for oil is established from the mechanism to be lubricated through inlet chamber 17, past the valve 18, through the inlet 6 and through the jacket 5, to the outlet 8 from which the oil flows through the auxiliary supply tank 15 and the pipe or conduit 14 back to the lubricated mechanism. As will be noted with reference to Fig. 3, this oil flow circuit completely by-passes the main baffled passages through the radiator or cooler unit and the main supply tank 12 whereby a small portion only of the entire oil supply will be circulated, and will quickly arrive at a temperature and viscosity commensurate with most efficient flow and lubrication qualities of the oil.

Further, it would be necessary to raise the temperature and decrease the viscosity of the entire volume of oil in the main supply reservoir 12, as well as the oil in the remainder of the system, before the oil would function at maximum efficiency, as a lubricant for high speed motors.

In accordance with this invention, a by-pass circuit is provided through which a small portion of the entire volume of lubricant may flow temporarily thus reducing the time in which the initial oil supply to the mechanism to be lubricated may reach a condition of temperature and viscosity where it will serve with the greatest efficiency. Provision is made for gradually raising the temperature and reducing the viscosity of the entire volume of oil in the system. The flow control means is of a nature to automatically direct the lubricating oil through the by-pass circuit or the main circuit in accordance with the temperature and viscosity of the oil. The flow of oil through the by-pass circuit, which includes the jacket 5, serves to raise the temperature and reduce the viscosity of the oil in the main baffled passage through the radiator or cooling unit whereby free oil flow therethrough may be inaugurated.

As the relatively small portion of the oil supply is circulated again and again through the by-pass circuit just described, the temperature of such oil is quickly raised and some of the heat from the oil is transferred to oil in main baffled passage through the radiator or cooler unit to thereby raise the temperature and lessen the viscosity of the oil in the heat exchange unit. At the same time increase in temperature and lessening of viscosity of the oil results in less resistance to flow through the Venturi passage 23, and the freer flow of oil through the Venturi passage 23 naturally results in a lessening of the static pressure on the rearward side of the valve 20.

When the oil pressure in the chamber 17 reaches the point at which the resistance to opening of the valve 20 is equal to the oil pressure against the valve 18 tending to hold it open, both of the valves 18 and 20 will be open substantially the same amount to permit a dual oil flow, one stream flowing through the by-pass circuit which includes the jacket 5 and the other stream flowing past the valve 20 and by way of the inlet 9 through the main baffled passage of the radiator or cooling unit, through the conduit 13, main supply reservoir 12 and conduit 14 back to the mechanism to be lubricated. Flow of the oil of high temperature and viscosity through the main oil circuit including the supply reservoir 12 will gradually raise the temperature and viscosity of the oil in the main circuit to a point where the oil in both circuits have the same flow and lubricating characteristics. The flow of oil through both circuits continues until the entire oil supply has reached a condition of temperature and viscosity at which it functions with the greatest efficiency.

Referring to the drawings and the preceding description, it will be seen that an oil circulatory system including the combination of a radiator or heat exchange unit and an oil flow control mechanism has been provided embodying numerous features of novelty and advantage. This oil circulatory system includes a by-pass circuit and a main circuit together with suitable flow control mechanism adapted to control the flow of oil through the respective circuits in accordance with the viscosity of the oil. That is, should the oil be at low temperature and high viscosity, the oil will be directed by the flow control mechanism through the by-pass circuit and a relatively small portion of the entire amount of oil in the circulatory system is used over and over again until such relatively small portion of the oil reaches the desired temperature and viscosity. At this time, the flow control mechanism is effective to direct a part of the oil at the desired temperature and viscosity through the main flow circuit while directing the remainder through the by-pass circuit to thereby bring the entire supply of lubricating oil to the desired temperature and viscosity gradually, and without affecting the flow and lubricating qualities of the oil passing through the mechanism to be lubricated. The flow control mechanism which includes two valves, one subordinate to the other, is then effective to direct all of the oil through the main flow circuit which includes the radiator and the main supply tank. Thus, the oil in the circuit is brought to a temperature and viscosity where it possesses the maximum efficiency substantially

immediately with the beginning of oil flow, and by subsequent cooling action of the radiator is maintained at such point of maximum efficiency throughout the entire operation of the mechanism to be lubricated.

From the above description it will be apparent that there is thus provided a device of the character described possessing the particular features of advantage before enumerated as desirable, but which obviously is susceptible of modification in its form, proportions, detail construction and arrangement of parts without departing from the principle involved or sacrificing any of its advantages.

While in order to comply with the statute, the invention has been described in language more or less specific as to structural features, it is to be understood that the invention is not limited to the specific features shown, but that the means and construction herein disclosed comprise the preferred form of several modes of putting the invention into effect, and the invention is therefore claimed in any of its forms or modifications within the legitimate and valid scope of the appended claims.

Having thus described our invention, we claim:

1. An oil circulatory system including a supply reservoir, oil circulating conduits leading to and from the reservoir, a heat exchange unit communicating with the reservoir, a conduit by-passing the reservoir and connecting said heat exchange unit with the return conduit from the reservoir, and viscosity responsive valves controlled by variation in viscosity of the oil governing the flow of oil alternately through the heat exchange unit and the by-pass to the exclusion of the reservoir and through the heat exchange unit and reservoir.

2. In an oil circulatory system, a reservoir, conduits leading to and from the reservoir, a heat exchange unit having dual passages therethrough one of which communicates with the conduit leading to the reservoir and the other of which communicates with the conduit leading from the reservoir, and valve means alternately directing the flow of oil through the respective passages of the heat exchange unit in accordance with fluctuations in viscosity thereof.

3. In an oil circulatory system, a heat exchange unit, having dual oil passages therethrough, an oil conduit leading to the heat exchange unit, a reservoir with which one of the passages of the heat exchange unit communicates, a return conduit from the heat exchange unit with which the other heat exchange unit passage communicates, and valve means for automatically alternating the flow of oil through the respective passages of the heat exchange unit in accordance with changes of the viscosity of the oil.

4. In a circulatory system for a thermally responsive liquid including a mechanism to be lubricated and a liquid supply tank, a fluid temperature regulator having a passage for the circulation of the liquid when in one state of viscosity and another passage for the circulation of the liquid when in another state of viscosity, means acting in response to the viscous state of the liquid for directing the flow of liquid through one or the other of the passages, and a shunt circuit for by-passing liquid in the supply tank when the fluid flows through one of the passages.

5. In an oil circulatory system, a heat exchange unit having alternate oil passages therethrough, an oil conduit leading to the heat exchange unit, an oil reservoir with which one of the alternate passages of the heat exchange unit communicates, a return conduit from the heat exchange unit with which the other alternate passage communicates, a valve control means for each of the alternate passages operable in response to viscosity of the oil for selectively directing oil through one of said alternate passages or the other.

6. In an oil circulatory system, a heat exchange unit having alternate oil passages therethrough, an oil conduit leading to the heat exchange unit, an oil reservoir with which one of the alternate passages of the heat exchange unit communicates, a return conduit from the heat exchange unit with which the other alternate passage communicates, an auxiliary reservoir in said return conduit, a valve control means for each of the alternate passages operable in response to viscosity of the oil for selectively directing oil through one of said alternate passages or the other.

7. In an oil circulatory system, a heat exchange unit having alternate oil passages therethrough, an oil conduit leading to the heat exchange unit, an oil reservoir with which one of the alternate passages of the heat exchange unit communicates, a return conduit from the heat exchange unit with which the other alternate passage communicates, an auxiliary reservoir of smaller capacity than the oil supply reservoir in said return conduit, a valve control means for each of the alternate passages operable in response to viscosity of the oil for selectively directing oil through one of said alternate passages or the other.

8. In an oil circulatory system leading to and from a mechanism to be lubricated and including an oil supply reservoir and a heat exchange unit, passages leading from the intake side of the heat exchange unit through the unit, one of such passages leading to the supply reservoir and the other passage being arranged to by-pass the circulated oil past the supply reservoir, and means for selectively directing oil through one or the other of the passages in response to the viscosity of the oil being circulated.

9. An oil circulatory system comprising, in combination with a heat exchange unit having alternate paths therethrough, one of which includes a main oil supply reservoir and the other of which includes an auxiliary oil supply reservoir, a valve means associated with each of the paths and operating in response to oil viscosity for permitting flow of oil through one or the other of the alternate paths, the construction and arrangement being such that the operation of one of the valve means is subordinate to operation of the other valve.

10. An oil circulatory system comprising, in combination with dual circulatory paths, one of which includes a main oil supply reservoir and the other of which includes an auxiliary oil supply reservoir, a valve means associated with each of the paths and operating in response to oil viscosity for permitting flow of oil through one or the other of the paths, a common chamber for the valves, the construction and arrangement being such that the operation of each of the valves is subordinate to operation of the other valve, and the valves being arranged for simultaneous operation under certain conditions of oil viscosity.

11. An oil circulatory system comprising, in

combination with a heat exchange unit having alternate paths therethrough, one of which includes a main oil supply reservoir and the other of which includes an auxiliary oil supply reservoir, a valve means associated with each of the paths and operating in response to oil viscosity for permitting flow of oil through one or the other of the alternate paths, the construction and arrangement being such that the operation of one of the valve means is subordinate to operation of the other valve.

12. An oil circulatory system comprising, in combination with dual circulatory paths, one of which includes a main oil supply reservoir, a valve means associated with each of the paths and operating in response to oil viscosity for permitting flow of oil through one or the other of the paths, and a common chamber for the valves, the construction and arrangement being such that the operation of each of the valves is alternately subordinate to operation of the other valve.

13. An oil circulatory system comprising, in combination with dual circulatory paths, one of which includes a main oil supply reservoir and the other of which includes an auxiliary oil supply reservoir, a valve means associated with each of the paths and operating in response to oil viscosity for permitting flow of oil through one or the other of the paths, a common chamber for the valves, the construction and arrangement being such that the operation of each of the valves is alternately subordinate to operation of the other valve, and the valves being capable of simultaneous operation under certain conditions of oil viscosity.

14. In an oil circulatory system, an oil reservoir and a heat exchange unit, dual passages through the heat exchange unit, one of which leads to the inlet side of the reservoir and the other of which leads to the outlet side of the reservoir thereby forming separate circulatory paths one of which excludes the reservoir, and valve means alternately directing oil through the respective passages in the heat exchange unit in response to fluctuations in oil viscosity.

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