June 3, 1941. L. F. FEDDERS 2,244,641

HEATING AND COOLING SYSTEM FOR ENGINE LUBRICATING OIL

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Fig. 1

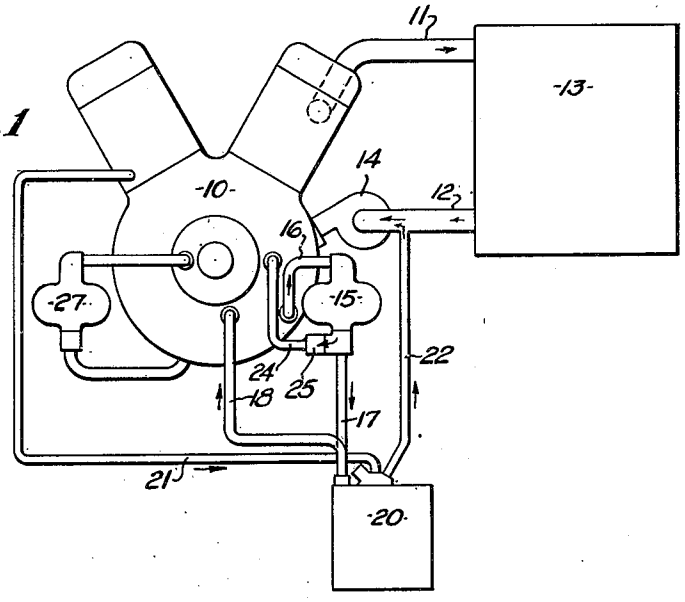


Fig. 5

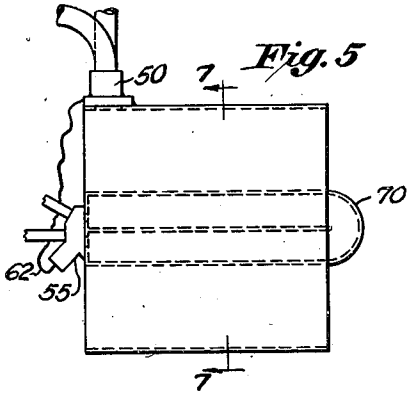


Fig. 7

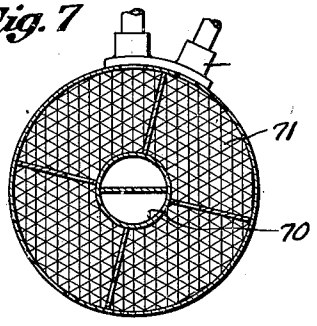


Fig. 6

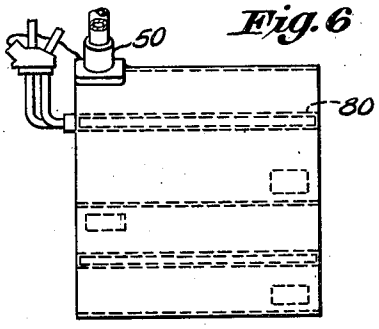
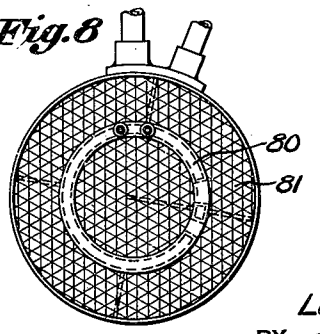


Fig. 8



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HEATING AND COOLING SYSTEM FOR ENGINE LUBRICATING OIL

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Fig. 4

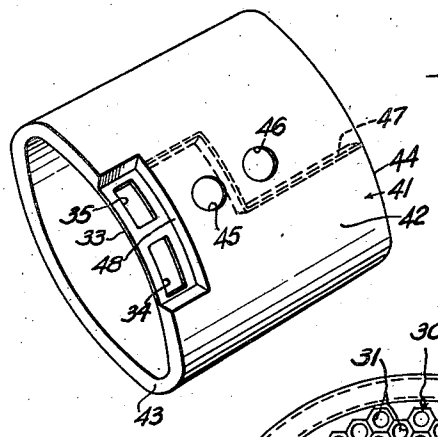
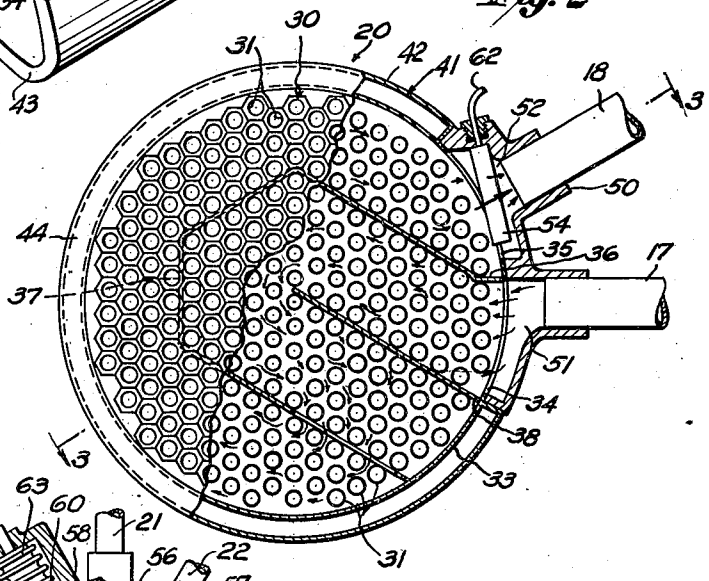


Fig. 2



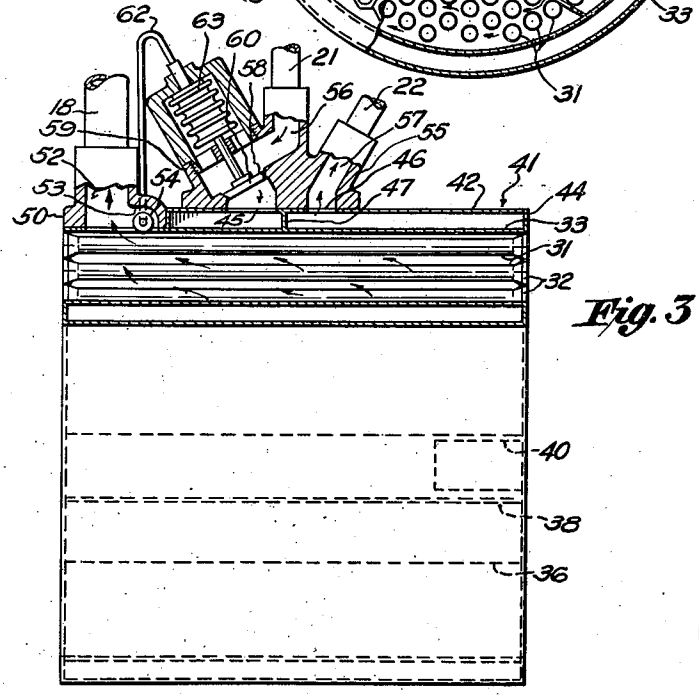


Fig. 3

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UNITED STATES PATENT OFFICE

2,244,641

HEATING AND COOLING SYSTEM FOR ENGINE LUBRICATING OIL

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Application October 27, 1939, Serial No. 301,631

7 Claims. (Cl. 123—196)

This invention relates to radiators for cooling the oil supply of internal combustion engines.

The invention is especially pertinent to the oil cooling problem of airplane engines, where heat dissipation requirements are extremely critical. It has heretofore been recognized that oil radiators are subject to blocking by cold oil, and that even after the engine has been properly warmed up the blockade continues and renders the oil radiator, or portions thereof, ineffective. Flying at high altitudes and at extremely low temperatures further aggravates this condition, and it will be apparent that when critical demands for oil cooling subsequently arise, the oil cooler must respond instantly, or the engine may be seriously overheated.

It has been proposed to utilize the heated oil in the crankcase to preheat or "thaw" the oil radiator under control of a by-pass circuit which responds to a pressure valve or like instrumentality. This expedient has proved itself to be inefficient when used in the most modern high-powered aircraft, chiefly because of the inability of the preheater to convey enough heat to the radiator during critical acceleration periods.

In the present invention, both oil heating and oil cooling are automatically available in response to temperature conditions in the oil cooler. In the former instance, a true heating effect is obtained by utilizing the glycol fluid which is taken directly from the engine block at temperatures ranging above 300° F. This heat supply, plus a critical control for the application thereof, is sufficient to bring the oil in the radiator to the proper degree of fluidity in a minimum of time during warming-up periods of the engine, and further it continues to maintain such condition automatically during active operation of the airplane under all flying conditions.

In the structure of the present invention, it is further proposed to simplify the oil cooler and the associated connections and controls to provide added effectiveness, as more fully set forth in the accompanying specification and drawings, wherein:

Fig. 1 is a diagrammatic view of an airplane engine and its accessories including a glycol radiator and the oil cooler and circuit of the present invention;

Fig. 2 is a front elevation of the oil cooler with portions broken away to show the passage structures;

Fig. 3 is a section on the line 3—3 of Fig. 2, with portions shown in elevation;

Fig. 4 is a perspective view of the sheet metal portion of the preheating jacket;

Figs. 5 and 6 are side elevations of further embodiments of the invention;

Fig. 7 is a section on the line 7—7 of Fig. 5;

Fig. 8 is an end view of the cooler of Fig. 6.

In Fig. 1 there is diagrammatically shown a jacketed glycol-cooled engine 10, having inlet and outlet conduits 11 and 12 leading to the glycol radiator 13, the latter conduit having a liquid circulating pump 14 interposed therein. The oil circuit for the engine includes an auxiliary pump 15 which receives oil from the engine sump through a conduit 16, and delivers it to the oil radiator or cooler 20 through a conduit 17. After passing through the cooler 20, the oil is directed back to the engine crankcase through a conduit 18. The cooler is jacketed, as will presently be described, to receive hot glycol from the engine block through a conduit 21 for preheating the oil, and the glycol is directed thence to the suction side of the pump 14 through a conduit 22. It will be understood that, according to modern practice, the glycol is retained at a relatively high temperature, say about 300° F., by suitable control devices cooperating with the glycol radiator 13.

The oil circuit also includes a by-pass, herein shown diagrammatically as a conduit 24 connecting the outlet of the oil pump 15 to the crankcase of the engine. This arrangement prevents rupture of the oil radiator elements when excessive head pressures are encountered, in which event oil is returned directly to the crankcase through the conduit 24 under control of a well-known type of pressure-responsive valve 25 included in such circuit. If desired, the oil cooling circuit may be dissociated from the bearing oil supply means, in which event a separate bearing pump 27 may be used to perform this function.

As shown in Fig. 2, the cooling unit of the oil radiator 20 is preferably in the form of a cylindrical tube bundle or core 30, which, as is well known in the art, is fabricated of elongated tubes 31 having nested hexagonal ends or heads 32 which are soldered together to form a rigid structure. The core is circumferentially sealed by an enclosing sheet metal tube 33, whose ends are soldered to the peripheral heads 32 of the core. As thus far described, it will be apparent that cooling air may pass through the tubes 31, while oil introduced through the tube 33 may pass about

the tubes in heat exchange relation with the air streams through the walls of the tubes.

The tube 33 is formed with adjacent oil inlet and outlet ports 34 and 35, respectively. A baffle plate 36 is interposed between the ports, and it extends in a horizontal direction through a portion of the core and terminates in a semi-circular scoop portion 37. A second baffle plate 38 extends substantially radially inward from the tube 33 to, in effect, divide the passage formed by the scoop portion 37. Thus, oil entering the core through the port 34 is directed by the scoop portion 37 in a reentrant path through a central section of the tube bundle, and thence it is diverted by the baffle plate 38 to peripheral portions of the core, through which it flows in a clockwise direction to the outlet port 35. Viewing the baffle arrangement from the side (Fig. 3), it will be noticed that the baffle plate 36 contains a port 40 located adjacent the end of the unit which is remote from the inlet and outlet ports. This insures that oil will also flow endwise along the tube spaces so that circulation is fairly uniform throughout the core.

The tube 33 forms part of an element or preheating jacket 41 in cooperation with an outer concentrically spaced shell 42 and end walls 43 and 44 (Fig. 4). The shell 42 is provided with glycol inlet and outlet ports 45 and 46. A transverse baffle wall 47 within the jacket 41 separates the adjacent ports and enhances circulation of the hot fluid about the device.

The jacket structure is cut back at one extremity, as indicated by the numeral 48, to expose the oil ports 34 and 35 in the tube 33. A valve fitting 50 is soldered to this portion of the tube 33, and it contains inlet and outlet passages 51 and 52 leading into the ports 34 and 35 respectively, and connecting such ports to the previously described conduits 17 and 18. The outlet passage 52 additionally is formed with a pocket 53 for receiving a thermostatic bulb 54. A glycol fitting 55 is similarly soldered over the oil ports 45 and 46 of the shell 42, and such fitting is formed with oil inlet and outlet passages 56 and 57 respectively leading to the glycol circuit conduits 21 and 22.

The fitting 55 is also formed with a seat 58 for receiving an outwardly opening valve 60. A cap 61 is secured over an angular extension 59 on the fitting 55, and such cap carries a thermostatic bellows 63. A tube 62 leads from the bellows 63 to the described bulb 54 in the oil outlet passage 52. The free extremity of the bellows 63 engages the projecting stem of the valve 60.

In the operation of the oil cooler, it will be apparent that on starting a cold engine the oil will circulate about the by-pass 24 of the auxiliary pump 15, since the normal oil path through the core of the oil cooler will be substantially blocked because of the highly viscous state of the oil in the narrow passages thereof. As the engine operates, the glycol fluid in the engine block will heat up more rapidly than the oil, and since it is continuously circulated through the jacket during this period, it will be apparent that the oil in the core will be rapidly brought to the desired degree of fluidity. When this occurs, flow through the oil cooler is immediately instituted, and the check valve 25 in the oil pump by-pass circuit gradually closes, until the full delivery of the pump 15 passes through the cooler.

It will thus be seen that during starting, or relatively cold engine conditions, the present device acts not only to "thaw" the oil radiator, but also to heat the entire oil volume, with the result that warm oil is more rapidly available to the bearings, and much of the engine damage and wear traceable to cold starts is eliminated. It may be mentioned that this feature is especially adapted to airplane engines of high horsepower ratings, where the normal glycol temperatures are retained at around 300° F., and the oil temperatures at 180° F., since this differential not only insures a faster heat transfer, but a steeper heat gradient during warming-up periods. Thus, during a phase of this period, the oil and glycol temperatures might be 90° and 150° respectively, with the latter fluid always available to warm the former.

When the oil subsequently approaches its proper operating temperature, the thermostatically controlled valve 60 automatically responds thereto and closes off the flow of glycol to the jacket. It will be understood that the device is also useful under actual flying conditions. For example, during a long gravity glide from a high altitude, the oil coolers in the prior art have been subject to partial or complete blockage, which could only be relieved after the glide by the introduction of copious volumes of hot oil in the jackets thereof. In the present invention, during the same maneuver, the valve 60 would immediately respond to the rapidly cooling oil in the unit, and it would direct the high temperature glycol through the jacket during the entire glide, and if the pilot subsequently desired to operate the plane under full throttle, the present oil cooler would be instantly available for critical cooling demands.

It will be apparent that the invention may be structurally changed in numerous manners without departing from the inventive concept. In Figs. 5 and 7, for example, the heating element 70 is cup-shaped and centrally located in the tube bundle 71. Otherwise, the fittings and circuits for the oil and glycol are similar to those of Fig. 2. In Figs. 6 and 8 the heating element 80 is cylindrical, but located centrally in the tube bundle 81, so that heat transference to the core is available from the inner and outer surfaces of the heating element. It will also be understood that while the invention has been described with particular reference to a liquid cooled engine, it is intended that the principle may be applied to other types of engines, whenever it is convenient to use the higher temperatures in the engine for heating the oil cooler.

I claim:

1. A combined heating and cooling system for the lubricating oil of internal combustion engines of the glycol cooled type, comprising an oil radiator having a thermally related core and heating element, said core having air passages therethrough and having a plurality of internal oil passages therein, said oil passages forming in effect a plurality of narrow paths through which hot oil may pass freely and through which cold oil may pass with difficulty, pump means for directing oil through the core, a return conduit from the core to the engine, a by-pass circuit for the pump having pressure-responsive means operative when the oil passages of the core are substantially blocked by cold oil, a glycol circuit including a feed conduit from the engine for directing the hot glycol fluid into the heating element and a return conduit from the element to the engine, a valve interposed in the glycol circuit, and thermostatic means responsive to tempera-

ture conditions in the core for controlling said valve in the glycol circuit.

2. An oil radiator having a cylindrically shaped core containing a plurality of axial openings for the passage of cooling air and having internal oil passages therein forming in effect a plurality of narrow paths through which hot oil may pass freely and through which cold oil may pass with difficulty, a jacket enclosing and sealing the periphery of the core, oil inlet and outlet passages leading through the jacket into the core, a chamber formed within the jacket for the reception of a heating fluid for the core, inlet and outlet passages leading into the chamber of the jacket, a valve in one of the jacket passages, thermostatically operable means for controlling the valve including a thermostatic bulb located in one of the oil passages whereby the operation of the valve in the jacket passage is controlled by the oil temperature.

3. An oil radiator having a core containing a plurality of parallel openings for the passage of cooling air and having internal passages therein forming in effect a plurality of narrow paths through which hot oil may pass freely and through which cold oil may pass with difficulty, a hollow heating element organized within the core, oil inlet and outlet passages leading into the core, inlet and outlet passages leading into the heating element, a valve in one of the element passages, thermostatically operable means for controlling the valve including a thermostatic bulb located in one of the oil passages, whereby operation of the valve in the element passage is controlled by the oil temperature.

4. A combined heating and cooling system for the lubricating oil of internal combustion engines of the glycol cooled type, comprising an oil radiator having cooling air passages extending therethrough, and also having thermally related oil passages, said oil passages forming in effect a plurality of narrow paths through which hot oil may pass freely and through which more viscous cold oil may pass with difficulty, pump means for directing oil through the oil passages, a return conduit from the oil radiator to the engine, a by-pass circuit for the pump having pressure-responsive means operative when the oil passages are blocked by cold oil, a glycol circuit from the engine including therein a heating element thermally associated with said oil radiator, a valve interposed in the glycol circuit, and thermostatic means responsive to temperature conditions in the oil radiator for controlling said valve.

5. A combined heating and cooling system for the lubricating oil of an internal combustion engine of the type whose cylinder walls are cooled by liquid having a high working temperature under normal operating conditions, comprising a cooling fluid circuit associated with the engine, engine activated means for maintaining the liquid in said circuit at a temperature higher than the normal working temperature of the lubricating oil for said engine, an oil radiator having a core and a thermally related heating element, said core also including separate and thermally related passages for the oil and for an extraneous cooling medium, said element being interposed in said high temperature fluid circuit, means responsive to the temperature of the oil in the core for controlling the flow of hot engine cooling liquid in its circuit and through said element, pump means associated with the engine for directing oil through said core, and a return conduit for oil extending from the core to the engine.

6. A combined heating and cooling system for the lubricating oil of an internal combustion engine of the type whose cylinder walls are cooled by liquid having a high working temperature under normal operating conditions, comprising a cooling liquid circuit associated with the engine, engine activated means for maintaining the liquid in said circuit at a temperature higher than the normal working temperature of the lubricating oil for said engine, an oil radiator having a core and a thermally related heating element, said core also including separate and thermally related passages for the oil and for air for cooling the oil, said element being interposed in said high temperature liquid circuit, means responsive to the temperature of the oil in the core for controlling the flow of hot engine cooling liquid in its circuit and through said element, pump means associated with the engine for directing oil through said core, a return conduit for oil extending from the core to the engine, and a by-pass circuit for the pump having pressure-responsive means operative when said core is blocked by viscous oil conditions in said radiator core.

7. A combined heating and cooling system for the lubricating oil of an internal combustion engine of the type whose cylinder walls are cooled by glycol whose normal working temperature is higher than the normal working temperature of water in a water-cooled engine, comprising an oil radiator having a thermally related core and heating element, said core also including separate and thermally related passages for the oil and for an extraneous cooling medium, pump means associated with the engine for directing oil through said core, an oil return conduit from the core to the engine, a by-pass circuit for the pump having pressure-responsive means operative when said core is blocked by viscous oil conditions in the oil passages in said core, a glycol circuit including a feed conduit from the engine for directing the hot glycol into the heating element, a return conduit from said element to the engine, a valve interposed in the glycol circuit, and thermostatic means responsive to temperature conditions in the oil in the core for controlling said valve in the glycol circuit.

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