June 28, 1949. J. M. DAVIES 2,474,518

INTERNAL-COMBUSTION ENGINE OIL COOLING MEANS

Filed March 31, 1944 3 Sheets-Sheet 1

Fig. 1.

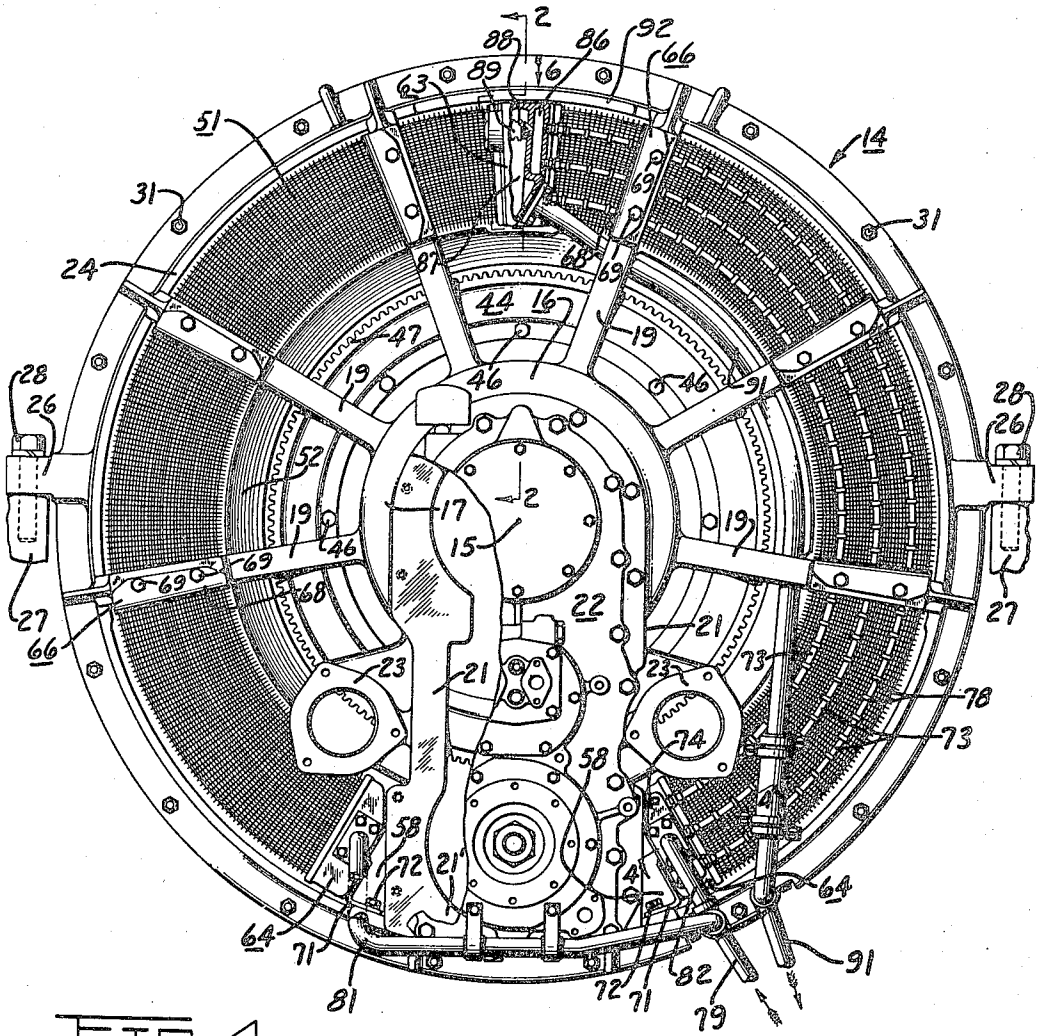


Fig. 4.

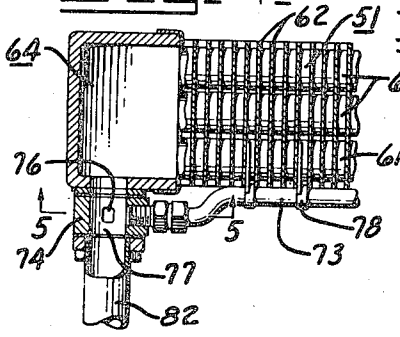
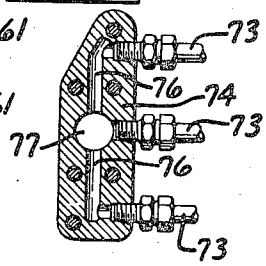


Fig. 5.



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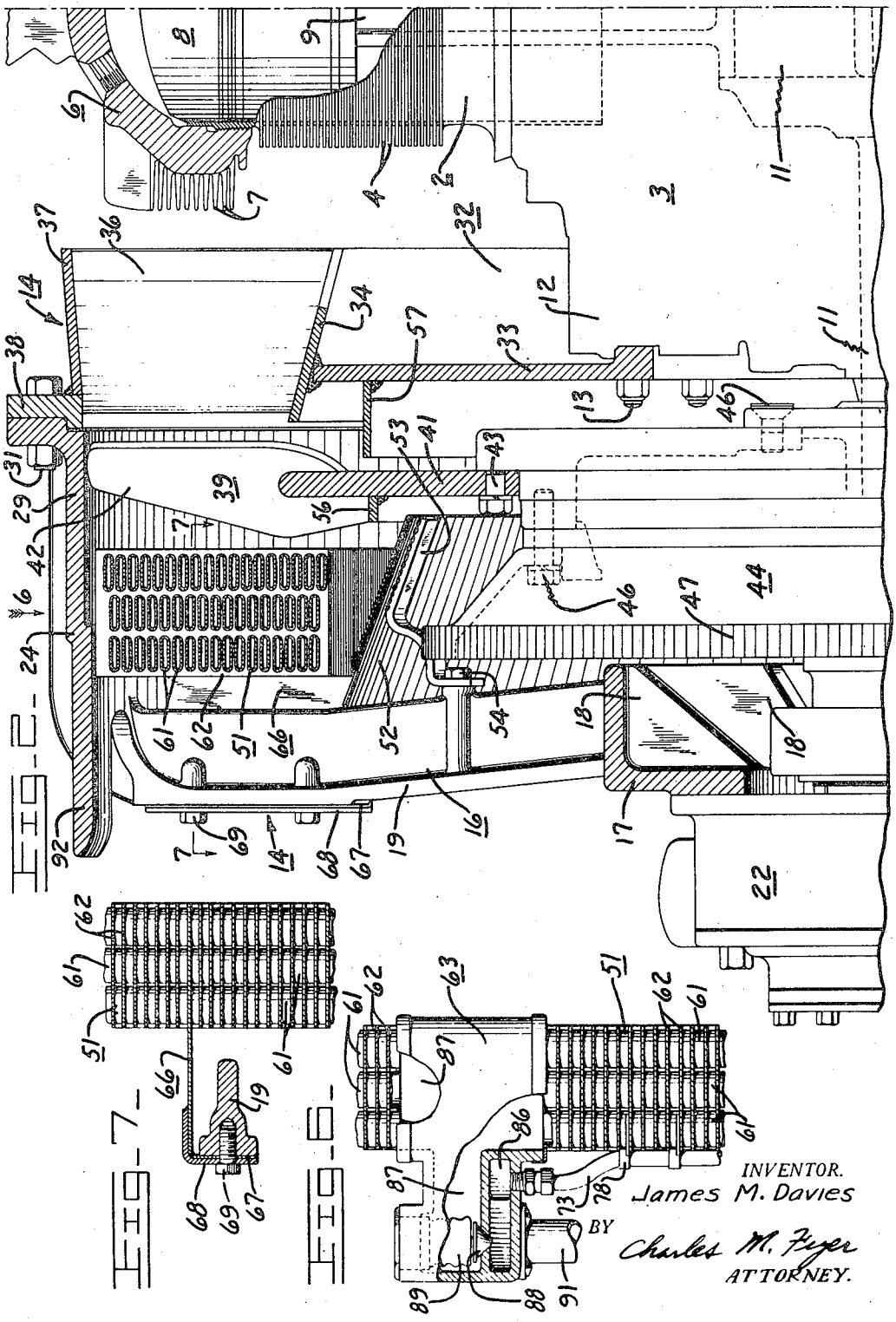


FIG-2-

FIG-7-

FIG-6-

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INTERNAL-COMBUSTION ENGINE OIL COOLING MEANS

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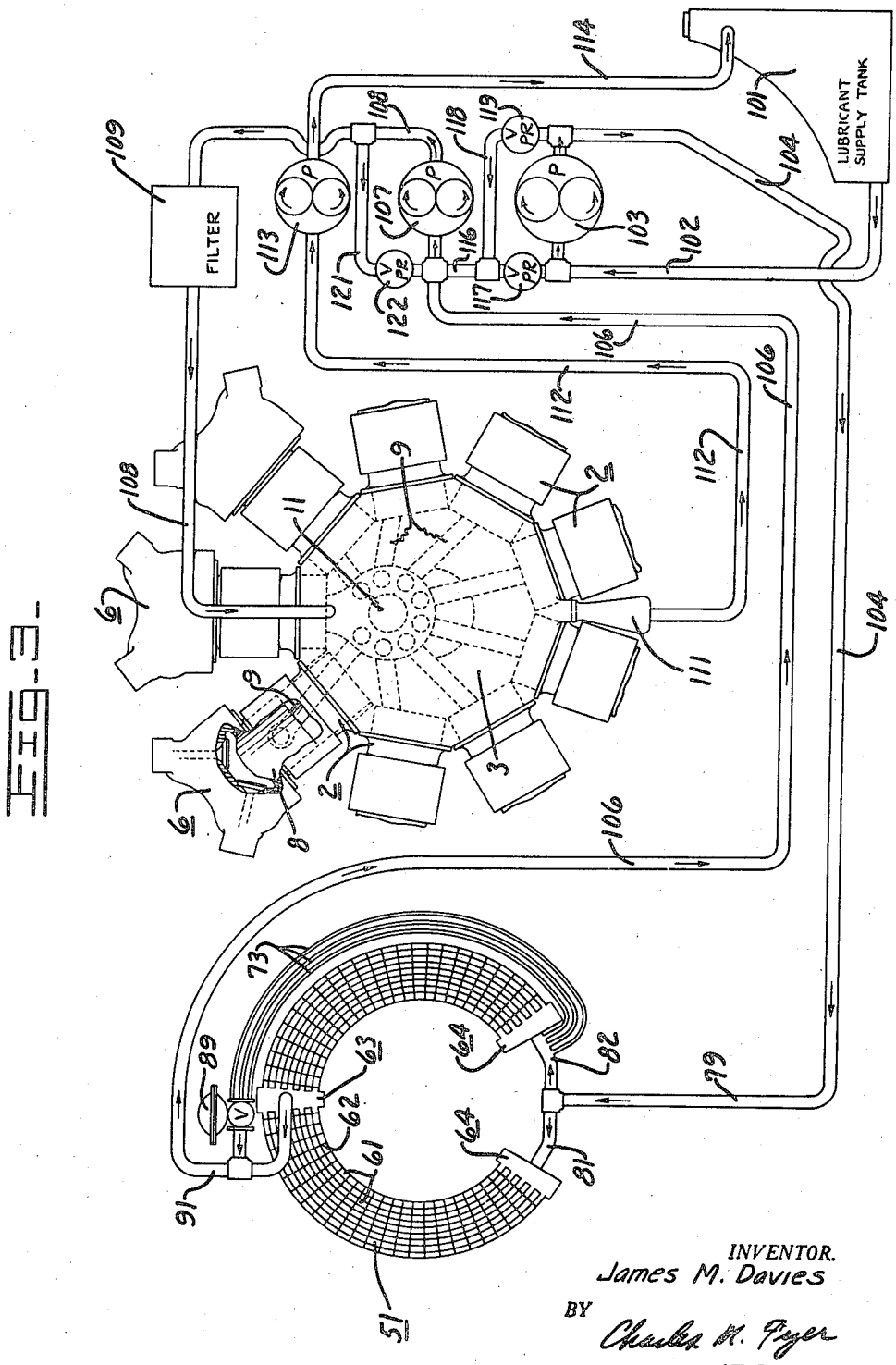


FIG-3-

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INTERNAL-COMBUSTION ENGINE OIL COOLING MEANS

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Application March 31, 1944, Serial No. 528,892

7 Claims. (Cl. 123—196)

1

My invention relates to internal combustion engines, and more particularly to a lubricating oil, cooling arrangement in a radial type of internal combustion engine.

It is desirable in an internal combustion engine to provide means for cooling the lubricating oil, as this has been found to enhance the life of the engine, not only because the bearings will have a longer life but also because the lubricant properties of the oil are preserved for a longer period. With respect to radial internal combustion engines, particularly of the air-cooled type, oil cooling systems have, heretofore, been employed but in such prior systems with which I am aware, there has been the problem of providing a suitable compact and efficient arrangement of the oil cooler with respect to the remainder of the engine.

My invention is directed to this problem, and has as its objects, among others, the provision of an improved oil cooler arrangement for a radial internal combustion engine, which is efficient; compact to thus occupy a minimum space; easy to assemble and get at; and of a relatively simple and economical construction. Other objects of my invention will become apparent from a perusal of the following description.

Referring to the drawings:

Fig. 1 is an end elevational view of a form of radial internal combustion engine embodying the oil cooling arrangement of my invention; parts being omitted from the view and other parts being shown broken away to illustrate more clearly the arrangement.

Fig. 2 is an enlarged vertical sectional view, taken in planes indicated by line 2—2 in Fig. 1; the portions of the structure not relating to the oil cooling radiator per se being shown more or less schematically.

Fig. 3 is a diagrammatic view of a preferred form of oil cooling system.

Fig. 4 is a fragmentary section taken in a plane indicated by line 4—4 in Fig. 1.

Fig. 5 is a section taken in a plane indicated by line 5—5 in Fig. 4.

Fig. 6 is a fragmentary sectional plan view, looking in the direction of arrow 6 in Figs. 1 and 2; portions of the structure being shown broken away to illustrate more clearly the construction.

Fig. 7 is a section taken in a plane indicated by line 7—7 in Fig. 2.

The engine illustrated is an air-cooled radial Diesel or compression ignition of the type shown and described in my assignee's co-pending application by Lloyd E. Johnson and Carl R. Maxwell, Serial No. 499,892, filed August 25, 1943, now Patent No. 2,398,182, for "Internal combustion engine." Although the arrangement of my invention is particularly adapted for such type of radial compression ignition engine, it is to be understood that such arrangement may be employed with any other form of radial engine. With reference to Fig. 2, which illustrates only the end portion of the engine in which the oil cooling radiator of my invention is embodied, the engine proper comprises a plurality of air-cooled cylinders 2 radially disposed about the periphery of crankcase 3, and which have cooling fins 4 extending therefrom. Heads 6 are secured to the cylinders, and are also provided with cooling fins 7. Pistons 8 in the cylinders are connected by connecting rods 9 to crankshaft 11, in any suitable manner known for connection of such rods to a crankshaft in a radial engine.

2

Crankcase 3 has attached thereto a so-called nosepiece part 12 to which is detachably connected by studs 13, a structure indicated generally by reference character 14 which extends transversely of the crankshaft axis 15 of the engine, and among other functions, serves as a supporting means for the nosepiece end of the engine. Such engine supporting means 14 includes a spider-like supporting bracket 16 formed of a plurality of integrally united parts, and which comprises a hub 17 having integral reenforcing ribs 18 and spaced radially or outwardly extending integral spokes or arms 19 projecting from the upper portion thereof. A pair of spaced integral pad members 21 extend outwardly from the lower part of hub 17, and are integral with a crosspad 21' at the outer ends thereof. These pads provide supporting means for a gear train housing structure 22 detachably secured thereto. Extending laterally from each pad 21 is a bracket ear 23 to provide a support for a starting motor (not shown).

Integrally secured with the outer ends of arms 19 and with crosspad 21', is a rim portion 24 which has an integral mounting lug 26 extending laterally from each of the opposite sides thereof; such lugs being adapted for support on suitable mounting pads 27 provided on the vehicle in which the engine is adapted for mounting. Capscrews 28 provide means for detachably securing lugs 26 to pads 27. Rim portion 24 has integral therewith an annular shroud forming part 29 which extends toward the engine, and completely encircles mechanism (to

be subsequently described) housed within the shroud.

At the right-hand portion, with reference to Fig. 2, shroud 29 is detachably connected by bolts 31, to a cover structure 32 which includes disk member 33 detachably connected to nosepiece part 12 of the engine by the previously mentioned studs 13. At its outer periphery, disk 33 is rigidly attached to an annular rim 34 which, by means of spaced air directing vanes 36, is rigidly secured to another annular rim 37 rigidly connected to ring 38 which provides the immediate part of attachment of cover structure 32 to shroud 29 by the previously mentioned bolts 31.

From the preceding, it is seen that because of the spacing of arms 19 and pad members 21, openings are provided which permit air to flow therebetween and out through the spaces between the vanes 36 of cover structure 32, against the heads and the cylinders of the engine to cool the same; the shroud 29 confining passage of air against outward escape. Means is provided for creating a blast of such cooling air against the engine comprising a fan structure 39 rotatable about the crankshaft axis 15 of the engine and which includes a disk 41 to the periphery of which are fixedly secured a plurality of fan blades 42 adjacent the openings between vanes 36. Disk 41 is secured by capscrews 43 to a rotatable mass 44 connected to be driven from the crankshaft of the engine and which includes a plurality of parts held together by capscrews 46; such rotatable mass 44 serving as the engine flywheel. One of the parts of the mass 44 is toothed at its periphery to provide a gear 47 adapted to be engaged by suitable starter mechanism (not shown). The drive from the engine is transmitted through suitable clutch mechanism (not shown) to gearing contained within the previously mentioned gear housing structure 22.

The oil cooler arrangement of my invention includes an open ring-like oil cooling radiator 51 adjacent fan blades 42 and which is supported about crankshaft axis 15, by the engine supporting means 14, in the space between fan blades 42 and arms 19; so as to be in the line of the draft of air creatable by the fan. At the inner side of oil cooling radiator 51, is a conically-shaped shroud 52 which cooperates with shroud 29 at the outer side of the radiator, to cause the flow of air to be directed substantially entirely through the radiator, to thus enhance the cooling effect of the radiator. Shroud 52 is secured to suitable brackets 53 in turn connected to supporting bracket 16, by capscrews 54; and it cooperates with a relatively short shroud 56 secured to fan disk 41, and with another shroud 57 secured to disk member 33, which baffle the air outwardly through the spaces between vanes 36.

Because of the ring-like shape of oil cooling radiator 51, it can be conveniently and compactly housed within the engine supporting means 14, and at the same time in the line of draft creatable by the engine cooling fan. A portion of the radiator is open at 58 to accommodate gear housing supporting pad members 21 which fit between the ends of the radiator adjacent such opening. Because of the mounting of the radiator on the engine supporting means 14, the radiator can be removed with such supporting means.

Radiator 51 comprises the usual tubes 61 which pass through and are secured by suitable means, such as soldering, to transversely extending cooling fins 62. For convenience of assembly, the radiator is composed of two arcuate sections, adjacent ends of which are connected to a common oil outlet tank 63; and the opposite ends adjacent opening 58 are each connected to an oil inlet tank 64. Thus there are two oil inlet tanks permitting a divided flow of oil through the radiator, and a common outlet tank.

For securing the radiator in position, it is provided at suitable spaced intervals with spaced bracket plates 66 through which tubes 61 pass, and to which such tubes are secured by suitable means, such as soldering.

Each of bracket plates 66 is provided with a flange portion 67 reenforced by an angle piece 68 welded thereto; such flanges 67 being adapted to engage the outer faces of arms 19, thus enabling capscrews 69, secured in such arms, to hold the radiator detachably in position. The inlet ends of the radiator are detachably supported on rim portion 24 of supporting bracket 16, by angles 71 secured to inlet tanks 64 by any suitable means such as welding, and detachably secured to rim portion 24 by capscrews 72. By virtue of the described mounting arrangement of oil cooling radiator 51, it is apparent that it may be readily mounted in position on, or removed from supporting bracket 16.

In normal operation, when the engine is running, the lubricating oil is heated by the engine, and, therefore, can readily pass through radiator tubes 61. However, when the engine is started in extremely cold weather after it has been idle for some time, the lubricant in radiator tubes 61 might be congealed, thus precluding free passage of lubricant therethrough. To enable adequate flow of lubricant under these circumstances, I provide radiator by-pass tubing which is of sufficient diameter to allow cold, relatively viscous oil to flow therethrough readily. A plurality of such by-pass tubes 73 is employed, which are arcuate and are mounted on one of the radiator sections in heat transfer relationship therewith, so that oil heated by the engine and passing through the by-pass tubes, can heat up the oil in radiator tubes 61, by conduction, for the purpose of facilitating warming of the oil in the latter tubes.

Tubes 73 are connected at one end thereof to a manifold fitting 74 detachably connected to the right-hand inlet tank 64 appearing in Fig. 1, and which has a passageway 76 communicating with a central aperture 77 open to such inlet tank 64. For conducting heat from by-pass tubes 73 to the radiator, such tubes are fastened to the radiator by clips 78 of a metal of a relatively high heat conductivity, such as copper, soldered to the tubes and also to various of the radiator fins 62 and the radiator tubes 61. Lubricant is fed into the cooling radiator by inlet piping 79 which is branched adjacent radiator inlet tanks 64. One of such branches 81 is connected to the left-hand inlet tank 64 appearing in Fig. 1; while the other branch 82 is connected to manifold 74 attached to the right-hand inlet tank 64 appearing in Fig. 1. The discharge ends of by-pass tubes 73 are connected to a separate chamber 86 in outlet tank 63, which chamber communicates with the main chamber 87 in such tank, by means of a port the opening and closing of which is controlled by valve 88 connected to a thermostat 89 of any suitable construction. Oil outlet pipe 91 is connected to receive discharge of oil from main chamber 87 of outlet tank 63, as can be seen more clearly from Fig. 1.

Thermostat 89 is designed to keep valve 88

closed, and thus shut off by-pass chamber 86, at temperatures at which the lubricating oil will be relatively non-viscous, so that it can flow readily through radiator tubes 61. Thus, under this condition, there will be no communication between chamber 86 and main chamber 87 of the outlet tank; and the oil will flow from the radiator tubes 61 into main chamber 87 of outlet tank 63, and out through oil outlet pipe 91. However, when the temperature is such that the oil is relatively viscous, the thermostat control is such as to open outomatically valve 88. Under this condition, even if the oil is congealed in radiator tubes 61, which are exaggerated as to size in the drawings to illustrate them clearly, the oil can flow through the much larger by-pass tubes 73, into chamber 86, past valve 88, into chamber 87, and out through outlet pipe 91, thus insuring that the engine will not be starved of oil.

During warming up of the engine, the oil from the engine passing through by-pass tubes 73 will transfer heat to the congealed oil in the one section of the radiator to which such tubes are connected, thus facilitating warming up of oil in such one section; and when the oil can flow through such one section, warming up of the oil in the other radiator section will occur as the engine proceeds to operate. Thus, unless the outside temperature is extremely low, the engine will in time cause sufficient warming of the oil; so that valve 88 will become closed by the thermostat, and the oil will flow through the radiator.

Even if the outside temperature is extremely low so that the oil in the radiator remains relatively viscous after the engine is started, but the oil in by-pass tubes 73 is warmed by the engine to the extent that valve 88 is closed by the thermostat, the pressure of oil flowing through by-pass tubes 73 can act against valve 88 to open the valve; so as to insure that the engine will have a supply of lubricant under this extreme condition. In order to protect the portion of outlet tank 63 which contains thermostat 89, rim portion 24 of supporting bracket 16 is provided with an outwardly extending flange 92 over outlet tank 63, and which extends between the arms 19 at either side of such outlet tank.

Any suitable oil pumping and circulating system may be employed for causing circulation of oil among the engine, the oil cooling radiator, and a source of lubricant supply. A preferred form of system is schematically illustrated by Fig. 3. Lubricant from supply tank 101 is pumped into oil cooling radiator 51 through conduit 102 connected to the inlet side of a constant volumetric discharge gear pump 103, the discharge side of which is connected by conduit 104 to the previously mentioned radiator inlet piping 79. Connected to radiator outlet piping 91, is a conduit 106 which in turn is connected to the inlet side of a constant volumetric discharge gear pump 107 which supplies oil to the engine by means of a conduit 108 connected to the discharge side of pump 107 and to the engine; any suitable filtering means 109 being connected in engine feed conduit 108. From engine sump 111, oil is conducted back to the lubricant supply tank 101 by means of conduit 112 connected to the inlet side of a third constant volumetric discharge pump 113; the discharge side of which is connected to the lubricant supply tank 101 by conduit 114.

Radiator supply pump 103 is of a larger capacity than the engine supply pump 107, to insure an adequate supply of lubricant for the engine; and to take care of this excess supply, a conduit

116 is connected between the inlet side of engine supply pump 107 and the inlet side of radiator supply pump 103, in which is located a pressure relief valve 117 designed to open automatically at a predetermined low pressure of about ten (10) pounds per square inch to allow return of excess lubricant from the radiator, to the inlet side of radiator supply pump 103. In case anything should become wrong with the radiator cooling system, precluding flow of oil through either the radiator or its by-pass tubes 73, means is provided to automatically by-pass such radiator system. For this purpose, a by-pass conduit 118 is connected between the discharge side of radiator supply pump 103 and to conduit 116 at the inlet side of engine supply pump 107, which conduit 118 has a pressure relief valve 119 therein.

Valve 119 is designed to open above a predetermined pressure which would be created should the radiator system become clogged. As a result, radiator supply pump 103 will feed oil to the inlet side of engine supply pump 107 through conduit 118; and excess oil will be returned to the inlet side of radiator supply pump 103 by means of opening of valve 117. To control the pressure of oil fed to the engine by engine supply pump 107, a by-pass conduit 121 is connected between the discharge side of pump 107 and the inlet side thereof, in which is located the usual pressure control valve 122.

I claim:

1. In a radial internal combustion engine, engine supporting means extending transversely with respect to the crankshaft axis of the engine and having spaced arms extending outwardly with reference to such axis and between which air may pass, a ring-like oil cooling radiator about the axis, and means mounting the radiator on the supporting means including a plurality of bracket plates secured to the radiator and to such arms.

2. In a radial internal combustion engine, engine supporting means extending transversely with respect to the crankshaft axis of the engine and having spaced arms extending outwardly with reference to such axis and between which air may pass, an open ring-like oil cooling radiator about the axis and having a tank connected thereto at each of the ends at the open portion thereof; and means mounting the radiator on the supporting means including a plurality of bracket plates secured to the radiator and to such arms, and a bracket securing each of the tanks to the supporting means.

3. A radial internal combustion engine having a plurality of cylinders adjacent one end thereof extending radially with respect to the crankshaft axis of the engine, supporting means for the opposite end of the engine extending transversely with respect to said axis, an oil cooling radiator between the cylinders and the supporting means, and a fan between the radiator and the cylinders.

4. A radial internal combustion engine having a plurality of cylinders adjacent one end thereof extending radially with respect to the crankshaft axis of the engine, supporting means for the opposite end of the engine extending transversely with respect to said axis, a ring-like oil cooling radiator about the axis between the cylinders and the supporting means, and a fan about the axis between the radiator and the cylinders.

5. A radial internal combustion engine having a plurality of cylinders adjacent one end thereof extending radially with respect to the crankshaft axis of the engine, spider-like detachably

mounted supporting means for the opposite end of the engine having spaced arms extending transversely with respect to such axis forming openings therebetween, a ring-like oil cooling radiator about the axis, and means detachably mounting the radiator on the supporting means.

6. A radial internal combustion engine having a plurality of cylinders adjacent one end thereof extending radially with respect to the crankshaft axis of the engine, spider-like detachably mounted supporting means for the opposite end of the engine having spaced arms extending transversely with respect to such axis forming openings therebetween, a ring-like oil cooling radiator including a plurality of tubes about the axis, and means detachably mounting the radiator on the supporting means including bracket plates detachably secured to a plurality of such arms and through which the tubes pass.

7. A radial internal combustion engine having a plurality of cylinders adjacent one end thereof extending radially with respect to the crankshaft axis of the engine; spider-like detachably mounted supporting means for the opposite end of the engine having spaced arms extending transversely with respect to such axis forming openings therebetween; an open ring-like oil cooling radiator about the axis including a pair

of arcuately-shaped portions having tubes about the axis, an outlet tank common to and connected to adjacent ends of such portions, and an inlet tank connected to each of the ends at the open portion of the radiator; and means detachably mounting the radiator on the supporting means including bracket plates detachably secured to a plurality of such arms and through which the tubes pass, and a bracket for detachably connecting each of the tanks to the supporting means.

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