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E. PIQUEREZ

LUBRICATION OF AERO AND OTHER ENGINES

Filed Dec. 16, 1938

Serial No. 246,211

3 Sheets-Sheet 1

Fig. 1

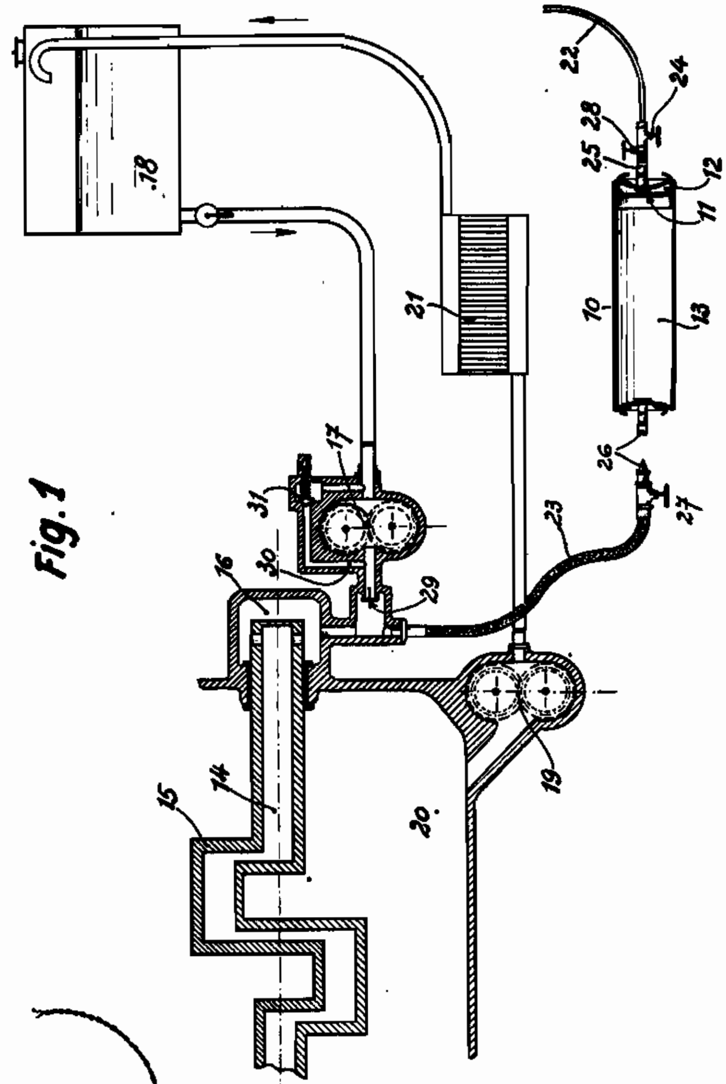

Fig. 2

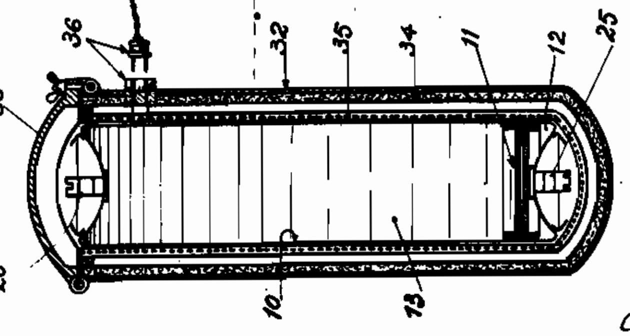

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Fig. 3

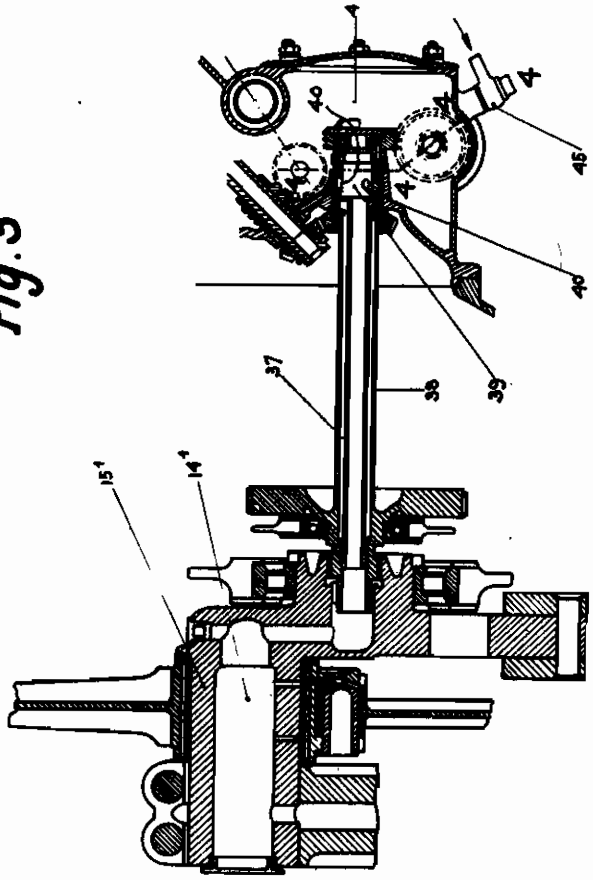

Fig. 4

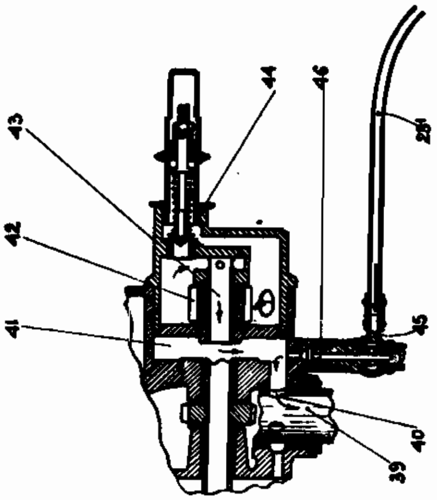

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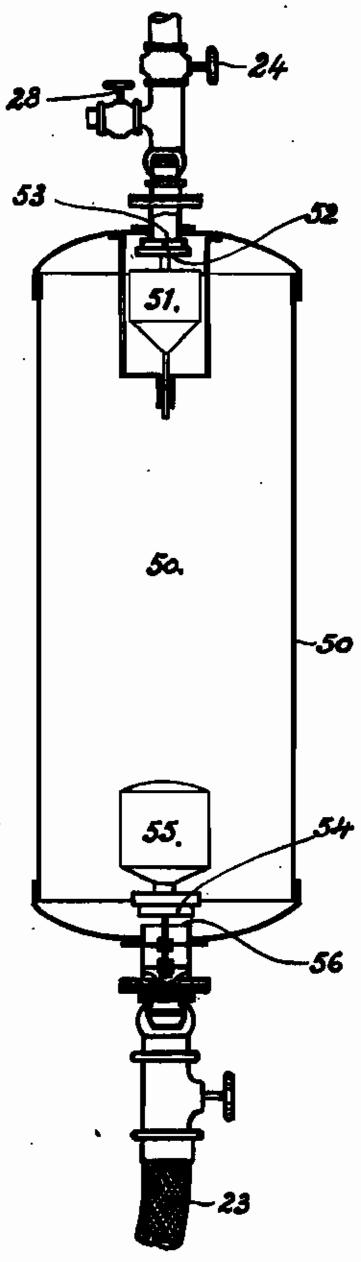
Fig. 5



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ALIEN PROPERTY CUSTODIAN

LUBRICATION OF AERO AND OTHER ENGINES

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This invention relates to the lubrication of aero and other engines and has for its chief object the provision of improvements in the lubrication of such engines when starting, particularly under conditions of low temperatures.

In a general way the lubrication of aero engines is effected by means of a pump which is fed from a reservoir and forces the oil into the crankshaft of the engine, the said reservoir being itself fed by a so-called exhaust pump, which, drawing the oil from the crankcase of the engine, forces it through a radiator, the object of which is to ensure the cooling of the oil, to the reservoir. The first said pump, properly called the lubricating pump, is provided with a by-pass which opens at a predetermined pressure and, when the resistance to the lubricant flow and consequently the pressure in the crankshaft, rises above the aforesaid pressure limit, discharges directly into the engine crank case or returns the lubricant to the inlet side of the pump.

When starting in cold weather the oil may be congealed in the crank case. The resistance which it then offers to the delivery of the pump causes the operation of the said by-pass, so that, in the absence of any other arrangement, the lubrication of the engine is inadequate or uncertain.

The only way of overcoming this drawback in practice has been to heat the oil in the feed reservoir of the lubricating pump either in situ, which is often inconvenient and is always a lengthy procedure, or in a separate vessel, which necessitates the provision of heating devices, some forms of which have no connection with the said reservoir, the contents of which are completely transferred, while others of which are included in a closed circuit starting from and returning to this reservoir.

In all these cases the apparatus is expensive, generally bulky, and in any case only permits of starting being effected after a lapse of sufficient time for the heating of the oil. It is an object of this invention to provide a method for ensuring the lubrication of engines of all types, but more particularly of aero engines, when starting in cold weather, whereby these drawbacks are avoided.

This method consists essentially in delivering into the crankshaft, an auxiliary flow of hot oil additional to the main flow of oil from the lubricating pump, the said hot oil being under a pressure greater than the delivery pressure of the pump so that this hot oil passes into the crankshaft forming eventually an annular stream around a core of cold oil; and then passes directly to the discharge ports of the crankshaft, ensuring on the way the liquefying of the cold oil. This injection of hot oil can take place either before the starting of the engine or during the starting thereof. In this last case the injection can be effected concurrently with the flow of oil coming from the lubricating pump; but the quantity of the supply should be less than that of the latter.

The lubrication of the engine is thus assured from the start by means of at least the hot oil so that the engine can begin to operate immediately. The engine then itself constributes to the heating of the lubricating oil; it being understood that the auxiliary injection of hot oil can be very limited in duration and in quantity.

The preliminary heating of the oil of the auxiliary flow injected according to the present method can be effected by any suitable means, but an important improvement can be applied to the method already set forth by providing a reserve of hot oil for the injection by withdrawing a proportion of oil from the engine lubricating circuit itself during the running of the engine when the oil is consequently at a relatively high temperature. It will in this way be sufficient to insulate this reserve thermally and to supply it with only enough heat to make up for the losses of the insulated system, and in this way ensure, during the stopping of the engine, that this reserve is in a condition to be used for the next starting. Further, the compressed air ordinarily provided and stored on the aeroplane itself is advantageously used to provide the pressure for the injection of the auxiliary flow of hot oil.

It is also an object of the invention to provide apparatus for carrying out the present method, comprising essentially a storage container for hot oil provided with a piston dividing it into two compartments of variable size, one of which is connected to a source of fluid under pressure, while the other, containing the hot oil, is connected to the inlet of the crankshaft of the engine, jointly with the discharge of the lubricating pump, a non-return valve being provided in this discharge below the by-pass to prevent any possibility of the hot oil flowing back towards the pump and towards the feed reservoir.

In an advantageous construction for carrying out the improved process as set forth above, the pressure chamber of the said container is provided with means for connecting it with the atmosphere, the operation of which means, after the emptying of the container when the engine is running normally and after the lapse of a certain time, permits of this tank being re-filled with the oil of the normal lubricating system which under these conditions is at a relatively high temperature, the operation being effected preferably just before the stopping of the engine. The piston in the container can be omitted, in which case the container is provided with means for, on the one hand, closing the oil outlet once the emptying has been completed, and, on the other hand, shutting off the communication of the container with the atmosphere at the end of the filling operation.

The container having been filled in the manner set forth above, can be enclosed in a thermally insulated casing which is provided with a permanent source of heat, which can be sufficient merely to compensate for the slow heat losses of the insulated system and the losses by conduction along the pipes.

This heat source can consist, for example, of an electric resistance fed from the current supply of the aircraft, or it can consist of a catalytic petrol heater.

This system can be further improved by the adoption of means avoiding losses by conduction along the pipes. To this end the container is movably connected between two quickly detachable couplings, and an insulating and heating casing capable of receiving the detached container is provided.

The heating means can in this last case have a lower heating power than in the aforesaid case. This last system can be arranged separate from the aircraft and this avoids the necessity of using means on the craft, in particular the current from the batteries.

Finally it is obvious that the power of the heating means can then be very much reduced, it being understood that the thermally insulating means can be arranged to ensure the maintaining of the temperature for a relatively long time. It would be of advantage to arrange that this heating means should be able, when necessary, to furnish a greater supply of heat which would only be required when it is desired to effect the complete initial heating of the contents of the container before putting it into use.

Finally it follows that, in place of the aforesaid arrangements, a permanent supply of oil containers can be provided on the aerodrome arranged in a heating and insulating casing. These would be used in accordance with requirements, the container which has just been removed being replaced each time by a full container, such as that which would have been removed from the engine.

The accompanying drawings show by way of example a schematic arrangement of apparatus for carrying out the method according to the invention, and the adaptation of this apparatus to a particular engine. In the drawings:—

Figure 1 shows the assembly diagrammatically in elevation and partly in section;

Figure 2 shows in vertical section an arrangement for heating the container when removed from the apparatus;

Figure 3 is a partial longitudinal section of a particular engine to which the apparatus is applied;

Figure 4 is a section along the line 4—4—4—4— of Figure 3, and

Figure 5 is a vertical diagrammatic section of another form of container.

As can be seen from the drawing (Figure 1) the apparatus for carrying out the method according to the invention comprises essentially a container **10**, preferably constructed of metal, which is provided with an internal sliding piston **11** which defines two compartments **12** and **13** one of which, **12**, is connected to a source of air under pressure, such as a reservoir, while the other **13** containing the hot oil is connected to the inlet of the internal passage **14** of the crankshaft **15** of the engine, for example by means of the box **16** normally provided for the admission of the oil delivered by the lubricating pump **17**.

In Figure 1, **18** indicates the feed reservoir of the said pump **17**, which reservoir is itself fed by the pump **19**, drawing from the crank case **20** through the radiator **21**.

The container **10** is connected to the source of pressure air and to the crankshaft, for example by pipes **22** and **23** respectively. A valve **24** in the pipe **22** enables the admission of air under pressure to be permitted or prevented at will.

The container **10** can be permanently connected between the pipes **22** and **23**. In this case it would be surrounded in place by some suitable source of heat, itself preferably contained in an insulated casing.

In the particular preferred embodiment of Figure 1 the container is removably connected between the two pipes, for example by means of quick action couplings **25** and **26** having a valve opening automatically under the action of the coupling. In this case a valve **27** included in the pipe **23** enables the latter to be closed when the container is not in place. In the drawing (Figure 1) the container is shown as being detached from the pipe **23** solely for the purpose of showing the coupling **26** more clearly. To avoid all error in connecting up it is advantageous to provide two types of coupling, the one **25** having three coupling dogs and the other **26** having two dogs.

In the above case where a removable container is used it is obvious that it could be refilled outside the apparatus by suitable means, but as has been said this operation is advantageously performed by refilling the container in place, when it has fulfilled its purpose, by means of the lubricating pump itself. For this it will suffice to provide means for connecting the compartment **12** to the atmosphere for example by means of a valve **28**.

When this is possible the installation can be completed by providing a check valve such as **29** below the passage of the by-pass **30** of the pump **17**, the valve of which is indicated at **31**. This is to avoid any flow of the hot oil in the direction of the pump, and beyond it. By reason of the small flow of the hot oil and its direct passage leading to the crankshaft and thanks to its high pressure the possibility of a back flow towards the pump is very unlikely.

In these conditions, assuming the container to be full of hot oil and in place in the apparatus, the operation is as follows:

The valves **27** and **24** are opened, the valve **28** being closed. The compressed air entering the container forces back the piston **11** which by its movement gradually forces the hot oil from the compartment **13** into the pipe **23** and thence to the box **16** and the crankshaft **14—15**.

While allowing that this last may be full of cold congealed oil, it will be clearly understood that the injected oil will find a passage around the core of cold oil and will advance in the form of an annular stream around this core. Thus while liquifying the cold oil it will pass directly to the delivery ports of the crankshaft so that lubrication of the engine will begin, it being ensured that the latter can, under these conditions, be started at the same time as the injection of hot oil or some moments after the beginning of this injection.

Hence the fluidity, and consequently the rate of flow, of the main oil, which is initially negligible, will increase rapidly owing to the additional heating provided by the operation of the engine, and at the end of a short time the main flow by itself will be sufficient to ensure lubrication. The capacity of the container and the rate of flow of hot oil will naturally be adjusted so that this flow stops at this moment.

When the aeroplane is nearly ready to land, at any rate a little before the stopping of the engine, it is enough merely to open the valve **28** communicating with the atmosphere, after having closed the valve **24** to avoid any loss of compressed air, to ensure the automatic filling of the container with oil from the main lubricating system itself, which oil is consequently already at a relatively high temperature.

In order to have this reserve when a fresh start is made it will, in practice, suffice to maintain the temperature of the oil or to increase it slightly. To do this, in the embodiment according to Figure 1 where the container is removable, the valve **27** is closed and the container lifted up and transferred to an insulating and heating apparatus such as that shown in Figure 2, arranged either on the craft, or on land.

This apparatus comprises, for example, a casing **32** provided with a quick acting cover **33** and having an internal heat insulating lining **34** and heating means such as an asbestos-covered or otherwise insulated electrical resistance **35**. An air space is left between this resistance **35** and the lining **34** while a connector **36** permits the supply of current to the resistance. The free internal space of the apparatus is adapted to receive the container **10** to which are attached only the two coupling elements.

The heating capacity of the resistance **35**, or of any other heating means which may be employed can be a minimum, less than in the case where the heating is effected on board the aeroplane, owing to the fact that the losses by conduction along the pipes are avoided. It would be desirable, nevertheless, to make it sufficient for it to be able to effect in time the entire heating of the contents of the container, which would only be necessary when the container is first put in service. In the case of an electrical resistance it is sufficient for this purpose to provide a rheostat or the equivalent.

It will be understood also that, in place of an arrangement of a single container such as that of Figure 2, a number of such arrangements could be provided, with a casing having a number of compartments, so as to provide a reserve of containers which are used as required, each container removed being replaced by a full container such as that just being replaced on the aeroplane.

Figures 3 and 4 show a modified adaptation of the apparatus to a particular engine, which is only distinguished from the preceding arrangement by the fact that in this case there is no check valve **29**.

In Figure 3, **15**[1] indicates the crankshaft and **14**[1] its internal passage. The latter is in this case supplied through a passage **37** within the pump operating shaft **38**, which passage opens at its after extremity into a chamber **39** communicating by means of ports **48** with a casing **41** enclosing the operating gears of the various pumps.

In Figure 4 the chamber **39** is shown as a pipe in order to make this figure more understandable. In Figure 4, **42** indicates one of the gears of the lubricating pump which discharges into the axial passage **43** opening into the chamber **41**; **44** indicates the by-pass valve of this pump.

The injection of the auxiliary stream of hot oil takes place through the conduit **23**[1] which is identical to the conduit **23** of Figure 1. This conduit ends in a pipe **45** which connects it with a passage **46** opening into the chamber **41**.

The apparatus supplying hot oil is not reproduced in Figure 3 being similar to that of Figure 1.

The apparatus described above can naturally operate in any position.

In the embodiment of Figure 5 the container, which is arranged to operate only in a vertical position, does not comprise a piston, but is provided with means, on the one hand, for closing its discharge opening at the end of the emptying operation to avoid the admission of compressed air into the lubricating system and, on the other hand, for cutting automatically the communication with the atmosphere at the end of the filling of the container with oil drawn from the lubricating system.

As can be seen from Figure 5, in this embodiment the hot oil container **50** comprises, on the side where the compressed air is admitted a float **51** guided in any suitable manner and attached to a valve **52**. This latter is adapted to close the port **53** at the completion of the filling of the container with hot oil from the main lubricating circuit of the engine, the valve **28** communicating with the atmosphere then being open and the compressed air valve **24** closed, as has been explained above.

As soon as filling is complete the valve **28** is closed.

The container being full can be left in place in the case where thermally insulating means has been provided to maintain the temperature of the hot oil.

When the time for the oil to be used arrives it is sufficient to open the compressed air valve **24** and the contents of the container will be delivered to the crankshaft of the engine through the pipe **23**.

To prevent the admission, at the end of the emptying of the container, of compressed air into the lubricating system, there is provided at the bottom of the container another valve arrangement **54** having a float **55** adapted to close the outlet port **56** at that moment. It is obvious that the functions of closing these ports **53** and **56**, opened in good time, could be fulfilled by two valves attached to a single instead of to two floats.

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