Nov. 25, 1941. R. AVIGDOR 2,263,864

FUEL FEED DEVICE FOR AIRCRAFT

Filed Feb. 13, 1939 2 Sheets-Sheet 1

Fig. 1.

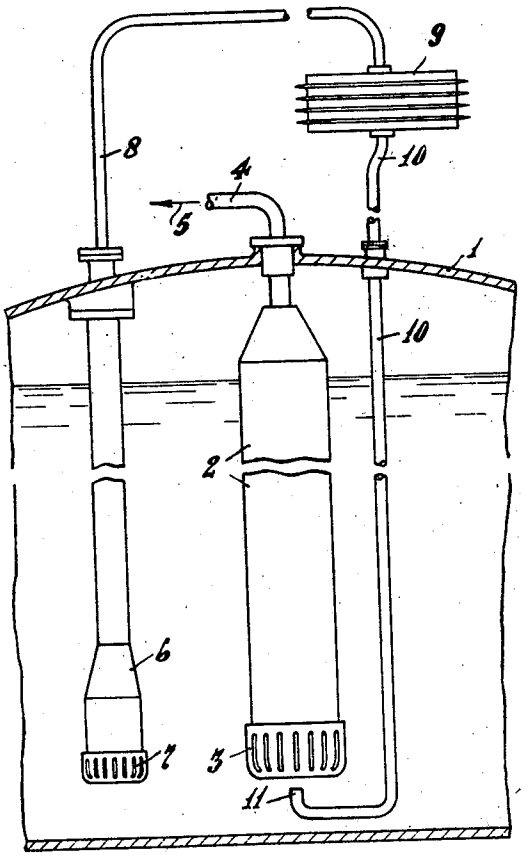
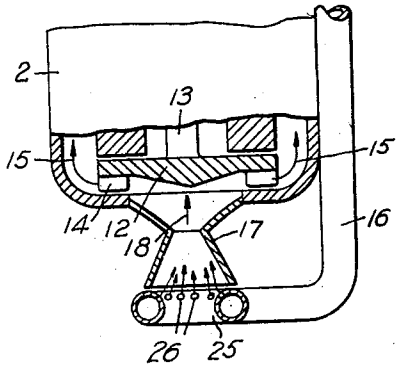


Fig. 4



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Fig. 2.

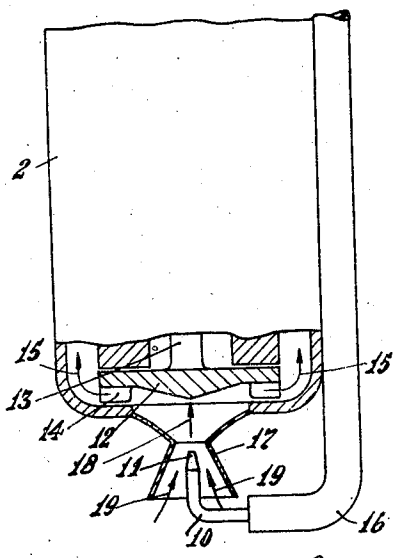
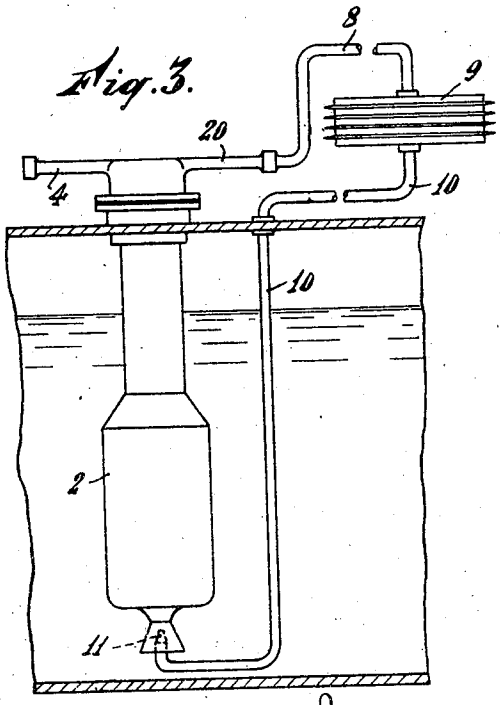


Fig. 3.



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FUEL FEED DEVICE FOR AIRCRAFT

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7 Claims. (Cl. 10?—5)

The invention relates to an arrangement in fuel feeding devices for aircraft. The liquid fuel required for the operation of the internal combustion engine of an aeroplane is fed to the engine by means of a pump from one or more tanks arranged at suitable places in the aeroplane. This pump is preferably arranged as a so-called submersible pump set within the fuel tank or tanks. The pump is driven by an electro-motor, which in a suitable way is mounted in the casing of the pump. The arrangement is such that the pump is located in close proximity to the tank bottom and is suspended from the upper cover plate of the tank.

The tank may have thick walls, which, if necessary, are either covered by insulating material or consist of non-metallic substances.

Now it has occurred in practice that tanks of this type behave as heat-accumulators so that the fuel within the tank is heated and accumulates the heat absorbed for a considerable time. The heating is, during the summer months, a consequence of the sun rays and the outside temperature. Now as soon as an aeroplane with a fuel heated in this way ascends to considerable height the fuel in the tank will begin to evaporate and gasify due to the decreasing air pressure. The effect thereof is that the pump can no longer satisfactorily feed the fuel to the engine since generally a blade pump is used, the feeding action of which will stop as soon as trapped gases or vapors of the fuel occur in the feed path of the pump. A cooling of the fuel within the tank is impossible by reason of the insulating effect of the walls, in particular since the ascending of an aeroplane to considerable height takes place in a short time. The fuel supply is therefore uncertain and the case may occur that the supply is entirely interrupted.

When the fuel within the tank is heated gases and vapors are trapped, in particular closely above the bottom of the tank. Now, since the inlet of the feed pump is located at this place within the tank it may occur that the fuel supply is already stopped in the case of a small increase of the temperature of the fuel. Moreover, just at the inlet zone of the pump a somewhat reduced pressure is created by the suction of the pump rotor as compared with the pressure in the surrounding mass of liquid, whereby the evaporation or gasification of the fuel will occur still earlier or more intensively.

These disadvantages are removed, according to the invention, by effecting a cooling of the fuel by circulation from the tank through an outside cooler and back to the tank. This circulation of the fuel may according to the invention be produced by means of a submersible pump in the tank. Preferably the return flow of the fuel from the cooler is to enter at or in the vicinity of the inlet of the pump feeding the fuel to the motor.

Instead of a submersible pump maintaining the circulation for the cooling of the fuel, according to the invention use may also be made of the pump feeding the fuel to the engine. In this case, part of the fuel delivered by the engine feed pump is branched off and passed through a cooler, located outside the tank. The return flow of the fuel preferably enters again at or in the vicinity of the inlet of the feed pump supplying the motor.

The cooler is arranged at a convenient place on the aeroplane preferably so as to be subjected to the air current. A cooler of this nature need have but relatively small dimensions since the outside temperature at considerable height is very low and moreover the strong air current caused by the flight produces a vigorous cooling.

Since for devices of the type described above pumps are used which always have a feeding capacity which is greater than the fuel consumption of the engine, the branching off of part of the fuel for the circulation through a cooler for the cooling of the fuel contents of the tank may be carried out without taking any further steps.

The fuel returning from the cooler is introduced into the inlet of the feed-pump at a certain pressure or at a certain speed so that the pump will have to produce less power than if the fuel were flowing to the pump only at the pressure head of the liquid column in the tank. The energy used for the circulation of the fuel to cool the fuel is therefore partially compensated by the smaller amount of energy to be produced by the pump. The cooling device as such therefore consumes relatively little power.

It is especially advantageous to construct in accordance with the invention the outlet end of the return conduit so as to form an injector for the fuel surrounding said return conduit end. In this embodiment the fuel carried along by the injector action is not only cooled but also urged towards the rotor of the pump. The speed of the cooled fuel leaving the return conduit is then utilised in a particular way. Preferably several injector-nozzles are arranged ringwise around the inlet of the pump.

With the device described above it is possible to effectively cool in a short time the contents

of a fuel tank by circulation, so that in the hottest season and under very strong radiation of the sun the temperature of the fuel is kept so low that no evaporation or gasification can occur.

The invention is illustrated in the drawings schematically and by way of example.

Figure 1 is an elevation of an embodiment of the device according to the invention;

Figure 2 is an elevation, partly sectional, of the lower portion of the feed-pump;

Figure 3 shows a further embodiment of the device according to the invention, and

Figure 4 is a view similar to Figure 2 illustrating a modification.

1 denotes the tank of an aeroplane in which the submersible pump 2 is suspended. The fuel in the tank flows to the pump through the strainer 3 constituting the lower end of the pump. The fuel is fed through the pipe conduit 4 to the internal combustion engine in the direction of the arrow 5.

In the embodiment shown in Figure 1 another pump 6 is arranged in the tank 1 to which pump the fuel flows through a strainer 7 mounted on the pump 6. The pump 6 feeds the fuel through a pipe conduit 8 into a cooler 9. The cooler is mounted on the aeroplane in such a manner that it is subjected to the air current or is exposed in such a manner that the fuel is effectively cooled. 10 denotes the outlet conduit of the cooler 9. This conduit returns the fuel to the tank 1 and opens at 11 into the inlet strainer 3 of the feed-pump 2 or into the vicinity thereof.

The operation of this embodiment is as follows:

The pump 6 feeds fuel continuously through the conduit 8 into the cooler 9. In the cooler the warm fuel coming from the tank is cooled and flows in this cooled condition through the conduit 10 back to the tank. Part of the fuel leaving the outlet end 11 of the conduit 10 is mixed with the warm fuel in the tank 1 and already thereby reduces gradually the temperature of the fuel. A further portion of the fuel leaving the outlet end 11 flows directly into the inlet strainer 3 and is supplied to the engine through the conduit 4 by the main feed pump 2.

After a short time the total amount of fuel contained in the tank 1 has passed through the cooler 9 whereby a rapid cooling of the fuel is obtained, so that no evaporation or gasification due to the heat accumulating walls of the tank can occur.

Now in order to utilize the pressure head of the circulating fuel resulting from the operation of the pump and the position of the cooler 9, the outlet end of the return conduit of the fuel is formed as an injector as shown in the embodiment according to Figure 2. The casing of the pump, through which the fuel is fed to the engine, is again denoted by 2.

In the lower portion of this pump the rotor 12 of the pump is secured to the end of the shaft 13. The blades of the pump are schematically shown and denoted by 14. The fuel flowing to the pump rotor is forced upwards in the direction of the arrow 15 and flows through the conduit 4 to the engine. Similarly as in the embodiment according to Figure 1 the conduit 10 of the return flow of the cooler 9 enters underneath the inlet of the feed pump. The conduit 10 is provided with a special heat insulating layer 16, so that the fuel is supplied to the feed pump at the lowest possible temperature. The outlet end 11 of said conduit is located within a tapering hollow member 17 and together therewith forms an injector. By the fuel leaving the outlet 10 in the direction of the arrow 18 the fuel surrounding the injector is drawn and carried along in the direction of the arrows 19. At the same time the fuel carried along by the action of the injector is in this way cooled, while the pressure head of the return conduit at the same time promotes the feed. Now, the fuel flows at a certain speed or at a certain pressure to the rotor 12 of the feed pump, so that the advantages referred to above are obtained.

The injector device is shown in Figure 2 only schematically. In the existing pumps provided with an inlet strainer, it is preferred to use a plurality of injectors arranged in a circle around the inlet strainer in the form of an injector-annulus. In Figure 4 such a construction is shown in which the conduit 10 together with its special heat insulating layer 16 terminates in an annulus 25 provided with a plurality of injector openings 26.

In the embodiment according to Figure 3 the main feed-pump 2 is at the same time used to produce the circulation of the fuel for the purpose of cooling the latter. The main part of the fuel fed by the pump flows through the conduit 4 to the engine. Part of the fuel is branched off through the branch-pipe 20 and it is supplied to the cooler 9 through the conduit 8. The fuel cooled leaves the cooler through the conduit 10 and is returned to the inlet of the pump at 11. An additional feed pump for the circulation of the power medium is not necessary in this case.

The cooler 9 is shown in the drawings only schematically and a coil cooler or a cooler of any other type may be used for the same purpose.

I claim:

1. A fuel feed device for air craft comprising a fuel tank, a submersible pump unit the pump of which constitutes the motor feed pump, a cooler located outside said fuel tank, a motor feed conduit connected to said pump, a conduit connecting the motor feed conduit to said cooler for feeding to said cooler part of the fuel delivered by the motor feed pump, and a conduit from the cooler to the inlet of the motor feed pump to return the cooled fuel to the feed pump.

2. A fuel feeding device for aircraft comprising a fuel tank, a cooler located outside said tank, an engine feed pump in said tank, means for branching off a portion of the fuel delivered by said pump to said cooler and means for returning the fuel cooled by said cooler to said tank at the vicinity of the inlet of said pump.

3. A fuel feeding device as set forth in claim 2 in which said means for returning the fuel cooled by said cocler cooperates with the pump inlet so as to form a fuel injector.

4. A fuel feeding device as set forth in claim 2 in which said means for returning the fuel cooled by said cooler terminates in annularly arranged injectors at the inlet of said fuel pump.

5. A feed device for readily volatile liquid fuel for aircraft comprising a fuel tank, a motor feed pump for withdrawing fuel from said tank, a cooler having means to facilitate heat exchange to insure maintaining the fuel in liquid form located outside said fuel tank, a motor feed conduit connected to said pump, a conduit connecting said motor feed conduit to said cooler for feeding to said cooler part of the fuel delivered by the motor feed pump and a conduit from said

cooler to a point adjacent the inlet of said pump for returning cooled fuel in liquid form to said feed pump.

6. A feeding device for readily volatile liquid fuel for aircraft comprising a fuel tank, a cooler having means to facilitate heat exchange to insure maintaining the fuel in liquid form located outside said tank, an engine feed pump for withdrawing fuel from said tank, means for branching off a portion of the fuel delivered by said pump to said cooler and means for returning the fuel cooled by said cooler in liquid form to the vicinity of the inlet of said pump.

7. A feed device for readily volatile liquid fuel for aircraft comprising a fuel tank, a motor feed pump for withdrawing fuel from said tank, a cooler having means to facilitate heat exchange to insure maintaining the fuel in liquid form located outside said fuel tank, a motor feed conduit connected to said pump, a conduit connecting said motor feed conduit to said cooler for feeding to said cooler part of the fuel delivered by the motor feed pump and a conduit from said cooler to a point adjacent the inlet of said pump for returning cooled fuel in liquid form to said feed pump and said last named conduit cooperating with said pump inlet so as to form a fuel injector.

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