Nov. 11, 1941. P. L'ORANGE 2,262,617

SYSTEM FOR FEEDING LIQUIDS IN GAS-FREE CONDITION TO DEVICES USING OR DISPOSING OF THE SAME

Filed Aug. 29, 1938

Fig.1.

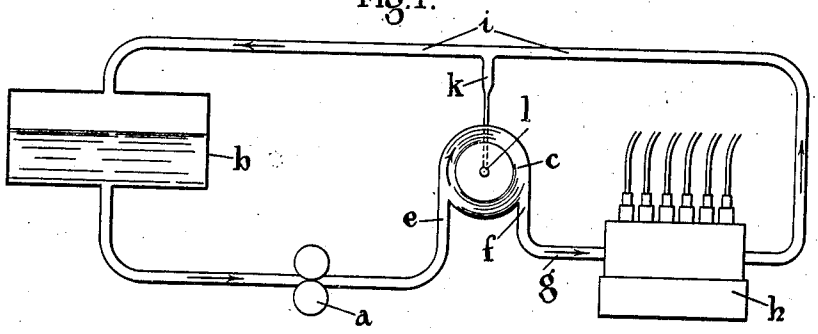


Fig.2.

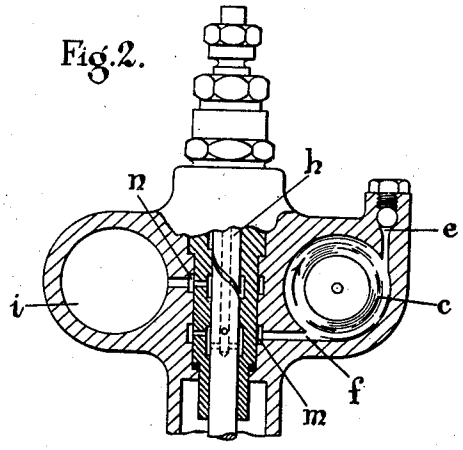
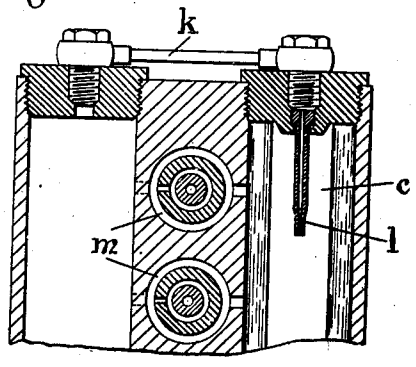


Fig.3.



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SYSTEM FOR FEEDING LIQUIDS IN GAS-FREE CONDITION TO DEVICES USING OR DISPOSING OF THE SAME

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4 Claims. (Cl. 103—203)

This invention relates to liquid fuel injection pumps for internal combustion engines. The invention more especially concerns such pumps for use in connection with multi-cylinder aeroplane engines.

The object of the invention is to provide an improved construction of pump which will in an exceedingly simple and effective manner achieve the freeing of the fuel supplied by the pump of entrained air or gas, it having been found to be highly important for the successful operation of, say, a multi-cylinder aeroplane engine that the fuel that is supplied to the engine shall be as free as possible from disengaged air or other gas carried along in it.

According to the invention, a liquid fuel injection pump for an internal combustion engine, more especially an aeroplane engine, comprises in combination a pump casing; an inlet for fuel therein; an outlet for fuel therein; a pump chamber situated between the inlet and the outlet; an outlet port for fuel leading from the pump chamber to the fuel outlet; a cylindrical chamber interposed in the path of the fuel from the fuel inlet to the pump chamber; an inflow port for the fuel communicating with the fuel inlet and leading tangentially into the cylindrical chamber; an outflow port for the fuel leading tangentially out of the cylindrical chamber and communicating with the pump chamber, the arrangement being such that the cylindrical chamber constitutes a centrifugal separator for separating any entrained air or gas in the fuel as the latter passes forward to the pump chamber; and a connecting pipe leading from the central zone of the cylindrical chamber, which in the operation of the pump is occupied by separated air or gas, to the fuel outlet, which connecting pipe is throttled so as to be capable, under normal working pressure, of passing at most in the event of there being no air or gas in the cylindrical chamber, a small fraction only, of the order of between 10 and 20%, of the fuel that flows into the chamber by way of the fuel inlet.

It is found that such a construction according to the invention as set forth above, both lends itself to great simplicity of design in the design of the pump as a whole and also ensures a highly efficient separation of entrained air or gas in the fuel. This is more especially so in the case of a fuel injection pump for use with a multi-cylinder engine and wherein accordingly there are a number of pump chambers allocated respectively to the several cylinders of the engine, the construction being one in this case according to which the fuel outlet of the pump is in the form of a manifold which is common to all the pump chambers of the pump and similarly the centrifugal separating chamber is also common to the various pump chambers, there being as many outflow ports from the separating chamber as there are pump chambers and the several outflow ports leading respectively to the several pump chambers.

It will be understood that the pump will either incorporate or be combined with a circulating pump for feeding the fuel to the fuel inlet of the pump, the inlet of the circulating pump being in communication with the fuel outlet of the pump by way of the supply tank so that the circulating pump forms with the injection pump a continuous recycling circuit for the fuel.

It will further be understood, with reference to the action of the centrifugal separator which is incorporated in the pump in accordance with the present invention, that the separator operates on the fundamental idea of suitably throttling the separated air outlet in such a manner that at most a negligibly small proportion only of the total quantity of fuel delivered by the pump can be lost in the sense of being by-passed in the circulation of the fuel, past the injection pump, whereas through the same separated air outlet, as much more air can escape as the root of the specific gravity thereof is smaller than that of the specific gravity of the fuel; that is, assuming an excess pressure in the delivery pipe from the circulating pump at 2 atmospheres and atmospheric pressure in the return pipe leading back to the supply tank, about fiftten times as much. This means that an opening in the separated air outlet which at the most can carry away 10% of the fuel to the return pipe leading back to the circulating pump, can carry away more than 100% of the volume pumped, of air and, therefore, all the air that could possibly be delivered by the pump.

The invention will now be further described with reference to the accompanying drawing,

Figure 1 of which illustrates the general principle of the system, purely diagrammatically as will be appreciated, and

Figures 2 and 3 illustrate a constructional embodiment of the invention as applied to the fuel injection system of a multi-cylinder internal combustion engine of an aeroplane.

Referring to Figure 1, the fuel delivered by a circulating pump *a* from a tank *b* is conveyed tangentially into a vessel *c* by way of openings therein *e*.

These openings *e* are of nozzle form, so that a part of the delivery pressure in the fuel is converted into increased velocity thereof.

The fuel leaves the vessel *c* through openings *f* in the wall thereof which are arranged as far as possible from the central point of rotary movement of the fuel and, therefore, on the periphery of the vessel and preferably also tangentially thereof.

The openings *f* lead to a suction pipe *g* of an injection pump *h* from which is branched a return pipe *i* carrying away the excess portion of the fuel and connected to the tank or to the suction pipe of the circulating pump.

From the centre of the vessel *c* there runs to this return pipe *i* a connection *k* having a very narrow inlet opening *l*.

The opening *l* is so calculated and tested, that through it only a small part of the fuel escapes to the return pipe *i*, when the circulating pump *a* only pumps fuel past it, but all air which in the most unfavourable case is also pumped by the circulating pump *a* can escape into the return pipe *i*.

Referring now to Figures 2 and 3, the vessel *c* of the system as illustrated in Figure 1 is here formed by the collecting pipe *c* of the injection pump *h*.

The quantity of fuel delivered passes through suitably throttled openings *e* into this collecting pipe, where it undergoes a rapid rotating movement and from whence it is carried through bores *f* positioned, as in the case of the openings *e* as far as possible from the centre of rotary movement of the fuel and disposed, again as in the case of the openings *e*, tangentially of the collecting pipe, into the suction spaces *m* of the injection pump *h*.

From the return flow spaces *n* of this pump, the excess portion of the fuel passes into the return pipe *i* which by means of a connecting pipe *k* projecting centrally into the collecting pipe *c*, communicates with the gas-occupied portion of the interior thereof. This pipe *k* has one or more small holes *l*, through which all air and gas or at the most (assuming no air or gas is present in the fuel) a small part only of the fuel passes into the return pipe *i*.

From the foregoing, it will be appreciated that the collecting pipe *c* constitutes in effect a centrifugal gas separator the gas outlet of which, namely the small holes *l* in the pipe *k*, by-passes the injection pump of the system so as to divert the separated air or other gas from the fuel past it and back into the return pipe of the system, along which it flows to the supply tank where it finds a vent from the system before, in the circulation of the fuel, the latter becomes recycled back to the circulating pump.

What I claim as my invention and desire to secure by Letters Patent of the United States is:

1. A liquid fuel injection pump for an internal combustion engine, more especially an aeroplane engine, comprising in combination a pump casing; an inlet for fuel therein; an outlet for excess fuel therein; a pump chamber in said casing between said inlet and outlet; an outlet port for fuel leading from the pump chamber to said fuel outlet; a cylindrical chamber in said casing between the fuel inlet and the pump chamber; an inflow port for the fuel communicating with the fuel inlet and leading tangentially into the cylindrical chamber; an outflow port for the fuel leading tangentially out of the cylindrical chamber and communicating with the pump chamber, the arrangement being such that the cylindrical chamber constitutes a centrifugal separator for separating any entrained air or gas in the fuel as the latter passes forward to the pump chamber; and a connecting pipe leading from the central zone of the cylindrical chamber, which in the operation of the pump is occupied by separated air or gas, to said excess fuel outlet, which connecting pipe is throttled as and for the purpose specified herein.

2. A liquid fuel injection pump for a multi-cylinder internal combustion engine, more especially an aeroplane engine, comprising in combination, a pump casing; an inlet for fuel therein; an outlet for excess fuel therein; a plurality of pump chambers respectively allocated to the cylinders of the engine to be supplied by the pump, the pump chambers being situated between the said inlet and outlet and being disposed in a row side by side; a plurality of outlet ports for fuel leading respectively from the several pump chambers to said fuel outlet, which fuel outlet is in the form of a manifold common to all of the pump chambers; a cylindrical chamber disposed abreast of the row of pump chambers and interposed in the path of the fuel from the fuel inlet to the pump chambers; at least one inflow port for the fuel communicating with the fuel inlet and leading tangentially into the cylindrical chamber; a plurality of outflow ports for the fuel leading tangentially out of the cylindrical chamber and communicating respectively with the several pump chambers, the arrangement being such that the cylindrical chamber constitutes a centrifugal separator for separating any entrained air or gas in the fuel as the latter passes forward to the pump chamber; and a connecting pipe leading from the central zone of the cylindrical chamber, which in the operation of the pump is occupied by separated air or gas, to the fuel outlet, which connecting pipe is throttled as and for the purpose specified herein.

3. A liquid fuel injection pump for an internal combustion engine, more especially an aeroplane engine, the pump being arranged to be supplied with fuel under pressure and in excess by a delivery pump drawing from a supply tank for the fuel which in turn is connected to the injection pump for the return therefrom to the tank of the excess quantity of fuel undelivered by the injection pump, by a return pipe for the fuel, which injection pump comprises, incorporated in a unitary structure forming the pump, a pump casing; a fuel inlet therein; a pump chamber in said casing; a cylindrical chamber in said casing between said inlet and said pump chamber; an inflow port for the fuel communicating with the fuel inlet and leading tangentially into the cylindrical chamber; an outflow port for the fuel leading tangentially out of the cylindrical chamber and communicating with the pump chamber, the arrangement being such that the fuel is delivered at high speed into the cylindrical chamber and constrained therein by centrifugal action to form a liquid ring against the wall of the chamber with consequent separation of entrained air or gas in the fuel, which thereby is caused to occupy a central zone of the chamber; and a by-pass for the separated air or gas, leading from said central zone of the cylindrical chamber to a fuel outlet in the pump casing communicating with the return pipe for the fuel, the said by-pass projecting deeply into the cylindrical chamber so as to communicate at its inlet

end with a point in the central zone of the chamber well removed from either end thereof.

4. A liquid fuel injection pump for an internal combustion engine, more especially an aeroplane engine, the pump being arranged to be supplied with fuel under pressure and in excess by a delivery pump drawing from a supply tank for the fuel which in turn is connected to the injection pump for the return therefrom to the tank of the excess quantity of fuel undelivered by the injection pump, by a return pipe for the fuel, which injection pump comprises, incorporated in a unitary structure forming the pump, a pump casing; a fuel inlet therein; a row of pump chambers disposed with their axes parallel to one another; a cylindrical chamber disposed adjacent the row of pump chambers with its axis perpendicular thereto; inflow ports for the fuel communicating with the fuel inlet and leading tangentially into the cylindrical chamber; outflow ports for the fuel leading tangentially out of the cylindrical chamber and communicating respectively with the pump chambers, the arrangement being such that the fuel is delivered at high speed into the cylindrical chamber and constrained therein by centrifugal action to form a liquid ring against the wall of the chamber with consequent separation of entrained air or gas in the fuel, which thereby is caused to occupy a central zone of the chamber; and a by-pass for the separated air or gas, leading from said central zone of the cylindrical chamber to a collecting chamber incorporated also in the pump casing and interposed in the path of the fuel between the pump chambers and the return pipe, the said by-pass projecting deeply into the cylindrical chamber so as to communicate at its inlet end with a point in the central zone of the chamber well removed from either end thereof.

PROSPER L'ORANGE.