June 5, 1962 Y. FOULON 3,037,552

PREFILLING SYSTEM FOR THE FUEL-FEED CIRCUIT OF A RAM-JET UNIT

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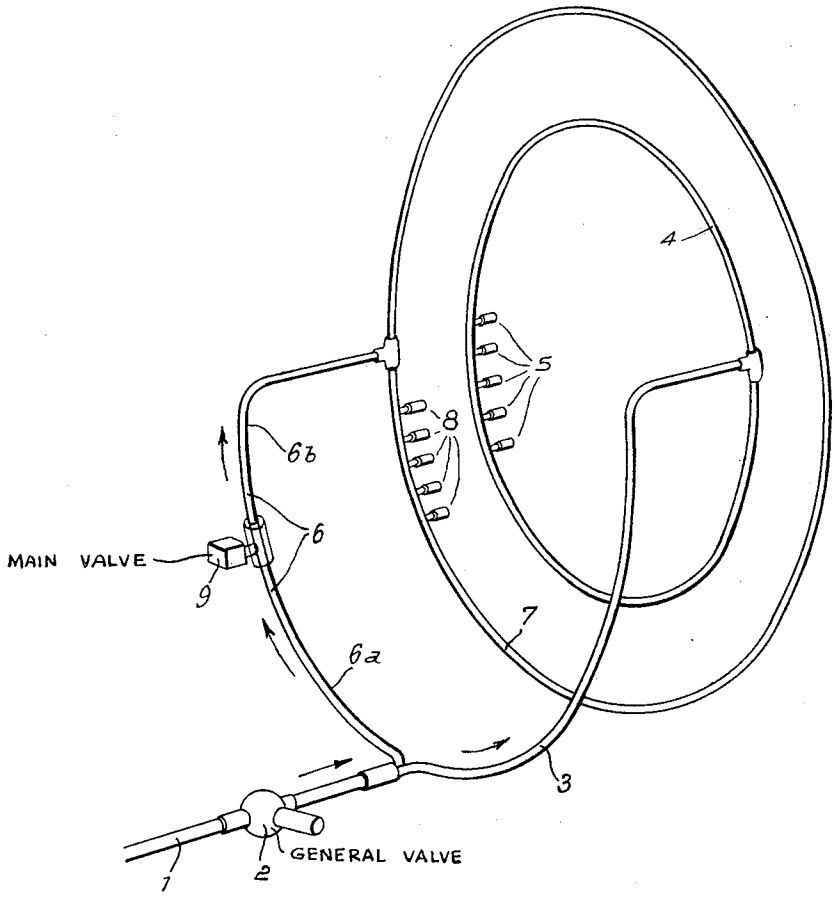


Fig. 1.

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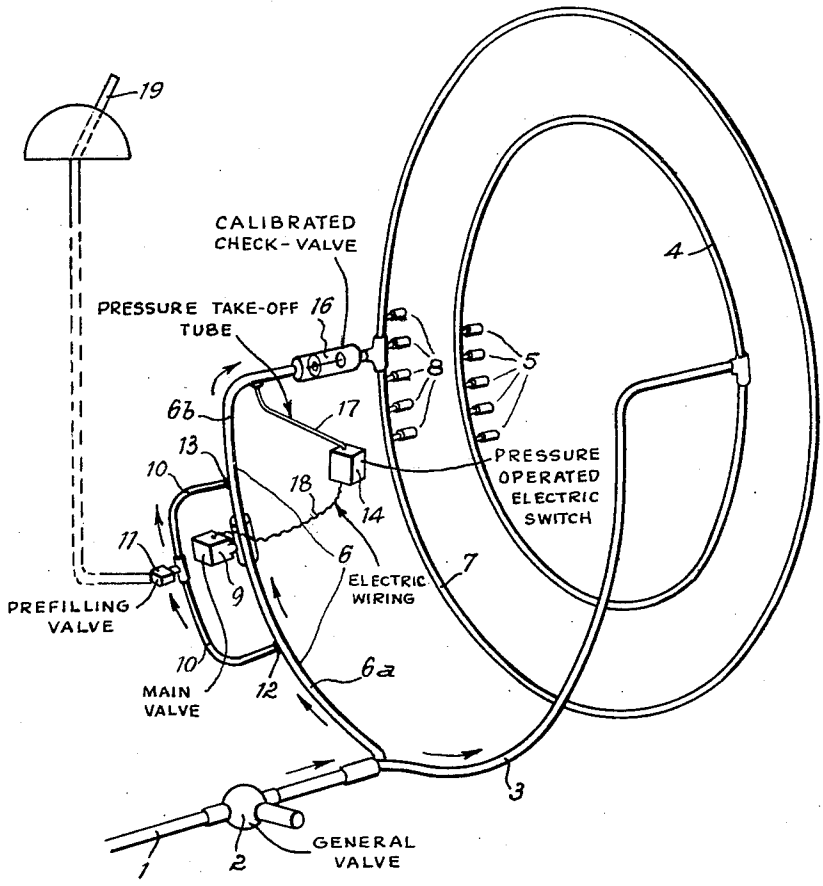


FIG. 2.

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3,037,552

Patented June 5, 1962

3,037,552

PREFILLING SYSTEM FOR THE FUEL-FEED CIRCUIT OF A RAM-JET UNIT

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Filed May 4, 1959, Ser. No. 810,938
Claims priority, application France Feb. 27, 1959
3 Claims. (Cl. 158—36)

The present invention relates to a prefilling system adapted to start up an injection-manifold of a multi-manifold fuel feed system, without any risk of extinguishing the manifolds already functioning.

It can be as effectively applied to ram-jet units as to combined turbo-jet-ram-jet propulsive units having two or more injection manifolds.

Without thereby limiting the scope of the invention, the following description will be applied solely to the case of a ram-jet provided with only two concentrically mounted injection manifolds which will be referred to hereafter as the inner and outer manifold respectively, these manifolds each being fed through a supply line, and these two supply lines being themselves fed from a general line having its output controlled by a general valve. Moreover, the outer-manifold feed line includes a conventional so called main valve enabling extinguishing or starting at will.

Such an arrangement enables the ram-jet to be operated either by means of one injection manifold (in this case the inner manifold, or by means of both manifolds whereby a great operating flexibility is ensured by avoiding too sudden accelerations when the ram-jet is started, and also too sudden decelerations when the ram-jet is stopped; besides, in the case of single-manifold operation, relatively low thrust values can be attained which are suitable for flight at cruising speed.

Known systems having the aforesaid characteristics are fully satisfactory in operation in the case when, both manifolds being operated, one of them is extinguished (the outer manfold in the considered instance) in order to slow down the ram-jet; in fact, in this case, the closing of the valve controlling the supply line of the manifold to be extinguished leads to practically no disturbance dangerous to the operation of the other manifold, which is required to be kept functioning.

By contrast, if it is desired to carry out the opposite manoeuvre, i.e. if when one manifold only is operating the other has to be started, the control valve of the latter must be opened, and this leads to a rapid and substantial pressure-drop in the supply line of the manifold operating, such that the latter will almost certainly be extinguished and hence the ram-jet will be completely and suddenly stopped.

It is therefore absolutely necessary to suppress this danger, and such is the object of the present invention.

More specifically, this invention which relates, in a general manner, to ram-jet units and combined turbo-jet-ram-jet propulsive units having at least two injection manifolds, consists in a prefilling device adapted to start up one injection manifold of a fuel supply system having at least two manifolds, one or more of the remaining manifolds being in operation, without the risk of extinguishing the latter, said prefilling device being essentially characterised in that on the one hand, it includes a small cross-section secondary line provided with a so-called prefilling valve, and being branched to form a loop with the main fuel supply-line of the manifold under consideration, its two junction points with said main supply line being located one upstream and the other downstream of the latter relative to the control valve

of said manifold, and on the other hand, it includes means including a pressure operated electric switch to open the valve of said manifold as soon as, owing to fuel supply from said secondary line, the fuel pressure in the downstream portion of said main line reaches the value required to operate the manifold, and to close said prefilling valve.

In addition, one or more check valves maintain the fuel in the downstream portion at a minimum pressure, and when the manifold is re-started, the purpose of the secondary line is to increase the fuel pressure in the downstream portion until the manifold operating value is reached.

Other features and advantages of the present invention will become clear on reading the following description, with reference to the accompanying drawings, giving merely by way of explanatory example without limiting the scope of the invention one embodiment according to the invention. In these drawings:

FIGURE 1 is a diagrammatic view of a fuel supply system for two manifolds not comprising the device according to the invention; and

FIGURE 2 is a diagrammatic view identical with that of FIGURE 1 but including the prefilling device and a check-valve in accordance with the invention.

Referring to FIGURE 1, a general fuel supply line **1** provided with a general valve **2** is subdivided into two lines, viz. a main line **3** supplying an inner manifold **4** having injectors **5**, and a main line **6** supplying an outer manifold **7** provided with injectors **8**.

A so called main valve **9** which for example, may be of the conventional solenoid type connected into the line **6** divides said line into two sections: an upstream section *6a* and a downstream section *6b*.

For previously-stated reasons, when manifold **4** only is functioning and it is desired to start manifold **7** as well, the opening of main valve **9** causes the fuel pressure in line **3** to drop rapidly and the ram-jet's combustion is extinguished.

The prefilling device according to the invention which suppresses this danger of extinguishing is shown in FIGURE 2.

In FIGURE 2, where like elements to that in FIGURE 1 bear like reference numerals, a secondary line **10** of small cross-section provided with a prefilling valve **11** is branched off from line **6**, having two junction points **12** and **13** therewith, arranged on the upstream portion *6a* of line **6** and on the downstream portion *6b* respectively; numeral **14** stands for a pressure-operated electric switch connected to the downstream portion *6b* by a pressure-take-off-tube **17** and to valve **9** by an electric wiring **18**, and numeral **16** stands for a single check valve arranged at the inlet of manifold **7**.

Check-valve **16** suitably calibrated is closed as soon as the fuel pressure in portion *6b* drops to its calibration value and it is reopened when the secondary line **10** causes the fuel pressure to be raised to the pressure value required for operating manifold **7**.

The operation of the filling device shown in FIGURE 2, is as follows:

With the ram-jet operating only on the inner manifold **4**, when the pilot wishes to have both manifolds operating he controls the opening of the prefilling valve **11** by means of the ram-jet throttle lever **19**.

The downstream portion *6b* of the main line **6** comprised between the main valve **9** and the injectors **8** of the outer manifold, is filled through the secondary line **10**, the output of which has been carefully calculated, taking into account the fuel pressure value to be attained in *6b* for the manifold **7** to become operative. However, when opening the prefilling valve **11** care

must be taken to avoid causing a sizable pressure drop in the line 3, since this would reintroduce the disadvantages inherent to known systems and the inner manifold 4 would become extinguished.

A pressure operated electric switch 14 is connected to the downstream circuit 6*b* by a pressure-take-off-tube 17, and as soon as the pressure required for operating the manifold 7 is achieved in 6*b*, it controls the opening of valve 9 electrically, by means of an electric wiring 18.

The normal feed to manifold 7 is then established, and the ram-jet can function with both manifolds.

A certain-pressure is maintained in downstream portion 6*b* (lower than the operating pressure of manifold 7) in order to avoid having to pressurise from zero.

In this respect a carefully calibrated check valve 16 is mounted downstream of main valve 9 at the inlet of manifold 7; it is closed as soon as the pressure in 6*b* drops to its calibration value.

This check-valve is used for maintaining the downstream portion 6*b* completely filled, and under low pressure, when manifold 7 is not operating.

When the manifold 7 is to become operative, the purpose of the secondary line 10 and of the prefilling valve 11 is shown in FIG. 2, but merely to provide additional pressure to portion 6*b*, so as to exceed the calibration pressure of the check-valve and to reach the pressure required for operating manifold 7.

According to another form of embodiment (not shown), a carefully calibrated check-valve is located within each injector 8 of manifold 7; these check-valves act in the same manner as single check-valve 16. It is to be noted that, with the embodiment using a check-valve within each injector, the starting phase is slightly longer than with the single check-valve 16, since the time for filling manifold 7 has to be added to the time necessary for the pressurising of the downstream portion 6*b*.

It is to be understood that the invention has been described merely by way of explanation without any intent of limiting its scope, and that numerous alterations of detail can be made therein without falling outside its scope.

It can be applied to any fuel feed assemblies for combined turbo-jet-ram-jet units, whether of the multi-grid or single-manifold type.

More generally, in the case of a unit with more than two manifolds, all manifolds but one are each provided with a device according to the invention (viz, a main line 6, a valve 9, a secondary line 10, a prefilling valve 11, an automatic system for the opening of valve 9 and, if desired, check-valves). In the case of a single manifold, this is divided into two or more separately fed sectors.

What I claim is:

1. A pressurised fuel feed system comprising a general fuel supply line provided wtih a general valve; at least two manifolds; a plurality of injectors on each of said manifolds; main lines branching from said general line, each of them being adapted to supply with fuel one of said manifolds; a main valve mounted on each of all but one of said main lines, each main valve defining in the main line in which it is mounted an ipstream portion adapted to receive fuel directly from said general supply line, and a downstream portion connected to the manifold supplied with fuel by said main line; at least one pressure sensitive check valve located downstream of each of said main valve and adapted to close when the fuel pressure in said downstream portion is lower than a predetermined value; a secondary line mounted on each of said all but one main lines, and connected to the upstream portion on the one hand, and to the downstream portion of the main line on which it is mounted, on the other hand, each secondary line being of a substantially smaller cross-section than the main line on which it is mounted; a so-called prefilling valve mounted on each of said secondary lines; for each of said all but one main lines, on the one hand a pressure operated electric switch, in communication with the downstream portion of said main line by means of a pressure-take-off-tube, and an electric wiring between said switch and said main valve, whereby said main valve is caused to be opened as soon as the fuel pressure in said downstream portion has reached the value for the operation of the manifold which is supplied with fuel thereby.

2. A fuel feed system according to claim 1, wherein a single check valve is mounted on the downstream portion of each of said all but one main lines, at the junction of said downstream portion with the manifold supplied with fuel thereby.

3. A fuel feed system according to claim 1, wherein the injectors of the manifolds fed by said all but one main lines, are each provided with a calibrated check-valve, the check-valves of the injectors of each individual manifold being adapted to close when the fuel pressure in the downstream portion of the main line feeding said individual manifold drops to the calibration pressure thereof.

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