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JET PUMP FLUID FLOW SYSTEM

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The present invention relates to improvements in fuel systems particularly adapted to supply fuel under pressure to aircraft engines and more particularly relates to such systems having a jet booster pump therein to boost the pressure at the intake side of the engine fuel pump.

A principal object of the invention is to provide a new and improved booster pump fuel system particularly adapted to supply fuel under pressure to aircraft engines and having a jet booster pump arranged to take fuel from the fuel tank until substantially dry, and having a positive pressure means by-passing fuel from the engine fuel pump and supplying fuel at a high pressure and velocity to said jet booster pump.

Another object of our invention is to provide means of a simplified form and arrangement adapted to completely scavenge material from a tank or casing.

A further object of our invention is to provide a fuel system particularly adapted to supply fuel under pressure to aircraft engines wherein all of the high pressure lines of the system are protected to prevent loss of fuel therefrom in case of rupture of any of said lines.

A still further and more specific object of our invention is to provide a fuel system for aircraft engines having a high pressure line adapted to supply fluid under pressure to the engine and a self-sealing low pressure line connected to return fuel which may leak from said high pressure line, for use by the engine.

A further and more specific object of this invention is to provide a fuel system for aircraft engines wherein a power-driven fuel pump is used to supply fluid under pressure to the engine, a jet pump is provided in the fuel tank for the engine to boost the intake pressure to said fuel pump, and an independent pump is utilized to by-pass fuel from the intake side of said fuel pump and supply fluid under a high pressure and velocity to the jet pump to assure a constant supply of fuel to the engine under various atmospheric conditions and until the fuel tank of the engine is substantially dry.

These and other objects of our invention will appear from time to time as the following specification proceeds and with reference to the accompanying drawings wherein:

Figure 1 is a diagrammatic view of a fuel system constructed in accordance with our invention;

Figure 2 is a cross-sectional view taken through a coaxial high pressure and low pressure fuel line constructed in accordance with our invention; and

Figure 3 is a diagrammatic view illustrating a modified form in which our invention may be utilized.

As shown on the drawings:

In Figure 1 of the drawing, the reference character 10 designates generally a tank for fuel with a top wall 11 having a vent therein. The tank 10 is also shown as having a bottom wall 12 having a sump 13 therein, with a high pressure line 14 for a high pressure jet 15 of a jet pump 16 leading through an opening 17 in said tank.

The high pressure jet 15 is shown as extending within the mouth of a venturi 18 of the jet booster pump 16 for boosting the pressure in an intake fuel line 20 leading from the bottom of said tank to a main engine fuel supply pump 21.

A high pressure fuel supply line 22 leads from the discharge side of said pump 21 to an aircraft engine 23 for supplying fuel under pressure thereto.

The aircraft engine 23 may be of any well known form commonly used to propel aircraft and is herein shown as being an in-line engine having a crank shaft 24. A suitable drive means 25 is shown as connecting said crank shaft to said main engine fuel pump 21 to drive said pump therefrom. Said drive means may be of any well known form commonly used to drive pumps from internal combustion engines such as a chain and sprocket drive or a well known form of V-belt drive.

A by-pass line 26 is connected from the fuel intake line 20 for the pump 21 to the intake side of a high pressure pump 27 adapted to supply fuel at a high pressure and velocity to the jet booster pump 16. A valve 29 is connected in the by-pass line 26 and controls the passage of fuel to said high pressure pump 27. The high pressure line 14 connects the discharge side of said high pressure pump 27 to the high pressure jet 15 for supplying fuel thereto at a high pressure and velocity to serve as the motivating force for the jet pump 16. A by-pass line 31 is connected from the fuel supply line 22 to the high pressure line 14 to by-pass fuel from the discharge side of the main engine fuel pump 21 to be used as a source of supply for fluid at a high pressure and velocity to the jet 15. A control valve 33 is provided in the by-pass line 31 to control the passage of fuel under pressure through said by-pass line.

The high pressure pump 27 may be a well known form of gear pump and may be driven from the crank shaft 24 of the engine 23 by a drive means indicated generally by reference character 34. Said drive means, like the drive means 25, may

be of any well known form such as a V-belt or a chain and sprocket drive.

The high pressure supply line 22, the by-pass line 31, and the high pressure line 14 are all diagrammatically shown as being encircled by and spaced inwardly from a coaxial casing 35, the space between the outside of said high pressure line and the inside of said casing forming a low pressure line or passageway 36. Said low pressure passageway is herein shown as being closed at its ends adjacent the pump 21 and engine 23 and as leading through the opening 17 in the sump 13 in the bottom of the tank 10 to permit or conduct any fuel leaking from a ruptured high pressure line to be returned to the tank 10.

As shown in Figure 2, the casing 35 for the low pressure line 36 is self-sealing, so as to seal itself in the event of damage thereto, as by gun fire, so that a bullet passing through said casing may rupture the casing of the low pressure line but the rupture in the casing of the low pressure line will seal itself and thus prevent the loss of fuel, which may be returned to the tank 10 to prevent the building up of pressure in said low pressure line to an undesirable extent.

From the foregoing description it is obvious that fuel at a low pressure is drawn into the throat of the venturi 18 by the motivating force or aspirating effect of the fuel discharged from the jet 15 at a high velocity into the throat 18 of the venturi to boost the fuel pressure at the intake of the main engine pump 21 and thus to assure that the fuel be delivered to the engine under various atmospheric conditions and assuring a constant supply of fuel from the tank 10 until it has been scavenged substantially dry by said jet booster pump. It will also be seen that a separate pump driven from the aircraft engine is provided to by-pass fuel from the intake side of the main engine fuel pump 21 under a high pressure and velocity to jet 15; that fuel may also be by-passed to the high pressure line 14 through the by-pass line 31 controlled by the valve 33; and that either or both the high pressure pump 27 or the by-pass line 31 may be used to supply fuel to the jet 15. It may further be seen that all high pressure lines in this system are enclosed and encircled by a self-sealing low pressure line connected to prevent the loss of fuel from the high pressure line upon rupture thereof.

In Figure 3 we show the application of our invention to scavenging lubricating oil from a casing for the lubricated parts of an aircraft engine or transmission. In this form of our invention a casing 40 for transmission gearing, indicated generally by reference character 41, is shown as having a venturi 42 of a jet pump 43 leading from the bottom thereof and as being connected to a return line 44 leading to an oil storage reservoir 45. An intake line 46 for an oil pump 47 leads from the bottom of said reservoir 45 to the intake side of said pump. A high pressure line 48 leads from the pressure or discharge side of said pump to jets 49—49, shown as extending through the top of the casing 40 and directed to supply lubricant under pressure to the gearing 41. A by-pass line 50 is connected from the high pressure line 48 to a high pressure jet 51 arranged to discharge oil at a high pressure and velocity into the mouth of the venturi 43.

Lubricant at high pressure thus enters the casing 40 through the jets 49—49, and after it has been used, drops to the bottom of said casing where the high pressure jet 51 of the jet pump 43 pumps it back to the tank 45 through the return line 44. This arrangement assures com-

plete scavenging of the oil from said casing, returning it for re-use in the lubricating system, and also makes it possible to scavenge oil which may contain large quantities of contaminants, since the oil entering the throat of the venturi 42 under a high pressure and velocity continually passes into said throat and forces the oil thereinto at such a high pressure and velocity that said throat must be completely plugged before the pumping operation will cease.

It will be understood that various modifications and variations may be effected without departing from the spirit and scope of the novel concepts of the present invention.

We claim as our invention:

1. A fuel system for aircraft engines including a source of fuel supply, a pump connected thereto, a high pressure line from said pump adapted to be connected to the engine, and a self-sealing low pressure line encircling said high pressure line and closed at one end and communicating with said source of fuel supply at its opposite end to return fuel leaking from said high pressure line for use by the engine.

2. In a fuel system for aircraft engines, a tank, a pump, an intake from said tank to said pump, and a coaxial line from the pump to the engine including a high pressure line connected to supply fuel to the engine, a self-sealing low pressure line encircling said high pressure line, and a return connection from said low pressure line to the tank to return fuel leaking from said high pressure line thereto.

3. In a fuel system for aircraft engines, a tank, a pump, a jet booster pump within said tank boosting the pressure of fluid supplied to said pump, a high pressure line connected to supply fuel under high pressure and velocity to said booster pump, and a coaxial self-sealing low pressure line connected to said tank and encircling said high pressure line to return fuel leaking from said high pressure line to said tank.

4. In a fuel system for aircraft engines including a tank, a pump, an intake line from said tank to said pump and a high pressure supply line from said pump to the engine, the improvement comprising a self-sealing low pressure line encircling said high pressure line and connected to said tank to return fuel to said tank leaking from said high pressure line.

5. In a fuel system for aircraft engines including a tank, a pump, an intake line from said tank to said pump, a high pressure supply line from said pump to the engine, a jet booster pump within said tank connected to boost the intake pressure to said pump and having an intake adjacent and opening to the bottom of said tank and a by-pass line from said high pressure line to said jet booster pump to supply fuel thereto under a high pressure and velocity, the improvement comprising a coaxial low pressure line encircling said high pressure and by-pass lines and opening into said tank in communication with said intake of said jet booster pump, said low pressure line being self-sealing and being spaced from said high pressure line to collect fuel leaking therefrom and prevent the leakage of fuel from the system upon rupture of said high pressure line.

6. In a fuel system for aircraft engines including a tank, a pump, an intake line from said tank to said pump, a high pressure supply line from said pump to the engine, a jet booster pump within said tank connected to boost the intake pressure to said pump and a by-pass line from said high pressure line to said jet booster to supply fuel thereto under a high pressure and ve-

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locity, the improvement comprising a coaxial self-sealing low pressure line encircling said high pressure and by-pass lines and connected to communicate with said tank and return fuel leaking from said high pressure line to said tank.

7. In a fuel system for aircraft engines including a tank, a pump, an intake from said tank to said pump, a high pressure supply line from said pump to the engine, a jet booster pump within said tank connected to boost the intake pressure to said pump having an intake adjacent and opening to the bottom of said tank, a second pump, a fluid connection from the intake to said first pump to the intake side of said second pump, a high pressure line from said second pump to said jet booster, to supply fuel thereto under a high pressure and velocity, the improvement comprising a coaxial self-sealing low pressure line encircling said high pressure lines to said engine and said jet booster communicating with the bottom of said tank in alignment with said intake of said jet booster pump and being spaced from said high pressure lines and connected to collect and prevent the leakage of fuel from the system upon rupture of said high pressure lines.

8. In a fuel system for aircraft engines including a tank, a pump, an intake from said tank to said pump, a high pressure supply line from said pump to the engine, a jet booster pump within said tank connected to boost the intake pressure to said pump having an intake adjacent and opening to the bottom of said tank, a second pump, a fluid connection from the intake to said first pump to the intake side of said second pump, a high pressure line from said second pump to said jet booster pump to supply fuel thereto under a high pressure and velocity, a by-pass from said high pressure line to said engine to said high pressure line to said jet booster pump the improvement comprising coaxial self-sealing low pressure means encircling said high pressure lines to said engine and said jet booster pump to collect and prevent the leakage of fuel from the system upon rupture of said high pressure lines,

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said coaxial self-sealing low pressure means opening to the bottom of said tank in alignment with said intake of said jet booster pump.

9. In a fuel system for aircraft engines including a tank, a pump, an intake from said tank to said pump, a high pressure supply line from said pump to the engine, a jet booster pump within said tank connected to boost the intake pressure to said pump, a second pump, a fluid connection from the intake to said first pump to the intake side of said second pump, a high pressure line from said second pump to said booster pump to supply fuel thereto under a high pressure and velocity, a by-pass from said high pressure line to said engine to said high pressure line to said jet booster pump, and coaxial self-sealing low pressure lines encircling said high pressure lines to said engine and said jet booster pump, said self-sealing coaxial low pressure lines being connected to communicate with said tank and return fuel thereto leaking from said high pressure lines.

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