

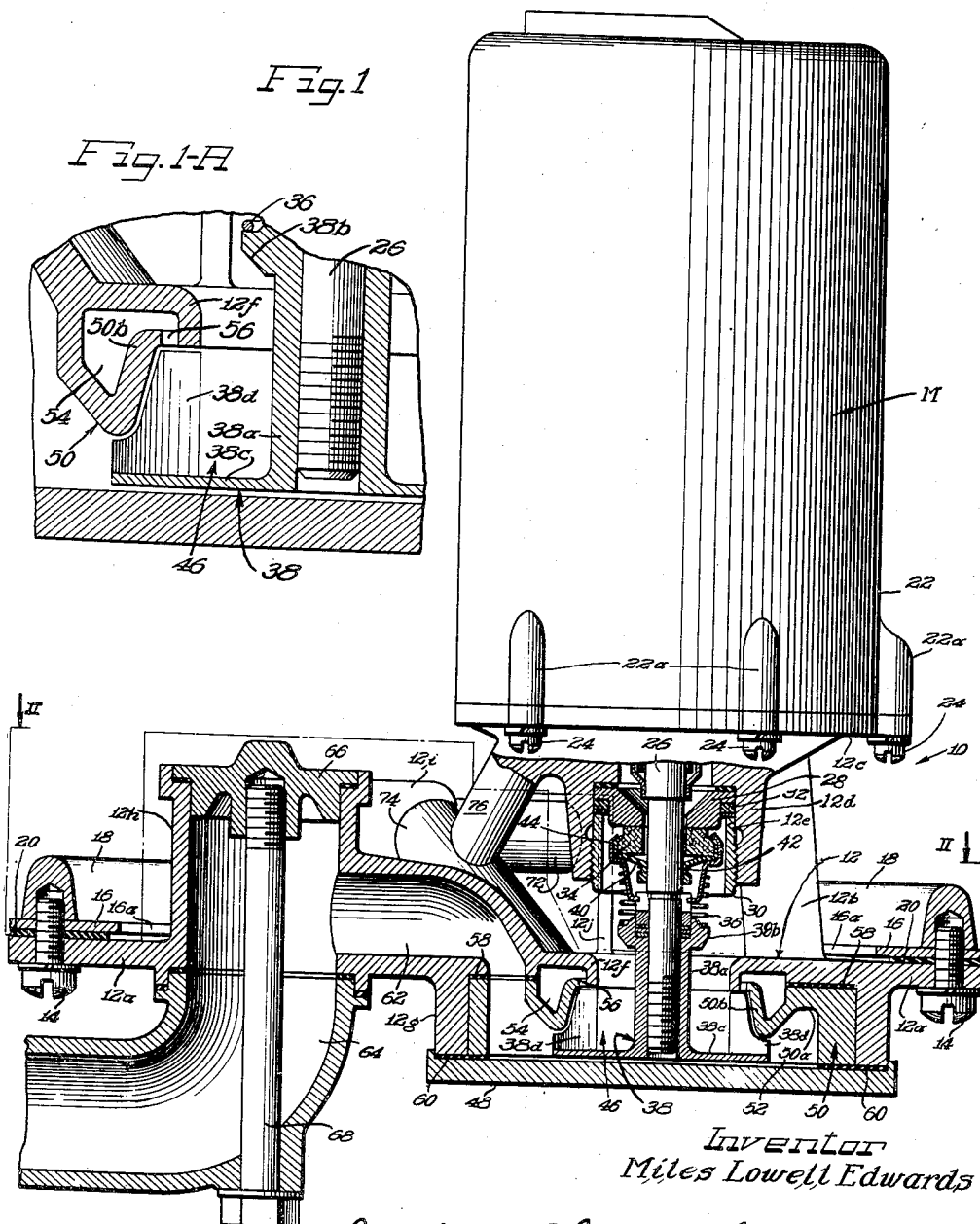
May 8, 1951

M. L. EDWARDS
VAPOR SEPARATING PUMP

2,552,264

Filed Feb. 25, 1949

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

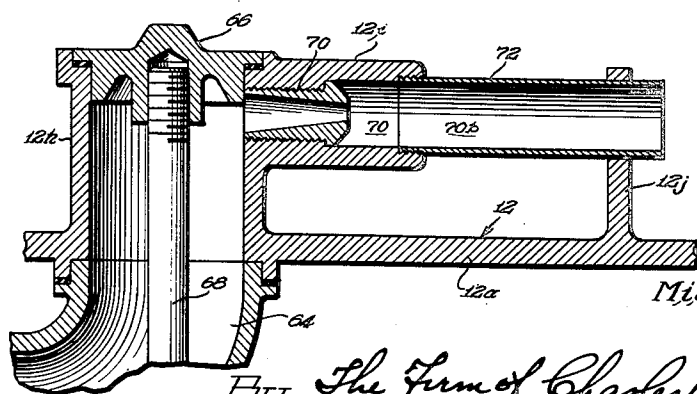
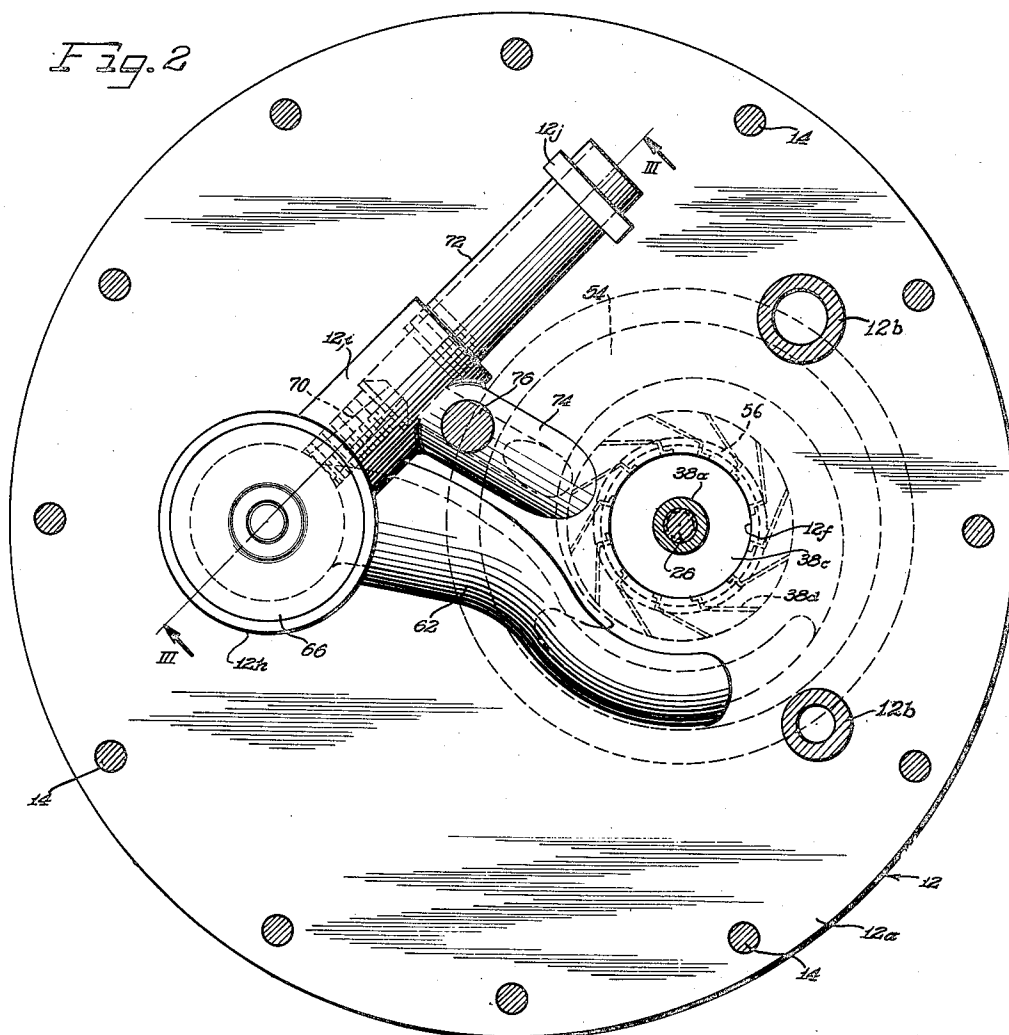


Fig. 3

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UNITED STATES PATENT OFFICE

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VAPOR SEPARATING PUMP

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3 Claims. (Cl. 222—385)

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This invention relates to a pump and motor assembly, particularly to a unitary booster pump and motor assembly for mounting within tanks as, for example, the fuel cell of an airplane.

The invention will hereinafter be specifically described as embodied in an electric motor driven booster pump submerged within an aircraft fuel cell.

With the advent of high altitude performing aircraft, difficulties have arisen in supplying an ample feed of fuel from the fuel cell or tank to the engine driven pump during periods of high altitude flight. Many of the difficulties arise due to the volatile nature of the aircraft fuel. At high altitudes the fuel becomes more gaseous and the formation of gas or vapor bubbles is encountered. Under such conditions, a normal feeding of fuel is not satisfactory because vapor locks or "air locks" form in the fuel line to cause a "rough running" engine. Centrifugal type booster pumps have been successfully employed to "beat out" these vapor bubbles at high altitudes and to pressure a constant supply of liquid fuel to the engine driven fuel pump.

However, since the beaten-out bubbles tend to gather about the axial portion of the centrifugal pump in increasing volume during continued operation of the booster pump, it is desirable to dissipate the bubbles within the fuel cell away from the pump to increase the pump efficiency.

Therefore, according to this invention, a centrifugal vapor separating pump assembly is equipped with a jet type pump or aspirator for removing the separated vapor bubbles from an annular vapor extraction chamber located above the pumping chamber. The jet pump receives a pressured stream of liquid from the discharge side of the vapor separating pump and produces an aspirator effect to draw the vapor from the extraction chamber and to discharge the vapor bubbles into the body of the fuel cell at a point spaced from the pump inlet and fuel pumping chamber.

It is, then, an object of this invention to provide a bubble dissipator for vapor separating pumps.

Another object of this invention is to provide an aircraft booster pump unit which effectively separates liquid and vapors and then propels the vapors away from the pump.

Another object of this invention is to provide a vapor separating and bubble dissipating pump which does not require more than one prime mover.

A specific object of this invention is to provide

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a unitary motor, vapor separating pump and bubble ejecting jet pump assembly of simplified construction.

Other and further objects of the invention will be apparent to those skilled in the art from the following detailed description of the annexed sheets of drawings which, by way of preferred example only, illustrate one specific embodiment of the invention.

On the drawings:

Figure 1 is an elevational view of the pump assembly showing the booster pump in vertical cross section and showing the location of the jet pump with respect to the motor and booster pump;

Figure 1A is an enlarged fragmentary cross-sectional view showing how vapor is taken off of the impeller;

Figure 2 is a top plan view along the line II—II of Figure 1 and showing parts in horizontal cross section;

Figure 3 is a vertical cross-sectional view of the jet or vapor extracting pump taken along the line III—III of Figure 2.

As shown on the drawings:

In Figure 1, the reference numeral 10 designates generally an electric motor pump unit according to this invention. A base casting 12 provides much of the casing for the unit and also serves as a support for the unit 10, its lower portion 12a being of disk-like configuration for securing as by bolts 14 to the bottom wall 16 of a fuel cell. The bolts 14 are threaded into a mounting ring 18 placed on the inner side of the bottom wall 16 of the fuel cell and a circular gasket 20 is provided to prevent leakage of fuel from the cell through the bottom wall aperture 16a which is provided for insertion of the unit 10 within the cell.

The casting 12 supports an electric motor assembly by a plurality of circumferentially spaced leg portions 12b. An upper portion 12c of casting 12 is the bottom wall of the motor casing 22 and is secured to casing 22 by a plurality of bolts 24 threaded into the circumferentially spaced lobes 22a on casing 22. The rotor of the motor M carries a downwardly depending shaft 26 which projects through a central aperture in a shaft hub portion 12d of casting 12. An open bottom well 12e in the hub portion 12d receives a seal ring 28 loosely embracing the shaft 26 and is fixedly held in the bottom of the well by a threaded sleeve 30 which is threaded into the hub 12d and presses against a washer 32 acting on the seal ring 28. A rotating seal ring 34 rides on

the stationary ring 28 and is spring urged against the ring 28 by means of a coil spring 36 surrounding the shaft 26 and bottomed on a boss portion 38b of an impeller hub 38a threaded onto the lower extremity of the shaft 26. A rubber sleeve 40 is sealingly engaged on the shaft 26 by means of a locking wire 42 and has a diaphragm portion extending over the seal ring 34 and clamped around the periphery of the ring 34 by the cap 44. Leakage along the shaft 26 is thereby effectively stopped by the diaphragm member 40 and by the riding contact of the seal ring 28 and 34.

As previously mentioned, the motor shaft 26 depends downwardly through the sealing assembly and the hub portion 12d to receive an impeller hub 38a in threaded relation. Impeller 38 has a flat disk portion 38c radiating from hub 38a thereof, and a ring of pumping vanes 38d are provided on top of the disk portion 38c in spaced relation from the hub 38a. Fuel from within the fuel cell enters this chamber 46 through a throat ring portion 12f of the casting 12, the throat portion 12f being centrally located about the shaft 26 in the same plane as the disk portion 12a of the casting 12. Thus it is obvious that the chamber 46 is located below the bottom wall 16 of the fuel cell. A downwardly extending cylindrical portion 12g of the casting 12 provides a pump casing for that part of the assembly below the bottom wall 16. The bottom wall 16 is closed by a cap 48. The cap 48, when removed, will permit a complete draining of the pump assembly and fuel cell.

A generally annular insert ring 50 is disposed within the cylindrical portion 12g of the casting 12 and has a groove 50a which defines a volute chamber 52 with the inner surface of the cap 48. The insert ring 50 also has a radially inwardly directed portion 50b which cooperates with the throat ring portion 12f of casting 12 to form the annular vapor extraction chamber 54. A narrow gap circular opening 56 between the throat ring 12f and the radial portion 50b opens to the impeller chamber 46. As best shown in Figure 1A, this gap 56 is radially outward from the inner edge of the impeller blade 38d. Since forced rotation of fluid in the chamber 46 begins at the inner leading edges of the ring of blades 38d, pressure of the fluid increases as the fluid passes outwardly. This fluid pressure increases due to centrifugal force as the diameter of the fluid chamber increases. Therefore, vapor will be under positive pressure at any annular area outwardly from the inner edges of the blades, and, since the annular gap 56 is appreciably outward from these inner edges, the vapor will be most effectively ejected. The insert ring 50 is closed at its top by a sealing gasket 53 and at its bottom by a sealing gasket 60. The sealing gasket 53 prevents the flow of fuel from about the insert ring 50 into the vapor extraction chamber 54, and the sealing gasket 60 prevents the loss of fuel from the cell by escape from the volute chamber 52 about the cap 48.

It should be noted that the inner edges of the ring of vanes or blades 38d lie on a circle having the same diameter as the circular inlet provided by the throat ring 12f while the annular gap 56 includes a diameter which is substantially greater. The inner ends of the blades 38d also terminate immediately adjacent the inlet.

In view of the foregoing description, it is apparent that fuel within the cell enters the separating chamber 46 by way of the throat ring 12f from whence it is pumped by the ring of rotated

vanes 38d into the volute 52 and into a generally tangential outlet passage 62 defined by the casting 12. The vapors and gases in the fuel, being lighter than the liquid, will not be centrifugally discharged into the volute with liquid, since the vanes are effective to release these lighter materials from the liquid to rise into the collecting chamber 54. The fuel freed from vapors and under booster pump pressure leaves the assembly outlet passage 62 and enters the fuel discharge line 64.

The casting 12 has a generally cylindrical upright portion 12h which cooperates with the fuel line 64 in providing an outlet passage and is capped by the member 66 which is secured in place by the bolt 68 which also serves to secure the fuel line 64 to the casting 12. The fuel within the fuel line 64 is under booster pump pressure which is of course greater than the pressure of the fuel within the fuel cell.

The cylindrical portion 12h of the casting 12 communicates with a horizontal cylindrical portion 12i, the portion 12i forming the barrel section of the jet pump. A nozzle 70 is threaded within the jet barrel 12i with its widest diameter opening communicating directly with the interior of the upright portion 12h of the casting 12. The lesser diameter end opening of the nozzle 70 communicates with the interior of the barrel 12i. Fuel under booster pressure within the fuel line will enter the nozzle 70 through the larger diameter opening 70a and pass through the nozzle 70 through the smaller diameter opening 70c. A pipe 72 is threaded into the barrel 12i with its open end communicating with the interior of the fuel cell. The bracket 12j on the casting 12 supports the pipe 72. The fuel under booster pressure passing from the larger to the smaller diameter portion in the nozzle 70 increases the velocity upon leaving the nozzle, creating aspirator pressure within the barrel 12i of the jet pump.

A vapor inlet pipe 74 is integral to and communicates with the jet pump barrel 12i to passage vapor from the vapor retraction chamber 54 into the cavity within the barrel 12i. The aspirator effect is well known in the art of jet pumping, and in this instance the low pressure area within the barrel 12i formed by the flow of fuel through the nozzle causes a vacuum to be created within the vapor extraction chamber 54. Vapor bubbles are withdrawn from the pumping chamber 46 through the annular narrow gap opening 56 into the extraction chamber 54. The bubbles are then drawn into the pump barrel 12i through the vapor inlet pipe 74. The pipe 74 additionally serves as a base for an additional motor support leg 76. The vapor bubbles are passed through the pipe 72 and escape into the fuel cell at a point well above the pumping chamber and directed generally away from the motor-pump unit 10.

From the above descriptions, it will be understood that the invention provides an improved airplane fuel system comprising a motor-pump unit with a jet vapor separating pump adapted to be submerged in airplane fuel cells wherein the motor driven booster pump will operate to pressure fuel to the engine driven pump, and the fuel pressure actuated jet pump operates to withdraw the vapor bubbles from the fuel in the motor-pump unit. The jet pump in withdrawing the vapor bubbles from the fuel within the motor-pump unit will also withdraw a certain amount of liquid fuel through the narrow gap opening

56, but due to the size of the gap will not withdraw liquid fuel in great volume.

It will also be understood that the units of this invention can be completely inoperative without stopping the flow of fuel from the fuel cell to the fuel line, since fuel can flow through the casing and impeller of the idle pump. During operation of the aircraft at relatively lower altitudes the vacuum pressure of the engine driven fuel pump is sufficient to steadily flow the fuel through the pump impeller into the fuel line.

It will be further understood that various details of construction may be varied through a wide range without departing from the principles of this invention, and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. In an aircraft fuel system, a fuel cell, a pump disposed in said cell and having its inlet adjacent the bottom of said cell, a motor disposed in said cell for driving said pump, means on said pump defining a vapor collection chamber, an aspirator chamber discharging into said cell at a point remote from said inlet, a jet pump having its inlet communicating with the outlet of said first pump and its outlet discharging into said aspirator chamber, a nozzle disposed in said jet pump and communicating with said jet inlet, and a duct between said aspirator chamber and said vapor collection chamber whereby vapors in said collecting chamber are withdrawn due to pressures created by the passage of fuel under pressure from said first pump through said jet nozzle.

2. A vapor separating pump comprising a pump housing having an impeller chamber, a vapor-receiving chamber, a pumping chamber surrounding said impeller chamber and in communication therewith around the periphery thereof and an inlet at one end of the impeller chamber, an impeller having a ring of blades in said impeller chamber defining pumping channels therebetween and arranged to receive fluids from the inlet along their inner ends to impart rotation to the fluids and release vapors therefrom, said blades having outer end portions arranged for

discharging liquids into the pumping chamber, means defining a gap connecting the impeller chamber with the vapor-receiving chamber at a zone radially outward from the inner edges of the vanes and at the upper ends of the vanes, an outlet for said vapor chamber, and an aspirator actuated by fluid from the pumping chamber for inducing flow through the outlet of the vapor chamber.

3. A vapor separating pump comprising a pump casing having a circular inlet adapted to be positioned at the bottom of a fuel cell, an impeller chamber in said casing receiving fluids from said inlet, a pumping chamber receiving fluids from the impeller chamber and an annular vapor outlet receiving vapor-rich fluids from the impeller chamber, an impeller rotatably mounted in the impeller chamber and having circumferentially spaced pumping vanes therein, said vanes having inner leading edges adjacent the inlet terminating in a circle having substantially the same diameter as the inlet, and said annular vapor outlet including a diameter greater than said circle an aspirator chamber supported on said casing having a discharge opening spaced from said inlet, a jet pump having an inlet communicating with said pumping chamber and an outlet discharging into said aspirator chamber, and a duct between said annular vapor outlet and a point in said aspirator chamber adjacent said jet outlet.

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