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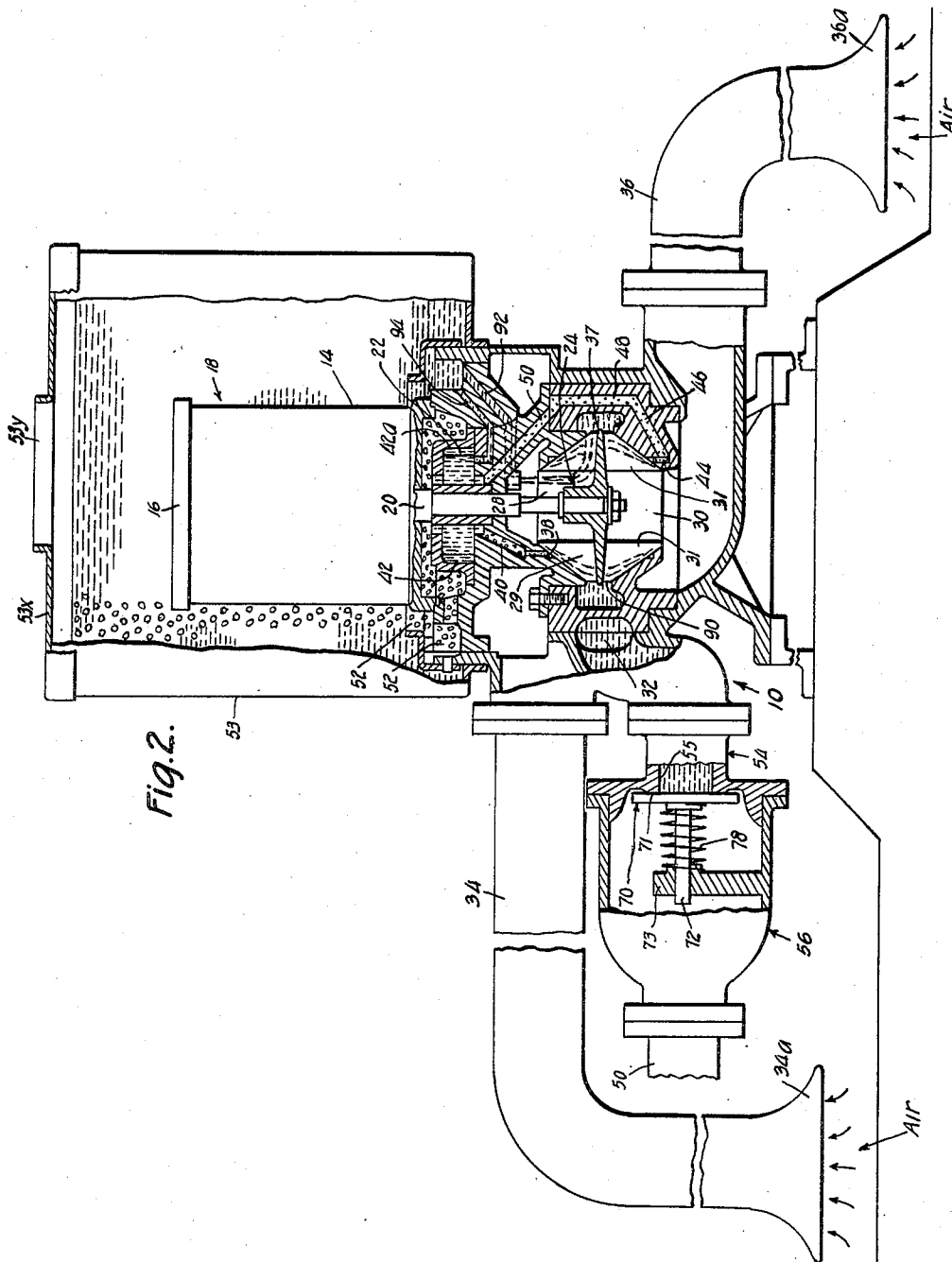
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2,850,983

AIRCRAFT FUEL PUMPS

Filed March 6, 1956

3 Sheets-Sheet 2



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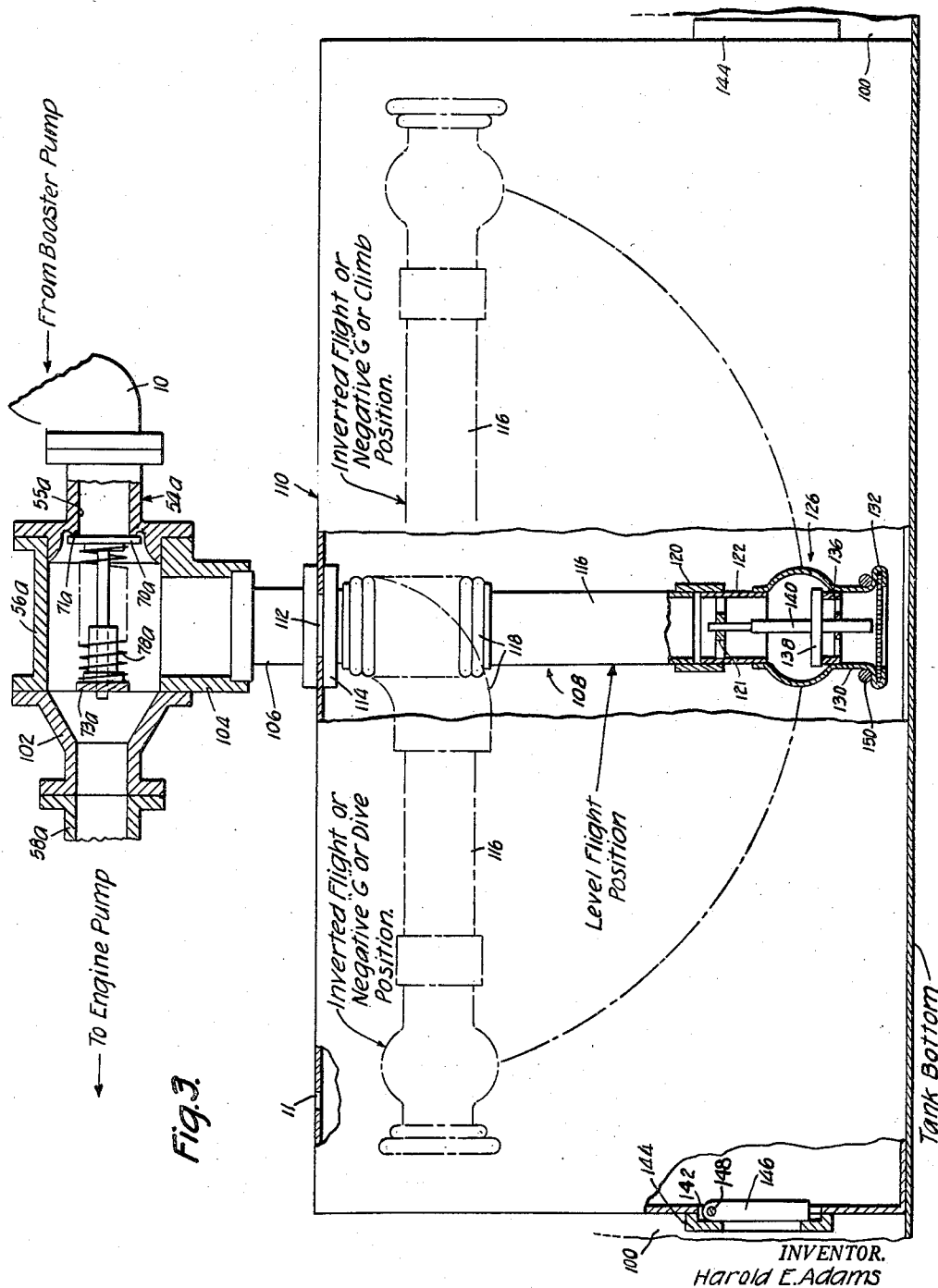
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AIRCRAFT FUEL PUMPS

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Application March 6, 1956, Serial No. 569,709

12 Claims. (Cl. 103—113)

This invention relates to fuel pumps for aircraft, and is in the nature of an improvement upon the fuel pumps of the kind disclosed and claimed in my copending application for Letters Patent of the United States, Serial No. 497,579, filed March 29, 1955 (Patent 2,804,022) for Booster Fuel Pumps.

In said application disclosure is illustratively made of a tank mounted fuel booster unit which comprises a double suction impeller centrifugal liquid pump and a priming vacuum pump of the liquid ring type. The centrifugal pump of that application includes separate, widely spaced fuel inlets in communication, respectively, with separate, but contiguous and merging, pumping chambers at opposite sides of a partitioned double suction impeller.

Although the pumping chambers have separate suction, they are arranged to deliver to a common outlet. Each chamber has a greater flow capacity than the common outlet, and each includes means for separating entrained gas and vapor from the liquid fuel. The vacuum pump is a two lobed pump whose lobes are connected, respectively, to draw off air and vapor from the respective liquid pumping chambers of the centrifugal pump.

The pumping mechanism of said prior application is of particular value because it will continue pumping when one of the suction inlets of the double suction impeller is uncovered, and this until the second suction inlet becomes uncovered also. The pump is especially valuable as an aircraft fuel pump because it takes care of temporary shifting of fuel within the tank caused by unusual maneuvers such as diving, rolling, inversion or any condition producing negative acceleration.

The invention of said copending application is particularly directed to the maintenance of a liquid seal between the centrifugal pumping chambers when both suction inlets are uncovered. If the sealing ring of liquid is dissipated, the subsequent re-covering of one of the inlets does not automatically lead to the repriming of the pumping chamber served by that inlet. Since both chambers, in the situation referred to, are exposed to free communication with the uncovered inlet, the liquid fuel cannot be sucked up through the covered inlet into sealing position, and no pumping of liquid can occur until the entire lower half of the impeller has been flooded.

In order to promote the maintenance of the sealing ring with both inlets uncovered, provision is made in the illustrative pump of the copending application of a spring loaded priming valve arranged to extend across the common outlet of the centrifugal pumping chambers and to be closed in response to the falling off of discharge pressure below a predetermined value. By this means a sufficient quantity of liquid is trapped and caused to act as a spinning liquid seal to prevent the passage of air from one pumping chamber to the other. With this sealing ring maintained, the mere re-submersion of one of the inlets closes off the pumping chamber served by it. The vacuum pump thereupon evacuates the air and vapor from the chamber thus closed off, causing the liquid to be sucked up into the chamber and to completely fill it.

The priming valve works well in practice and serves

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very materially to extend the maintenance of the sealing ring with both inlets uncovered. After a sufficiently prolonged exposure, however, the sealing ring in the centrifugal pump and/or the pumping ring in the vacuum pump is caused to be dissipated through splash, leakage and evaporation.

In accordance with the present invention, the principles outlined above as embodied in the prior pump are availed of, and the pumping unit is further improved by providing means to assure quick re-priming, even after an extended uncovering of both suction inlets, immediately after the re-submergence of either inlet.

To this end, it is a feature of the present invention that provision is made of a liquid replenishing reservoir into which a comparatively small part of the liquid is pumped so long as either pumping chamber is actively delivering fuel. This tank is connected constantly to deliver back liquid fuel to the centrifugal pump impeller. Normally, the liquid flows into the liquid replenishment reservoir faster than it is delivered back to the impeller, so that it accumulates in the reservoir to the point of overflowing. When both inlets become uncovered, however, no additional fuel is available for supplying the reservoir, and the fuel which has been stored in the reservoir is slowly used up by feeding it back to the impeller and to the vacuum pump intake. In this way liquid losses at the sealing ring of the centrifugal pump and at the pumping ring of the vacuum pump are more than made good for a protracted period, thus assuring the maintenance of both rings intact. The size of the replenishment reservoir can be chosen to assure immediate repriming during any desired period of uncovering of both inlets.

It is characteristic of liquid ring vacuum pumps that these pumps continually discharge a considerable amount of liquid along with the gas and vapor. It is a feature that this liquid, which has heretofore been allowed to return to the original source of liquid supply, is now delivered along with the gas and vapor to the replenishment reservoir and there separated from the gas or vapor. Thus, the mere provision of the replenishment reservoir serves without the expenditure of additional energy and without modification of the vacuum pump to provide the required reserve of fuel for maintaining the sealing and pumping rings.

It is a feature that the replenishment reservoir is provided with an orificed drain to feed liquid back to the intake side of one of the lobes of the vacuum pump, for maintaining the liquid ring of the pump. Most of this liquid is returned in liquid form to the replenishment reservoir by the vacuum pump.

It is a further feature that the liquid replenishing reservoir is placed around the pump operating electric motor to serve the additional function of providing effective cooling for the motor during the running period when both inlets are uncovered. This is an important feature, particularly at high altitudes.

In accordance with still another feature, the central partition of the centrifugal impeller is extended a short distance beyond the outer extremities of the impeller blade so that it extends into the discharge fluid of the pump. This extension provides a better seal between the chambers of the pump because it dips farther into the liquid which forms the sealing ring. The increased diameter of the partition enables the spring pressure acting on the priming valve to be reduced, thereby reducing the pressure drop at the priming valve.

Pumps embodying the invention may be used to advantage either for mere fuel transfer as from one tank to another of an aircraft or from one aircraft to another or they may be used for true booster service, i. e., for delivering pressurized fuel to the intake of another pump;

for example, of the main engine pump. For the latter service, but not for the former, a by-pass valve for the booster pump is provided. The by-pass valve is necessary in this type of installation for two basic reasons (1) to supply a relatively unrestricted flow of fuel to the suction of the main engine pump in the event of booster pump failure, and (2) to prevent the building up of sufficient suction by the main engine pump to open the priming valve and remove the liquid seal ring around the periphery of the impeller.

It has been contemplated, heretofore, that fuel would be present around the inlet of the by-pass valve. With the application of the two-way suction self-priming pumps of the present invention, however, there is the possibility that there may not be fuel present at the by-pass valve opening because this pump enables the airplane to operate at extreme angles. In such an event, the main engine pump will create a sufficient suction to open the uncovered by-pass valve, causing air to be drawn in through the valve and into the engine pump suction. The presence of air in the engine pump suction line, even for a short period of time is unfavorable to the operation of the engine. It provides a period during which the engine is deprived of fuel, and may cause a flame-out or failure of the engine during this intermediate period.

In accordance with an important feature of the invention provision is made of a small interceptor or trap tank around the intake of the by-pass valve, adapted through check valves to retain and hold available for the by-pass valve intake any fuel that may have entered the tank since the last previous opening of the by-pass valve. In order that substantially the entire contents of the interceptor tank may be made available in an emergency the by-pass valve is provided with a flexible intake line. This line is subject to the same forces which cause the fuel to collect in the bottom, side or top of the tank. Because the line is flexible, therefore, the mouth of the line is automatically maintained submerged in fuel so long as any substantial quantity of fuel is present in the interceptor tank.

Other objects and advantages will hereinafter appear.

In the drawing forming part of this specification;

Fig. 1 is a view in elevation, partly broken away, of one form of pumping unit embodying features of the invention, the unit being shown as operating with one suction inlet uncovered;

Fig. 1A is a fragmentary view in elevation, broken away intermediate its height, showing a modified form of pump intake;

Fig. 2 is a view similar to Fig. 1, showing the pumping unit of Fig. 1 with both inlets uncovered; and

Fig. 3 is a view in elevation of an appurtenant structure which adapts the pumping unit of Figures 1 and 2 for true booster service, said structure including a by-pass valve, a flexible line therefor, and an interceptor tank for retaining fuel and making it available to the by-pass valve when required.

The pumping structure illustratively disclosed in Figs. 1 and 2 is in principle the same as that illustrated in application Serial No. 497,579 (Patent 2,804,022), save that a liquid replenishing reservoir has been added and the impeller partition has been extended outward beyond the extremities of the impeller blade. The mechanism shown constitutes a unit which is adapted to be mounted within an aircraft fuel tank. Since no by-pass valve is shown in Figs. 1 and 2 the pumping unit shown is adapted to serve as a fuel transfer unit rather than a true booster unit. Casing members 10, 12, 14, and 16 jointly enclose a motor 18, a motor shaft 20, a vacuum pump rotor 22, and a centrifugal pump impeller 24, the rotor and impeller being fast on the shaft 20. A two-lobed housing member 26 is provided for the vacuum pump rotor 22.

The impeller 24 includes a partition 37 which divides the centrifugal pump into separate, but contiguous and

merging, upper and lower pumping chambers 28 and 30, both of which chambers discharge to a common volute 32. The impeller also includes blades 29 in the upper chamber and blades 31 in the lower chamber. The upper chamber 28 communicates with an intake member 34 whose mouth or inlet 34a is illustrated as being remote from the pump. The lower chamber 30 communicates with an intake member 36 whose mouth or inlet 36a is illustrated as being remote from the pump and from the inlet 34a. The pump and inlet pipes do not necessarily have to be disposed as shown in the drawings and there is no intent to be limited to this type of installation. The pump can be mounted at an angle or horizontally and the inlets can be directed, as desired, to different parts of the tank.

The centrifugal pump has all the physical characteristics and advantages of the pump of my copending application, Serial No. 270,614, filed February 8, 1952, for Fuel Booster Pumps. The pump parts are designed to separate entrained air and vapor from the liquid fuel. Air and vapor separated by centrifugal action in the upper chamber 28 are delivered to an annular groove 38 and are thence drawn off through a passage 40 to a first lobe 42 of the liquid ring vacuum pump. Air and vapor separated by centrifugal action in the lower chamber 30 are delivered to an annular groove 44 and are thence drawn off through passages 46, 48 and 50 to a second lobe 42a of the liquid ring vacuum pump. Both lobes 42 and 42a of the vacuum pump discharge liquid fuel together with gas and vapor through a common discharge passage 52 into a ring replenishing reservoir 53 which serves also as a separator in which air and vapor are separated from the liquid, the latter being accumulated to overflowing in the reservoir. It is characteristic of vacuum pumps of the liquid ring type that a small but substantial quantity of liquid is continually discharged by the pump. It is not necessary, therefore, to modify the vacuum pump for the purpose of causing it to deliver an abnormal amount of liquid. The lobes of the vacuum pump serve not only as independent suction means for drawing off separated air and vapor from the respective chambers of the centrifugal pump, but also as independent primers for said chambers. The reservoir 53 is desirably provided with a cover 53x having an opening 53y in the center.

A fitting 54, attached to the housing member 10, is formed with a port 55 through which the volute 32 discharges into a fitting 56 which forms a part of the fuel delivery line. A pipe 58 forms a further section of said fuel delivery line.

A priming valve 70 is shown in Figure 2 as bearing against a valve seat 71 of the fitting 54 which surrounds the port 55. The valve 70 is equipped with a guiding stem 72, the stem being surrounded by a compression coil spring 78 which bears against an abutment 73 and constantly urges the valve yieldingly toward the seat 71.

When the tank is full of liquid fuel, both inlet members 34 and 36 will be fully submerged and both sides of the impeller 24 will act simultaneously to pump fuel. This condition is very well understood and no illustration is deemed necessary. If the mouth of the inlet member 34 is uncovered, a condition like that illustrated in Figure 1 will then prevail. The liquid contained in the inlet member 34 and in the upper chamber of the centrifugal pump will soon become exhausted, except that a sufficient resistance to fuel discharge will be developed and maintained in the volute 32, by pressure developed in the lower chamber of the centrifugal pump, to maintain an undischarged revolving ring 90 of liquid fuel in the upper chamber. Since this ring is constantly driven by the impeller it is maintained in the location and form shown by centrifugal action, and serves effectively to seal off communication of air or vapor between the upper and lower chambers of the centrifugal pump. In this situation it is only necessary for the mouth of

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the intake member 36 to be barely submerged in order for the lower half of the centrifugal pump to be maintained fully effective. The lower intake member 36 and the lower chamber of the centrifugal pump start full of liquid, and as liquid is forced out through the volute 32 other liquid is drawn in through the mouth of the inlet member 36 to replace it. The operation as thus far described would occur with or without the priming valve 70 being present, and with or without the novel features of the present invention being present.

If the attitude or condition of the airplane should be altered in a way to cause the mouth of the inlet member 36 to be uncovered, and the mouth of the intake member 34 to be covered, the reverse condition to that described above would prevail. The intake member 36 and the chamber 30 would become emptied except for a sealing ring 90, but the upper half of the impeller could continue to function unimpaired.

If it is desired to place a pump in a tank that normally may be only partially full, and if under these circumstances such maneuvers as diving, climbing, banking accompanied by slip or skid, or other unusual attitudes be undertaken, it will frequently happen that the mouths of both inlet members will be temporarily uncovered, even though enough fuel be present to keep at least one inlet mouth covered under conditions of normal flight. Under these conditions there is temporarily a total failure of liquid fuel supply to the pump. As the liquid in the active chamber becomes depleted the mass of the spinning liquid is diminished, causing the centrifugal discharge pressure to be diminished. The pressure in the discharge line to and in the volute 32 also fail. Without the priming valve, all the spinning liquid in the active chamber of the centrifugal pump would be discharged into the volute, and the two chambers 30 and 32 should no longer be sealed off against the passage of air from one to another of them. As previously noted, when this condition has occurred in pumps which have no priming valve, the resumption of pumping cannot be achieved until the liquid has risen, without the aid of suction, to substantially the level of the impeller partition.

With the priming valve present, however, the lowering of the pump discharge pressure in response to depletion of the spinning body of liquid in the centrifugal pump permits the priming valve 70 to be closed by the spring 78 when there is still a sufficient ring 90 of revolving liquid in the centrifugal pump (as shown in Figure 2) to maintain the chambers 28 and 30 sealed off against the communication of air from one to the other. With the seal thus maintained it is necessary only for the mouth of the inlet member 34 or 36 to become barely resubmerged in order for pumping to be re-established. As soon as the mouth of the inlet member 36, for example, is fully covered, the priming lobe 42a of the vacuum pump, which acts through the passages 46, 48, 50, evacuates the air and gas from the inlet member 36 and the chamber 30, to suck the liquid up into the field of action of the lower half of the impeller. All air and gas are quickly withdrawn from the intake member 36 and the chamber 30, so that the pumping of air-free and gas-free liquid fuel through the chamber 30, as illustrated in Figure 1, is quickly re-established.

Should the mouths of both intake members 34 and 36 become uncovered and remain uncovered for a sufficient length of time to permit the liquid sealing ring 90 and the liquid pumping ring of the vacuum pump to be dissipated, the restoration of pumping would not occur in response merely to the resubmersion of the mouth of one of the inlet members.

It is the primary object of the present invention to prevent the dissipation and disappearance of either the sealing ring of the centrifugal pump or the working ring of the vacuum pump, even though both inlets 34a and 36a remain uncovered for a very considerable time. It is for this reason that the replenishing reservoir 53 is provided. An orificed drain passage 92 is provided from the

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lower extremity of the reservoir to the eye of the impeller, through which liquid fuel is constantly bled from the reservoir into the eye of the impeller. The liquid thus returned does no good during normal operation as illustrated in Fig. 1, but since it is liquid which would have been discharged by the vacuum pump in any event and which would have been normally returned to the fuel tank, the accumulating and bleeding off of the liquid costs nothing and does no harm. The rate of bleeding is normally less than the rate of delivery of fuel to the reservoir, and hence the liquid in the reservoir accumulates.

When, as illustrated in Fig. 2, both the inlets 34a and 36a become uncovered, the bleeding back of the accumulated liquid from the reservoir to the eye of the impeller causes liquid to be added at a slow, steady rate to the sealing ring, sufficient to prevent depletion or dissipation of the sealing ring through evaporation, leakage and splashing. This replenishment of the sealing ring will be continued for as long as the liquid in the replenishment reservoir holds out.

In addition to the bleeder passage 92, a further orificed bleeder passage 94 is provided from the lower extremity of the replenishment reservoir to the intake side of the lobe 42a of the liquid ring pump. The liquid thus furnished from the reservoir is added to the liquid ring of the vacuum pump to make up for liquid which passes from the vacuum pump ring to the reservoir. The bleeding off of liquid from the replenishment reservoir by the passage 94 has very little tendency to deplete the supply of liquid in the reservoir because it is returned almost in its entirety to the reservoir. The passage 94 is caused to communicate with the intake side of only one lobe, because the lobes are connected to act separately on the chambers of the centrifugal pump. It is not necessary to replenish the working ring of this liquid ring pump through both lobes because liquid fuel delivered through the intake of either lobe becomes impartially distributed in the liquid ring.

It has been mentioned that the impeller partition 37 has been extended outward according to the present invention beyond the radial bounds of the impeller blades 29 and 31. This is an important point in connection with the maintenance of the sealing ring. The tendency of the impeller is to drive out all liquid from the pumping chamber of the centrifugal pump right out to the very tips of the blades. If the sealing ring is to be maintained effective, it is essential that the periphery of the impeller partition dip into the ring at all times. In the arrangement of Serial No. 459,579, it was necessary to provide enough back pressure on the priming valve to assure overlap of the impeller blade by the liquid ring to a substantial depth. With the partition extended, however, the same sealing overlap may be obtained with considerably less overlap of the blades by the liquid. The spring pressure against the priming valve can therefore be substantially reduced. This is an important point, because it is only under the unusual conditions of both inlets being uncovered that the priming valve functions usefully whereas the resistance to flow interposed by the priming valve must be overcome throughout the normal operation.

The point should be noted that the motor 18 is disposed in the bottom of the replenishment reservoir 53 where it will be submerged in the fuel-contained in the reservoir and effectively cooled by such fuel.

If the installation is made in an aircraft which is expected to be subjected to negative G acceleration or to inverted flight, one of the intakes, say 34, is desirably provided with a swivel joint to enable the mouth of the intake to reach the fuel in what is normally the top of the tank. Such an arrangement is illustrated in Fig. 1A in which the intake 34c, corresponding to 34 of Fig. 1 is made to comprise sections 34d and 34e arranged end to end. One of these sections, 34e as shown is provided with a plain flange or collar 34f and the other is provided

with a threaded flange or collar 34g of slightly larger diameter than 34f. The sections 34d and 34e are drawn together by a union coupling 34h which is carried by the section 34e and threaded on the flange 34g of section 34h. A packing of suitable anti-friction material may be provided within the union coupling. The joint may be left loose enough to swivel freely. When the intake 34c is used, the opening 53y in the cover 53x of the replenishment tank is desirably provided with a weighted check valve (not shown) to prevent fuel from spilling out of the tank 53 under negative G or inverted flight conditions. The replenishment tank does not furnish sealing liquid during negative G or inverted flight conditions, but it is desirable to preserve the fuel in the replenishment tank so that it may be immediately available for use following such conditions.

In Fig. 3, the fuel pump unit is modified to adapt it for true booster service. The pumping unit, including both pumps, the motor and the replenishment reservoir are to be looked upon as included in the organization partially illustrated in Fig. 3 although only a fragment of the casing member 10 is shown. Beyond the casing member 10 the structure is modified, although the modified structure as shown also includes a priming valve 70a which operates upon the same principle as before. All the structure of Fig. 3 is located within a main fuel tank 100.

A fitting 54a, having a port 55a therein, is attached to the delivery end of the casing 10 as before. A fitting 66a is joined to the fitting 54a, and carries the priming valve 70a. The priming valve 70a has its stem 72a mounted for sliding movement in a stationary combined bearing and abutment member 73a. A compression coil spring 78a which surrounds the stem 72a bears at one end against the member 73a and at the other end against the head of the valve 70a, serving constantly to urge the valve toward closing position against a seat 71a of the fitting 54a which surrounds the port 55a. The fitting 56a has connected to it a reducing fitting 102, the latter fitting being, in turn, connected to a member 58a of the line which conducts the fuel to the main engine pump.

The only significant difference between the structures of Figs. 1 and 2 and the structure of Fig. 3 thus far described, lies in the fact that the fitting 56a includes a side or branch portion 104 through which connection and communication is established with a bypass intake line 108.

A conduit 106 forms the first section of the bypass intake line 108. It is connected at its upper end to the fitting 56a and at its lower end to the top wall 109 of an interceptor tank, 110, in line with an opening 112 formed in said wall. The wall 109 is also provided with a small air vent opening 111. A flanged fitting 114 is secured to the inner side of the top wall of the tank 110 in line with the opening 112, and constitutes a further section of the bypass line 108. The fitting 114 is connected to a conduit 116 through a flexible bellows 118. The lower end of the conduit 116 is connected through a coupling 120 to the upper end of a short circuit section 122, which conduit section has a spider 124 disposed across it at its upper end.

A mouthpiece 126, affixed to the lower end of the conduit section 122, carries the bypass check valve. The mouthpiece 126 includes a bulbous portion 128, a straight neck portion 130 and a lower out-turned flange 132. A spider 132 is disposed across the neck portion 130 near the upper end thereof. A ring 136, mounted on the spider, provides a valve seat at its upper end. A weighted bypass valve 138, fast on a stem 140, is normally maintained in contact with the ring 136 to close the bypass line. The stem 140 is guided for sliding movement in the spiders 124 and 134. When the valve is opened in response to suction of the main engine pump, the valve 138 is carried by the incoming fuel well away from its seat and into substantially the largest part of the

bulbous portion 128 of the mouthpiece 126, so that fuel can flow freely around the valve. The valve 138 opens more readily than the priming valve 70a when the delivery pressure of the booster unit fails, and hence serves to protect the priming valve against undesired opening.

Since the interceptor tank is required to furnish fuel only during the brief period when both intakes 34a and 36a are uncovered, the interceptor tank is desirably a small tank, having a capacity say, of the order of ten gallons. The tank is closed at the top, bottom and side portions, except that a plurality of openings 142 are provided in side wall portions of the tank near the tank bottom. Identical provision is made at each of these openings for permitting liquid fuel to enter the tank 110 while preventing escape of the fuel therefrom. A flanged plate 144, having an opening therethrough, is secured across each opening 142. An automatic check valve 146 is supported on a horizontal pivot pin 148 in position to lie normally against the inner face of the associated plate 144 to prevent escape of liquid fuel from the tank 110. The valve 146 is held closed by gravity, but is free to swing open in response to hydrostatic pressure or to the surging of the surrounding liquid fuel in the main fuel tank, to admit such fuel to the tank 110.

It is the purpose of the tank 110 to compel fuel to remain within reach of the mouthpiece 126 of the bypass intake line. Since the conditions encountered may tend to carry the fuel toward the top, or toward any side of the tank 110, and since the tank, even if initially full will not remain so when its contents are drawn upon by the bypass line, it is important that the bypass line be free to yield to the same forces which influence the fuel to shift about, so that the mouthpiece may remain submerged until the fuel in the tank 110 is nearly exhausted. It is for this reason that the flexible bellows is provided. The bellows permits the bypass line to swing in any direction, so that the mouthpiece 126 can be located near any wall of the tank. In Fig. 3 the mouthpiece is shown in full lines near the center of the bottom wall of the tank 110, and in dotted lines near the upper right hand and left-hand corners, these being but a few of the many positions which the mouthpiece can assume under flying conditions. A weight ring 150 surrounds the mouthpiece 126 in position to bear outward against the flange 132, the purpose of the weight being to assist in overcoming the resistance of the bellows 118 to distortion, and thereby to assist in carrying the mouthpiece to the various positions which it should assume in operation.

In order that all portions of the interceptor tank may be made substantially impartially accessible to the mouthpiece 126 of the bypass line 108, the interceptor tank is desirably made cylindrical in form, with upper and lower circular ends. The bypass line is passed through, and secured to, the central portion of the upper end of the tank, and the flexible section 118 is disposed just within the upper end wall of the tank.

I have described, what I believe to be the best embodiments of my invention, I do not wish, however, to be confined to the embodiments shown, but what I desire to cover by Letters Patents is set forth in the appended claims.

I claim:

1. A self-priming fuel pump unit for aircraft comprising, in combination, a double suction impeller centrifugal liquid pump, having two contiguous, merging pumping chambers in which opposite halves of the impeller are respectively contained, and in each of which air and vapor are centrifugally separated from the liquid fuel intake members providing separate, widely spaced inlets to the respective chambers, and a common discharge line member including a port through which the discharged fuel must pass enroute to its destination, vacuum pumping mechanism connected separately to the pumping cham-

bers of the centrifugal pump and including means for removing separated vapor from each chamber independently of the other chamber, and a spring loaded priming valve constructed and arranged automatically to cover and close the port of said discharge line when the fuel delivery pressure of the centrifugal pump falls below a predetermined value, said priming valve serving to retain a sealing ring of spinning liquid at the junction of the merging pumping chambers of the centrifugal liquid pump when the supply of liquid at the inlets of both chambers fails, a ring replenishment reservoir into which a minor part of the liquid fuel is delivered for accumulation so long as the unit is delivering fuel, and means for bleeding off liquid fuel from the replenishment reservoir and supplying it to the impeller for maintaining the sealing ring.

2. A self-priming fuel pump as set forth in claim 1, in which an electric motor is provided for driving the pump unit, said motor being mounted in the replenishment reservoir for submergence therein to provide effective cooling for the motor when both inlets are uncovered.

3. A self-priming fuel pump unit for aircraft comprising, in combination, a double suction impeller centrifugal liquid pump, having two contiguous, merging pumping chambers in which opposite halves of the impeller are respectively contained, and in each of which air and vapor are centrifugally separated from the liquid fuel, intake members providing separate, widely spaced inlets to the respective chambers, and a common discharge line including a port through which the discharged fuel must pass enroute to its destination, vacuum pumping mechanism of the liquid ring type connected separately to the pumping chambers of the centrifugal pump and including means for removing separated air and vapor from each chamber independently of the other chamber, and a spring loaded priming valve constructed and arranged automatically to cover and close the port of said discharge line when the fuel delivery pressure of the centrifugal pump falls below a predetermined value, said priming valve serving to retain a sealing ring of spinning liquid at the junction of the merging pumping chambers of the centrifugal liquid pump when the supply of liquid at the inlets of both chambers fails, a ring replenishment reservoir disposed to receive and accumulate liquid delivered by the liquid ring vacuum pump, and means for bleeding off liquid fuel from the replenishment reservoir and supplying it to the impeller for maintaining the sealing ring of the centrifugal pump.

4. A self-priming fuel pump unit for aircraft comprising, in combination, a double suction impeller centrifugal liquid pump, having two contiguous, merging pumping chambers in which opposite halves of the impeller are respectively contained, and in each of which air and vapor are centrifugally separated from the liquid fuel intake members providing separate, widely spaced inlets to the respective chambers and a common discharge line including a port through which the discharged fuel must pass enroute to its destination, vacuum pumping mechanism of the liquid ring type connected separately to the pumping chambers of the centrifugal pump and including means for removing separated air and vapor from each chamber independently of the other chamber, and a spring loaded priming valve constructed and arranged automatically to cover and close the port of said discharge line when the fuel delivery pressure of the centrifugal pump falls below a predetermined value, said priming valve serving to retain a sealing ring of spinning liquid at the junction of the merging pumping chambers of the centrifugal liquid pump when the supply of liquid at the inlets of both chambers fails, a ring replenishment reservoir disposed to receive and accumulate liquid delivered by the liquid ring vacuum pump, and means for bleeding off liquid fuel from the replenishment reservoir and supplying it in part to the impeller for maintaining the sealing ring of the centrifugal pump and in part to the vacuum

pump for maintaining the working ring of the vacuum pump.

5. A self-priming fuel pump unit for aircraft comprising, in combination, a double suction impeller centrifugal liquid pump, having two contiguous, merging pumping chambers in which opposite halves of the impeller are respectively contained and in each of which air and vapor are centrifugally separated from the liquid fuel, intake members providing separate, widely spaced inlets to the respective chambers, and a common discharge line including a port through which the discharged fuel must pass enroute to its destination, vacuum pumping mechanism connected separately to the pumping chambers of the centrifugal pump and including means for removing separated air and vapor from each chamber independently of the other chamber, and a spring loaded priming valve constructed and arranged automatically to cover and close the port of said discharge line when the fuel delivery pressure of the centrifugal pump falls below a predetermined value, said priming valve serving to retain a sealing ring of spinning liquid at the junction of the merging pumping chambers of the centrifugal liquid pump when the supply of liquid at the inlets of both chambers fails, the impeller including a circular partition which divides the chambers from one another and blades at each side of the partition, the partition being extended outward radially for a substantial distance beyond the ends of the blades to dip into the sealing ring.

6. A self-priming fuel pump unit for aircraft as set forth in claim 1 which is especially adapted as a booster unit for delivering pressurized fuel to the intake of a following pump, said unit including a bypass line in communication with the discharge line beyond said priming valve, the bypass line including a bypass check valve which is normally closed but which opens automatically in response to suction exerted by the following pump when the pressure of the booster pump unit fails, said bypass line serving then directly to conduct fuel and an interceptor fuel tank surrounding the mouth of the bypass line to maintain a limited amount of fuel within reach of the mouthpiece of the bypass line when the fuel surges, the bypass line including a flexible section for enabling said mouthpiece to follow the fuel in the interceptor tank under surging conditions as the fuel in the interceptor tank becomes depleted.

7. A booster fuel pump unit for aircraft adapted for installation in a main fuel tank and designed for delivering pressurized fuel to the intake of a following pump, said unit including, in combination, a booster pump, a discharge line leading from the booster pump to the intake of the following pump, a bypass line in communication with the discharge line, the bypass line including a bypass check valve which is normally closed and which opens automatically in response to suction exerted by the following pump when the pressure of the booster pump fails, said bypass line serving then directly to conduct fuel to the discharge line independently of the booster pump, an interceptor fuel tank within the main fuel tank, and surrounding the mouth of the bypass line, to maintain a limited amount of fuel within reach of the mouth of the bypass line when the fuel surges, the bypass line including a flexible section within the interceptor tank for enabling said mouth to follow the fuel in the interceptor tank under surging conditions as the fuel becomes depleted.

8. A booster fuel pump unit as set forth in claim 7, wherein the discharge line includes a priming valve after the booster pump and ahead of the bypass line and constructed and arranged to close the discharge line when the fuel delivery pressure of the booster pump falls below a predetermined value and to open automatically when the delivery pressure of the booster pump reaches a predetermined value, and means for causing the priming valve to be more resistant to opening than the bypass valve.

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9. A booster fuel pump unit as set forth in claim 7, wherein the bypass line is passed through a central portion of a wall of the interceptor tank and is secured thereto, and the flexible section of the bypass line is located just within said wall.

10. A booster fuel pump unit as set forth in claim 7, wherein the bypass line is passed through a central portion of a wall of the interceptor tank and is secured thereto, and the flexible section of the bypass line is located just within said wall and consists of a flexible bellows.

11. A booster fuel pump unit as set forth in claim 7, wherein the bypass line is passed through a central portion of a wall of the interceptor tank and is secured thereto, and the flexible section of the bypass line is located just within said wall, the mouth of the bypass line being weighted to induce it to shift with the surging fuel in response to the forces which cause the fuel to surge.

12. A booster fuel pump unit as set forth in claim 7,

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wherein the interceptor tank is cylindrical in form and has a height substantially equal to its radius, the bypass line is passed through the central part of a circular end wall of the tank and secured to said wall, and the flexible section of the bypass line is located adjacent to said wall.

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