

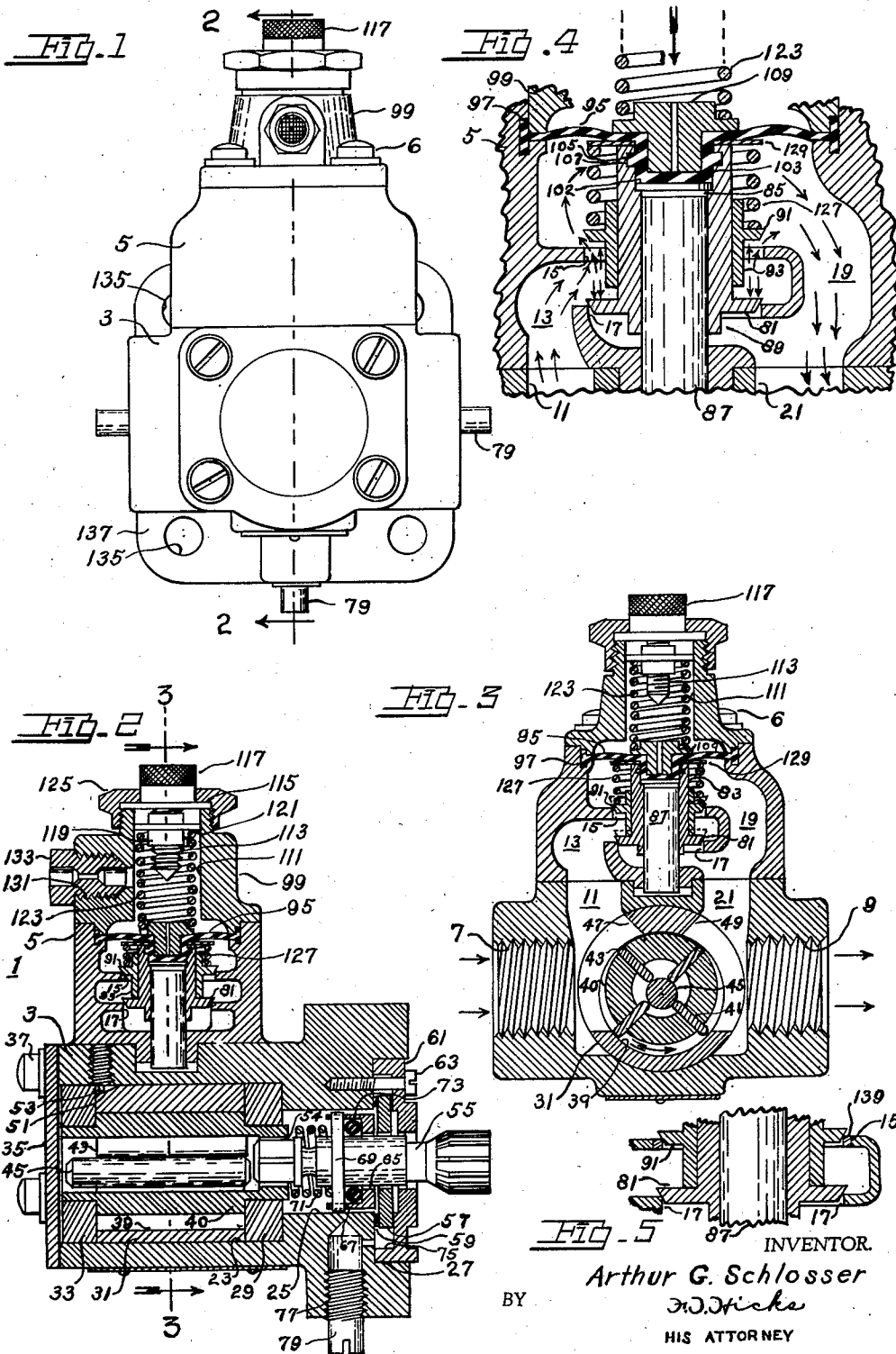
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PUMP

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PUMP

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My invention pertains to pumps, and more particularly to airplane fuel pumps of the type having automatic release and by-pass valve means for regulating the delivery pressure of the fuel supplied to the carburetor and for permitting the by-pass of fuel through the pump from an auxiliary or manual pump.

It is an object of my invention to provide a constant pressure fuel pump of improved compact construction having improved operating characteristics especially suitable for use on aircraft for delivering fuel to the carburetor at a uniform and constant pressure with greatly varying speeds of rotation and rates of fuel consumption and also of such construction that the discharge pressure is not affected either by a varying suction or pressure applied to the fuel at the intake of the fuel pump of such magnitude as may be caused by the maneuvering of an airplane.

It is also an object of my invention to provide a fuel pump having constant pressure delivery characteristics comprising a pump having in combination release valve means which is pressure balanced so that neither inlet pressure nor outlet pressures directly contacting the valve means have any substantial effect tending to open or close the valve means, and a fuel pressure responsive actuator connected therewith and the actuator being mounted in the pump assembly to be exposed only to the outlet pressure so that the pressure of the delivered fuel is automatically regulated and is not influenced by the variations of pressure in the inlet port as caused by the maneuvering of the aircraft.

It is a further object of my invention to provide an improved fuel release and by-pass valve assembly for such pumps.

It is also an object of my invention to provide a fuel pump having a compact double valve arrangement for releasing fuel from the outlet to the intake side of the pump through two spaced valve seat apertures, while also alternatively operable as a by-pass valve for by-passing fuel through the pump when applied under pressure in the intake port from an auxiliary pump.

Another object of my invention is to provide in such a fuel pump wherein the fuel release and by-pass valve assembly comprises two valves arranged to seat upon two spaced valve seat apertures, an actuator responsive only to the pressure of the pumped or discharged fuel and so connected to the valves that both are opened as a unit in response to increasing discharge pressure, and means permitting separate operation for by-passing in response to fuel applied under pressure in

the inlet port of the pump, as from an auxiliary or manual pump.

Another object of my invention is to provide such a fuel pump, double relief valve and by-pass assembly, wherein one of the valves is provided with an extending hub portion having an aperture therein, a stationary guide pin extends from the housing into the hub to act as a guide and also as a dashpot to damp out vibrations of the valve, the other valve is slidably disposed on the hub portion of the first valve and has a portion engageable therewith for simultaneous operation and the valves are seated upon spaced valve seat apertures in a passageway connecting between the inlet port and the outlet port of the pump in such a manner that the first mentioned valve opens against inlet pressure and the other valve opens against outlet pressure, spring means urging the valves to seated positions so that the second mentioned valve may be lifted by the fluid pressure to by-pass fuel from inlet to outlet when the inlet pressure is increased and outlet pressure decreases, and pressure responsive actuator means is provided exposed to the outlet pressure and connected to the first mentioned valve so that both valves are opened as a unit to release and discharge fluid from the outlet back to the inlet when the outlet pressure exceeds a predetermined value.

A further object of my invention is to provide an improved arrangement for attaching a non-metallic diaphragm in unpierced condition to a valve to be controlled thereby.

Further objects and advantages are within the scope of my invention, such as relate to the arrangement, operation and function of the related elements of the structure, to various details of construction and to combinations of parts, elements per se, and to economies of manufacture and numerous other features as will be apparent from a consideration of the specification in conjunction with the drawing disclosing specific embodiments of my invention, in which:

Fig. 1 is an end elevational view of my improved fuel pump;

Fig. 2 is a longitudinal sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is a transverse sectional view taken on line 3—3 of Fig. 2;

Fig. 4 is an enlarged partially diagrammatic view illustrating the operation of the valves; and

Fig. 5 is an enlarged fragmentary sectional view showing a modification of the valve seat construction.

Referring more particularly to Figs. 1, 2 and 3

of the drawing, I have illustratively disclosed an improved rotary type of fuel pump of a well known construction, although it is to be understood that my improved relief valve and by-pass arrangement may also be advantageously utilized in combination with other types of fuel pumps. As shown, the housing or casing 1 consists of a lower or pump housing 3 and an upper or valve housing 5 mounted and secured thereon as by bolts 6 passing down through the valve housing into the pump housing. The casings may be made in any suitable manner, and are preferably castings which have been cored to provide fluid conducting passages therein. The pump housing is provided with an inlet port opening 7 into one side and an outlet port opening 9 from the other side and these are internally threaded for convenient connection respectively with a fuel tank and carburetor in any system wherein the fuel pump is to be installed. From the inlet port 7 in the pump housing a passage 11 leads upwardly and connects with a passage 13 in the valve housing which is aligned therewith. The inlet pressure passage 13 in the valve housing opens in opposite directions through two spaced valve seat apertures 15 and 17 into an outlet pressure passage 19, which is suitably cored out of the valve housing 5 in surrounding relation. From the outlet port 9 in the pump housing a passage 21 leads up and connects with the outlet passage 19 in the valve housing, so the passages 11, 13, 19, and 21 connecting in conductive relation form a passageway through the housing of the unit, for by-passing fluid through the unit from the inlet 7 to the outlet 9 in shunt with the pump, or for releasing pumped fluid from the outlet back to the inlet.

Referring to Fig. 2, it will be seen that the pump housing 3 is provided with a pump aperture or bore 23 extending therethrough and having a portion 25 of reduced diameter and opening into an enlarged counter bore forming an annular socket 27 of shallow axial depth. Into the left hand end of the pump bore, as viewed in Fig. 2, is inserted an inner bearing ring 29 a hollow liner 31 and an outer bearing ring 33 and these elements are secured in assembled relation therein by a cover 35 clamped firmly on the end of the pump housing as by bolts 37 passing thereinto. The liner 31 is provided with a bore 39 which is eccentric to its outer diameter and which bore has a diameter larger than the inside diameter of the bearing rings. The outer diameters of the liner and of the bearing rings are equal and when assembled in the pump housing are held in proper alignment. A rotor 40 of cylindrical conformation is disposed between the rings 29 and 33 and within the liner and has end portions of reduced diameter journaled to rotate in the bearing rings. The intermediate portion of the rotor 40 is of larger diameter running closely against the upper side of the eccentric bore 39 in the liner 31. The intermediate portion of the rotor is provided with slots 41 cut radially therethrough for slidably guiding vanes 43, as shown in Fig. 3, the inner ends of which engage a vane spacer pin 45 which floats freely in an axial bore of larger diameter extending through the rotor. The outer ends and the inner ends of the vanes 43 are rounded or curved and the diameter of the vane spacer pin 45 is suitably selected with reference to the lengths of the vanes so that the outer ends of the vanes run snugly against the inner surface of the bore 39 in the liner which, being eccentric relative to the axis of rotation of

the rotor, causes the vanes to be extended from the rotor when in the lower portions of their circuit of rotation and to be retracted when rotated to the upper positions. With the rotor rotating counterclockwise, as seen in Fig. 3, the extended vanes carry the fluid through under the rotor in the direction represented by the arrows and the pumped fluid cannot return above the rotor because the vanes are there retracted and the rotor is running closely against the liner. The liner 31 is provided with cut away portions 47 and 49 adjacent the inlet and outlet ports of the pump for passing fluid to and from the rotor. To assure that the liner 31 is assembled and retained in a proper position in the pump housing, it is provided with a slot 51 in the upper side which receives the end of a pin 53, extending down from the housing 3.

Driving connection is extended from the right hand end of the rotor which has an aperture 54 of square or other non-circular shape for receiving one end of a drive shaft 55 which is similarly shaped. The other end of the drive shaft 55 extends from the pump housing to be meshed with and driven by any suitable driver on an engine on which the pump is mounted. A shaft seal is provided comprising a stationary seal ring 57 which is seated upon a gasket 59 in the annular socket 27 in the end of the pump housing, where it is firmly clamped by an annular rear plate 61 secured to the housing as by bolts 63 of which a plurality are provided at circumferentially spaced points around the annular plate. Running in snug fitting relation against the stationary seal ring 57 is a spring pressed sealing ring 65 having prongs 67 passed through slots in a shaft ring 69. A spring 71 reacts between the end of the rotor 40 and the shaft ring 69 for continuously pressing the rotating shaft seal ring 65 against the stationary seal ring 57. The shaft 55 is also provided with a seal ring or gasket 73 of rubber or other similar material of a suitable diameter to be pressed snugly on the shaft and to press snugly against both the shaft and the adjacent side of the rotatable sealing ring 65. This rubber ring gasket 73 serves to restrict the leakage of fluid and allows slight misalignment of the drive shaft 55.

As a further precaution, an annular leakage collecting groove 75 is formed in the surface of the annular rear plate 61 for receiving any fluid which might leak past the seal. A plurality of drain holes 77 are provided connecting from the collecting groove in various directions and these are internally threaded and closed by plugs 79, as may be seen in Fig. 1. When the pump is installed, the plug in the lowest position is removed, and a pipe line is screwed therein for draining away any leakage for safe disposal.

In accordance with my invention I provide an improved double release valve arrangement for automatically regulating the pressure of the fuel delivered by the pump and the same means also being operative to by-pass fuel through the housing around the pump when fuel is applied in the inlet port of the pump under pressure, as from a manual or other auxiliary pump. For this purpose the passage 13 in the valve housing, as may be seen in Figs. 3 and 4, connects through the two valve seat apertures 15 and 17 opening in opposite directions into the outlet connected passage 19. The two valve seat apertures 15 and 17 are spaced apart in aligned relation. To restrict the flow of fluid through the lower aperture 17 a lower or inner valve 81 is provided of a suitable size for

seating thereon. When the inner valve 81 is opened it is lifted from its seat against the inlet port pressure from the passage 13. For assembling the lower valve 81 the upper valve seat aperture 15 is made just slightly larger so that the valve can be passed therethrough. A hub portion 83 projects up from the upper side of the inner valve 81 extending upwardly toward or through the upper valve seat aperture 15. The hub 83 is provided with an axial aperture 85 for slidably receiving the upper end of a guide pin 87 which is secured stationarily at the lower end in a suitable aperture in the lower portion of the valve housing 5 and disposed in concentric alignment with the valve seat apertures. In this manner the inner valve 81 is guided in moving toward or away from the valve seat 17, and the diameter of the guide pin 87 is suitably selected relative to the diameter of the aperture 85 in the hub 83 so that it also serves as a dashpot to suitably damp out vibrations of the valve. A guide sleeve 89 may also be provided extending from the valve 81 down around the guide stem 87 to additionally resist any tendency of the valve to turn over.

An upper or outer valve 91 is provided for seating upon the upper valve seat aperture 15 to restrict the flow of fluid therethrough. The outer valve 91 is centrally apertured to slide freely upon the hub 83 of the inner valve for guiding said outer valve in its movements toward and away from its valve seat 15. Projecting downwardly from the outer valve 91 is an abutting portion or sleeve 93 for engaging the inner valve 81 so that both valves may be operated simultaneously as a unit under certain conditions to be described subsequently. The depending sleeve 93 also serves to accurately guide the movements of the outer valve. Because outlet pressure tends to close one valve and open the other, these two forces cancel out on the valve assembly as a unit but it does tend to maintain the two valves abutted together to act as a unit.

For controlling the operation of the valves I provide a pressure deformable diaphragm 95 which is preferably of circular conformation. The outer periphery of the diaphragm 95 is seated in an annular groove 97 in the upper end of the valve housing 5 where it is snugly clamped and sealed by the valve cover 99 which is secured thereon by bolts 6 passing into the valve housing. Although any suitable flexible material may be used for making a suitable diaphragm, I preferably utilize a non-metallic material such as rubber, synthetic rubber, or some rubber like material. For securing the central portion of the diaphragm to the valve I provide interfitted portions on these two elements so that they may be buttoned or snapped together without the necessity for piercing the diaphragm.

As shown in Figs. 3 and 4, one arrangement for accomplishing this is to provide the upper end of the valve hub 83 with a socket 102 and to provide connecting means comprising a hollow protuberance 103 on the diaphragm of a size suitable for fitting snugly therein. The aperture in the hub of the valve being thus formed all the way through facilitates grinding a smooth bore in the hub. Interlocking parts may be provided as by providing an annular groove 105 on the side walls of the socket for receiving laterally projecting lugs or flanges 107 extending from the central protuberance of the diaphragm. If preferred, the relation of parts may be reversed or, as will be understood, made of some other form to provide interfitted parts which may be

buttoned or snapped together without the necessity of perforating the diaphragm. Additional means may be provided for locking the interfitted parts together such as a plug 109 wedged into the hollow protuberance, as shown. In this construction the under side of the diaphragm 95 is exposed to the pressure of the pumped fluid discharged from the pump into the outlet port 9 of the pump.

The valve cover 99 is provided with an aperture 111 passing axially up through the upper end wherein is seated a manual pressure adjusting screw 113, having a lateral flange 115 resting thereon and a knurled knob 117 to provide for convenient adjustment. The threaded adjusting screw 113 projects down into the upper end of the aperture in the cover and it carries a follower 119 having a flange 121 pressing on the upper end of a compression spring 123 the lower end of which reacts upon the upper end of the plug 109 which may be inserted into the protuberance in the diaphragm. The plug 109 also serves as a wedge for more firmly attaching the diaphragm to the valve. To prevent the follower 119 rotating with the adjusting screw 113, the flange 121 on the follower and the cross-section of the aperture 111 are made of any non-circular shape, such as square or some other shape. The upper end of the valve cover 99 is turned down and externally threaded to receive a locknut 125 which is centrally apertured to pass down over the adjustable knob 117. When it is desired to change the adjustment of the outlet pressure of the pump, the locknut 125 is loosened enough to permit turning the adjusting knob 117 and the desired adjustment is accomplished. The locknut is then tightened which holds the adjustment permanently and also clamps the flange 115 of the adjusting screw down to make a fluid tight seal on the valve cover.

To seat the upper or outer valve 91 which is slidable upon the hub of the inner valve, I provide a second or auxiliary light weight spring 127 which is concentrically disposed thereon where it reacts between the outer valve and the diaphragm. If desired, the upper end of the spring 127 may press against the diaphragm or a member 129 projecting from the upper end of the hub of the inner valve. The auxiliary spring 127 acts in series with the main spring 123 for seating the outer valve 91 and normally the outlet pressure applied thereon also aids in seating this valve. The auxiliary spring 127 is selected of suitable strength so that when outlet pressure decreases and fuel under pressure is applied in the inlet port of the pump, as from a hand pump, this valve will be lifted to by-pass fuel through the housing and out of the outlet port to the carburetor.

The valve cover 99 is also provided with a vent aperture 131 opening through the side wall of the cover and internally threaded to receive a vent plug 133 which is apertured to the atmosphere. When used in an installation in conjunction with a super-charger the super-charger pressure is applied on the carburetor and backs up through the fuel line to the underside of the diaphragm. When used in such a system, a connection may be conveniently made through the vent for applying the super-charger pressure therethrough to the upper side of the diaphragm 95 to compensate for the super-charger pressure which is applied on the carburetor.

To provide fluid tight sealed joints, any suitable yielding gasket or packing material is inserted

between the various parts as these are assembled and clamped together such as between the pump housing, the cover and the outer bearing ring, also between the valve housing, the pump housing and the valve cover and locknut cap, as will be understood. In order to describe the operation of the improved fuel pump, relief valve and by-pass assembly, it has been necessary to assume a definite direction of rotation of the pump which has been taken as counter-clockwise, indicated by the arrow, as viewed in Fig. 3. Operating in this direction of rotation the port 7 at the left hand side is the inlet port and the port 9 at the right hand side is the outlet port as indicated by the arrows representing the direction of fluid flow.

However, the internal combustion engines used on aircraft do not all require the same pump rotation. My improved fuel pump also has the important advantage that it is reversible and may be operated equally well in either direction. When operating in the reverse direction from that assumed, the fuel is pumped in the reverse direction, the inlet becomes the outlet and vice versa. For such an installation the normal functioning of the pressure regulating relief and by-pass valves is maintained merely by the simple expedient of mounting the valve housing 5 on the pump housing 3 in a reversed position so that the inlet passage 13 therein is connected with the port in the right hand end of the pump housing and the outlet passage 19 in the valve housing is connected with the port in the left hand end of the pump housing, as viewed in Fig. 3.

Operation of the pump is attained by mounting the pump on the engine of the aircraft with the end of the drive shaft 55 in mesh with a driver on the engine where it is secured in position by bolts passing through the holes 135 in the mounting flange 137, shown in Fig. 1. Assuming that rotation is in a counter-clockwise direction, as viewed in Figs. 3 and 4, fuel is drawn into the left hand or inlet port 7 of the pump housing 3 and it is discharged from the outlet port 9 at the right hand end, as indicated by the arrows. It will be understood that in such an installation the inlet port 7 of the pump is connected by a suitable pipe line with the fuel reservoir and the outlet port 9 is connected to the carburetor of the engine.

As the pump operates, the volume of fuel delivered into the outlet port by the pump varies greatly with the speed of the pump and the engine which drives it. As the demand for fuel varies with the load on the engine and also because the capacity of the pump greatly exceeds the fuel requirements of the engine, a back pressure is built up in the discharge port 9. As previously described, the under side of the flexible diaphragm 95 is exposed to the pressure in the outlet port 9 and, as soon as the force applied thereon is greater than or over balances the main valve spring 123, the two valves 81 and 91 of the pressure balanced valve assembly are lifted.

In Fig. 3, both valves 81 and 91 are shown in closed positions which condition could only prevail for an instant as the engine is starting up or if a condition is assumed where the demand for fuel is equal to the full delivery capacity of the pump. During normal operation the two valves of the pressure balanced release valve assembly are opened more or less, as shown by dotted lines, depending upon the speed and load

conditions, so that the unused portion of the pumped fuel is being released back from the outlet port to the inlet port. The carburetor then receives an ample supply of fuel at a predetermined regulated pressure in accordance with the setting of the adjusting knob.

It will be seen that because there are two oppositely directed valve seat apertures, the release valve means is substantially pressure balanced, has large capacity in a small compact space, and being responsive only to outlet pressure which acts on the diaphragm a very accurate pressure regulation is obtained irrespective of variation of suction and pressure in the inlet port as caused by maneuvering of the aircraft, or other vehicle on which it may be installed. The two valves providing improved fluid flow capacity also provides more accurate pressure regulation in the pump.

Under certain conditions when the pump is inoperative, as when starting for example, it is desirable to be able to by-pass fuel to the carburetor from some manual or other auxiliary pump. This purpose is also effectively accomplished by the valve arrangement provided. When fuel under pressure is applied in the inlet port 7 of the pump, the upper or outer valve 91 is lifted and fuel flows therethrough, as shown in Fig. 4, and the manually pumped fuel is readily delivered to the carburetor without the necessity of providing a special by-passing line, or even the trouble of operating a by-pass valve manually, as the operation of the by-pass in the pump takes place automatically without any special attention from the operator.

In Fig. 5, I have shown a modified arrangement of the valve seat construction comprising a valve seat ring insert 139 which is disposed in the upper valve seat aperture 15. The valve seat insert 139 may be a snug fit pressed into the upper valve seat aperture, and it is installed after the lower or inner valve 81 has been installed. This arrangement has the advantage that the two valves 81 and 91 may be made exactly the same size and the valve assembly will be exactly pressure balanced in its operation. Also it is possible by this arrangement to make the inner or lower valve 81 larger than the outer valve 91 so that the pump will have a falling pressure delivery characteristic with increasing suction (decreasing absolute pressure) in the inlet port, if that is desired. In the first embodiment, previously described, the upper valve seat aperture 15 must be slightly larger than the lower or inner valve 81 which must be passed therethrough in assembly. This causes a slight rising pressure delivery characteristic with increasing suction in the fuel inlet port. However, the difference necessary in the sizes of the inner and the outer valves 81 and 91 is only slight, even when a ring insert is not provided in the upper valve seat aperture, and such expressions as "pressure balanced" as used throughout are intended to apply to either such arrangement of these valve seat apertures and valves. The improved release and by-pass assembly has been shown in combination with one type of rotary pump but it is to be understood that this arrangement may be advantageously utilized with various other types of pumps.

It is apparent that within the scope of the invention modifications and different arrangements may be made other than herein disclosed, and the present disclosure is illustrative merely, the invention comprehending variations thereof.

I claim:

1. In a fuel pump the combination of, a casing having a fuel inlet port and a fuel outlet port, a pump within said casing for effecting a transfer of fluid through the casing from the inlet port to the outlet port, said casing being provided with passage openings through which fluid may be transferred between said ports in shunt with said pumping means, pressure balanced valve means in said passage for restricting the flow of fluid therethrough and said valve means being balanced for variations of pressures in both the inlet port and the outlet port, discharge pressure responsive actuator means exposed to the discharge pressure in the outlet port from said pump, and means connecting said discharge pressure responsive actuator means to operate the valve means for returning pumped fluid from the outlet port to the inlet port to regulate the pressure of the fluid delivered by the pump to a substantially constant value.

2. In a fuel pump the combination of, a casing having a fuel inlet port and a fuel outlet port, a pump within said casing for effecting a transfer of fluid through the casing from the inlet port to the outlet port, said casing being provided with passage openings through which fluid may be transferred between said ports independently of the action of said pumping means, balanced pressure valve means in said passage for regulating the flow of fluid therethrough comprising two valve seat apertures stationary within the casing and spaced apart in aligned relation and opening from the inlet side to the outlet side, two valves for engaging said stationary valve seats in fluid flow obstructing relation, one of said valves opening toward the inlet pressure and the other valve opening toward the outlet port pressure, a pressure responsive actuator exposed to the discharge pressure in the outlet port from said pump, and means connecting said actuator to open said valves as a unit so that both valves open in response to a pressure greater than a predetermined pressure in the outlet port opening both valve seat apertures for returning a portion of the pumped fluid to the inlet to regulate the pressure of the fuel delivered by the pump.

3. In an aircraft fuel pump, relief valve and by-pass assembly the combination of, a housing having fuel inlet and outlet ports, pumping means within said housing for pumping fuel from the inlet port to the outlet port, said housing having a passageway through which fluid may be transferred between said ports independently of the action of said pumping means, balanced pressure valve means in said passageway for regulating the flow of fluid therethrough comprising two valve seat apertures spaced apart in aligned relation and opening in opposite directions, from the inlet port to the outlet port of the housing, two valves for engaging said valve seats in fluid flow obstructing relation, one of said valves opening against inlet port pressure and the other valve opening against outlet port pressure, guide means for slidably guiding said valves in relatively movable relation for closing or opening the respective seat apertures, a spring for urging one of said valves to seated position, a second spring acting in series with said first mentioned spring for urging the other valve toward seated position for restricting fluid flow from outlet to inlet and yieldable to permit fluid flow from inlet to outlet, pressure responsive actuator means exposed to the discharge pressure of said pump and connected to said valves in a suitable manner for

opposing the pressure of the pumped fluid against the first mentioned spring for opening both of said valves to return a portion of the fuel to the inlet for regulating the pressure of the delivered fuel.

4. In a fuel pump the combination of, a casing having a fuel inlet port and a fuel outlet port, a pump within said casing for effecting a transfer of fluid through the casing from the inlet port to the outlet port, said casing being provided with a passageway through which fluid may be transferred between said ports independently of the action of said pumping means, pressure balanced valve means in said passageway for regulating the flow of fluid therethrough, a flexible diaphragm exposed to the discharge pressure in the outlet port of said pump, and means securing the central portion of the discharge pressure responsive diaphragm to operate the pressure balanced valve means in accordance with fluid pressure in the outlet port of the pump for returning pumped fluid from the outlet port to the inlet port to regulate the pressure of the fluid delivered by the pump to a substantially constant value.

5. In a fuel pump the combination of, a casing having a fuel inlet port and a fuel outlet port, a pump within said casing for effecting a transfer of fluid through the casing from the inlet port to the outlet port, said casing being provided with passage openings through which fluid may be transferred between said ports independently of the action of said pumping means, balanced pressure valve means in said passageway for regulating the flow of fluid therethrough comprising two aligned stationary valve seat apertures spaced apart and opening in opposite directions from the inlet to the outlet of the pump, two valves for engaging said stationary valve seats in fluid flow obstructing relation, one of said valves opening toward inlet pressure and the other valve opening toward outlet port pressure, spring means for urging said valves to seated positions, a flexible pressure deformable member exposed to the discharge pressure of the pump and connected to said valves for opposing the force derived from the pumped fuel against said spring means for opening both of said valves to return a portion of the fuel to the inlet for regulating the pressure of the fuel delivered by the pump.

6. An aircraft fuel pump, relief valve and by-pass assembly comprising the combination of, a housing having fuel inlet and outlet ports, a pump in said housing for pumping fuel from the inlet port to the outlet port, said housing having a passageway through which fluid may be transferred between said ports independently of the action of the pump, said passageway including a passage extending into the housing from the outlet port and a passage extending into the housing from the inlet port and having two valve seat apertures opening in spaced aligned relation therefrom into the first mentioned passage, an inner valve adapted to seat upon one of said valve seat apertures and opening toward inlet port pressure, an outer valve arranged to seat upon the other valve seat aperture and open toward the outlet port pressure, a guide pin secured stationarily on said housing and projecting toward said valve seat apertures in axial alignment therewith, said inner valve having a centrally disposed hub extending therefrom, an aperture in said hub for receiving the end of said pin to serve as a guide for the valve and also as a dash pot for minimizing vibrations imparted to the valve, a spring in said housing

for urging said inner valve toward seated position, said outer valve being slidably disposed upon the hub portion of the inner valve and having an extending portion engaging the inner valve so that both valves are unseated as a unit when the inner valve is lifted, an auxiliary spring acting in series relation with the first mentioned spring to seat the outer valve so that said outer valve may be opened against said auxiliary spring by the pressure of fuel applied under pressure into the inlet port, as from a manual pump, for by-passing fuel through said housing at times when the pump is not operating, a pressure responsive actuator exposed to the discharge pressure in the outlet port and connected to said inner valve for lifting both valves to open positions for returning fuel to the inlet port to regulate the pressure of fuel delivered by the pump.

7. An aircraft fuel pump, relief valve and by-pass assembly comprising the combination of, a housing having fuel inlet and outlet ports, a pump in said housing for pumping fuel from the inlet port to the outlet port, said housing having a passageway through which fluid may be transferred between said ports independently of the action of the pump, said passageway including two valve seat apertures opening in spaced aligned relation, an inner valve arranged to seat upon one of said valve seat apertures and opening toward inlet port pressure, an outer valve adapted to seat upon the other valve seat aperture and to open toward the outlet port pressure, a guide pin secured stationarily on said housing and projecting concentrically toward said valve seat apertures, said inner valve having a centrally disposed hub extending therefrom toward the other valve, an aperture in said hub for receiving the end of said guide pin to serve as a guide for the valve and also as a dash pot for minimizing vibrations imparted to the valve, a spring in said housing for urging said inner valve toward seated position, said outer valve being slidably disposed upon the hub portion of the inner valve and having an extending portion engaging the inner valve so that both valves are unseated as a unit when the inner valve is lifted, an auxiliary spring acting in series relation with the first mentioned spring to seat the outer valve so that said outer valve may be opened against said auxiliary spring by the pressure of fuel applied under pressure into the inlet port, as from a manual pump, for by-passing fuel through said housing at times when the pump is not operating and a pressure responsive actuator exposed to the discharge pressure in the outlet port and connected to said inner valve for lifting both valves to open positions for returning fuel to the inlet port to regulate the pressure of fuel delivered by the pump.

8. In an aircraft fuel pump and relief valve assembly the combination of, a housing having fuel inlet and outlet ports, pumping means within said housing for pumping fuel from the inlet port to the outlet port, said housing having a passageway through which fluid may be transferred between said ports independently of the action of said pumping means, a valve in said passage for controlling the flow of fluid therethrough, a flexible non-metallic diaphragm for controlling the operation of said valve in accordance with fluid pressures, said valve and diaphragm having interfitting irregularities which may be buttoned together in interlocking relation for securing the unpierced diaphragm to

the valve and a spring for urging the valve to seated position.

9. In an aircraft fuel pump, relief valve and by-pass assembly the combination of, a housing having fuel inlet and outlet ports, pumping means within said housing for pumping fuel from the inlet port to the outlet port, said housing having a passageway through which fluid may be transferred between said ports independently of the action of said pumping means, balanced pressure valve means in said passageway for regulating the flow of fluid therethrough comprising two valve seat apertures, said valve seat apertures being stationary in the casing and spaced apart, two relatively movable valves engageable together and engaging said spaced valve seats in fluid flow obstructing relation, one of said valves opening against inlet pressure and the other valve opening against outlet discharge pressure, a pressure responsive actuator exposed to the discharge pressure in the outlet port from said pump, means connecting said actuator to the valve opening against inlet port pressure for moving it engaging the other valve for moving both valves as a unit to open both valve seat apertures in response to a pressure greater than a predetermined pressure in the outlet port for returning a portion of the pumped fluid to the inlet to regulate the pressure of the fuel delivered by the pump, spring means urging said valves respectively to seated positions on the spaced valve seats and suitably selected to permit the valve which opens against outlet pressure to open when outlet pressure decreases and the inlet pressure increases.

10. An aircraft fuel pump, relief valve and by-pass assembly comprising the combination of, a housing having fuel inlet and outlet ports, a pump in said housing for pumping fuel from the inlet port to the outlet port, said housing having a passageway through which fluid may be transferred between said ports independently of the action of the pump, said passageway including a passage extending into the housing from the outlet port and a passage extending into the housing from the inlet port and having two valve seat apertures opening in spaced aligned relation therefrom into the first mentioned passage, an inner valve adapted to seat upon one or said valve seat apertures and movable toward the inlet port pressure when opening, an outer valve adapted to seat upon the other seat aperture and movable toward outlet port pressures, a guide pin for slidably guiding the movements of said inner valve, said inner valve having a centrally disposed hub extending therefrom, a spring in said housing for urging said inner valve toward seated position, said outer valve being slidably disposed upon the hub portion of the inner valve and having an extending portion for engaging the inner valve so that both valves are unseated as a unit when the inner valve is lifted, an auxiliary spring acting in series relation with the first mentioned spring to seat said outer valve which may be unseated by the pressure of fuel applied under pressure into the inlet port, as from a manual pump, for by-passing fuel through said housing at times when the pump is not operating, a pressure responsive actuator exposed to the discharge pressure in the outlet and connected to said inner valve for lifting both valves to open positions for returning fuel to the inlet port to regulate the pressure of fuel delivered by the pump.

11. In an aircraft fuel pump the combination

of, a casing having a fuel inlet port and a fuel outlet port, a pump disposed in said casing for transferring fluid through the casing from the inlet port to the outlet port, said casing having a passageway through which fluid may be transferred independently of the action of the pump, pressure balanced valve means in said passageway for regulating the flow of fluid therethrough, a flexible diaphragm mounted in said casing so that the pump discharge pressure from the outlet port is applied on one side of the diaphragm, said diaphragm being connected to said pressure balanced valve means for opening the valve means when the pump outlet pressure exceeds a maximum value, a cover for enclosing the opposite side of the diaphragm, a spring for applying a predetermined biasing force tending to close said valve means against the tendency of the outlet pressure to open the valve means, a vent in said cover for applying any desired pressure and so that when the pump is used in a super-charged installation the super-charger pressure on the pumped fuel may be compensat-

ed for by also applying it on said other side of the diaphragm.

12. In a fuel pump the combination of, a casing having a fuel inlet port and a fuel outlet port, a pump within the casing for moving fluid through the casing from the inlet port to the outlet port, a passageway in said casing through which fluid may be transferred between said ports in shunt relation around said pump, a valve in said passageway for regulating the flow of fluid therethrough, said valve having a hub, an aperture extending axially through the hub of said valve, said aperture being of circular cross-section, means in one end of said aperture for guiding the movements of the valve, an annular recess in the side wall of said aperture adjacent the other end thereof, a flexible diaphragm mounted in said casing for exposure to outlet port pressures, connecting means projecting from said diaphragm into said aperture, and means extending into said annular recess in said aperture for securing said connecting means therein.

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