

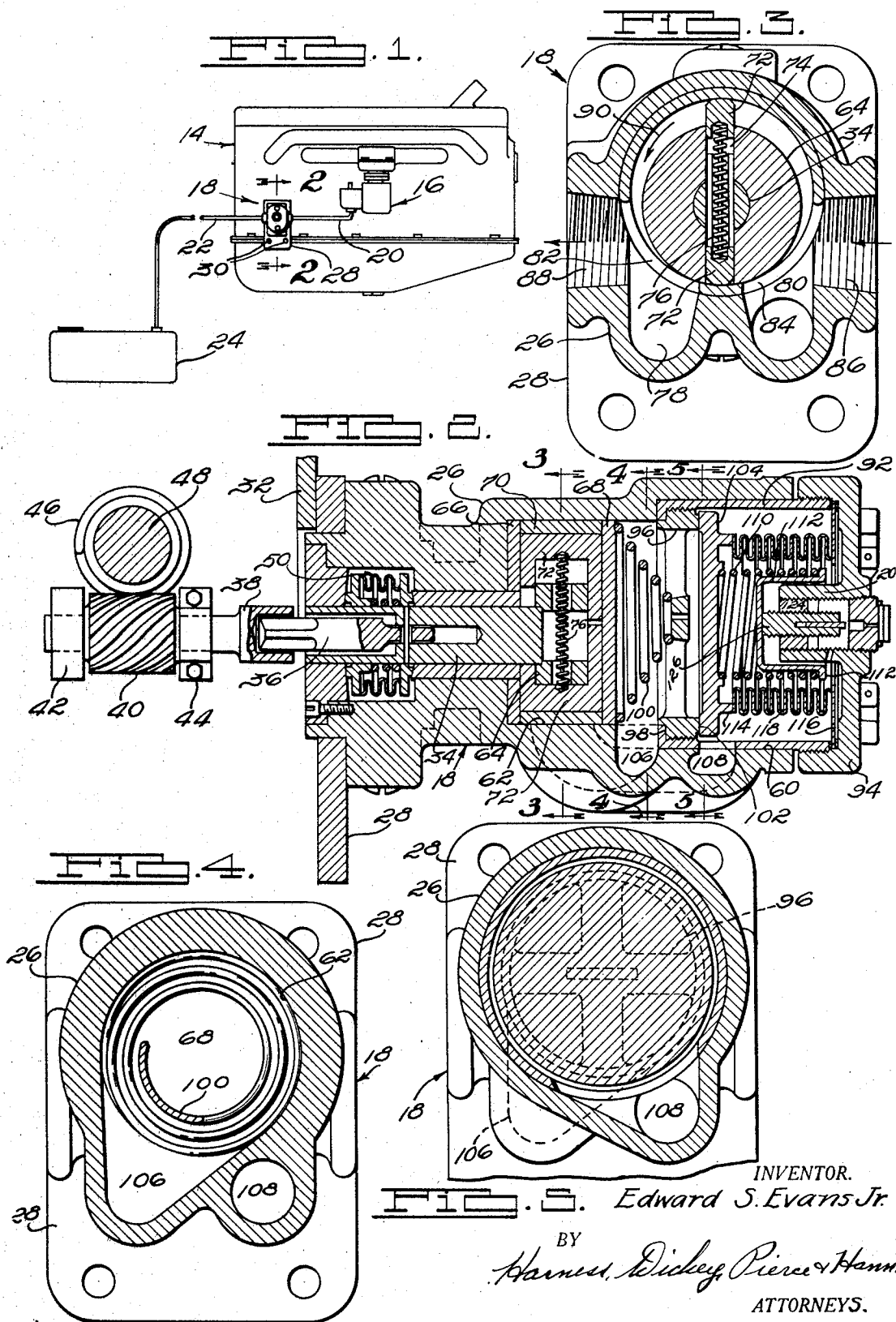
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PUMPING MECHANISM

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PUMPING MECHANISM

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This invention relates to pumping mechanism and particularly to one of the positive displacement type in which the discharge pressure of the pumping mechanism will be maintained at a constant value regardless of the variation in suction head against which the pump must draw its supply from a reservoir.

Objects of the invention include the provision of a pump structure provided with a bypass between the inlet and outlet sides thereof and spring controlled valve means in the bypass for limiting the discharge pressure of the pump, said means being so constructed and arranged as to eliminate, to a greater or lesser extent, the effects thereon of subatmospheric pressure at the suction side of the pump; the provision of a pump structure having a novel form of bypass control valve built into it and so constructed and arranged as to be substantially unaffected by variation in the pressures on the suction side of said pump; the provision of a pump structure including a spring pressed bypass valve built into it between the inlet and outlet sides thereof and which valve is so constructed and arranged as to substantially eliminate the effect of varying pressures on the suction side of the pump; the provision of a liquid pump including a casing having a bypass therein between the inlet and the outlet sides thereof and a spring pressed valve in the bypass to limit the pressure capable of being built up in the outlet side of the pump, the bypass valve having a bellows associated with the suction face thereof whereby to materially reduce the area of said suction face exposed to the suction pressure in said pump; and the provision of a fuel pump structure particularly applicable for aircraft use and embodying a bypass relief valve structure of new and novel design.

The above being among the objects of the present invention the same consists in certain novel features of construction and combinations of parts to be hereinafter described with reference to the accompanying drawing, and then claimed, having the above and other objects in view.

In the accompanying drawing which illustrates a suitable embodiment of the present invention and in which like numerals refer to like parts throughout the several different views,

Fig. 1 is a more or less diagrammatic side elevational view illustrating an internal combustion engine provided with a carburetor, a fuel pump driven from the engine and connected with the carburetor, and a fuel reservoir or tank connected with the inlet side of the pump.

Fig. 2 is an enlarged vertical sectional view

taken axially through the pump indicated in Fig. 1 as on the line 2—2 thereof, the view also including a portion of the wall of the crank case of the engine indicated in Fig. 1 and certain other parts indicating the method of driving the pump from the engine.

Fig. 3 is a vertical sectional view taken transversely of the axis of the pump as on the line 3—3 of Fig. 2.

Figs. 4 and 5 are transverse sectional view taken on the lines 4—4 and 5—5 respectively of Fig. 2.

It has been common practice in connection with positive displacement types of fluid pumps, particularly where such pumps are employed for instance to deliver a supply of fuel or lubricant to an internal combustion engine, to provide a bypass between the inlet and the outlet sides of the pump and to position a check valve in the bypass to permit liquid to flow therethrough only in the direction from the outlet side toward the inlet side. This check valve is backed up with a spring of suitable size and proportion such that when the differential of pressure existing between the inlet and outlet sides of the pump exceeds a predetermined value the check valve will open against the force of the spring and permit liquid to flow through the bypass and thereby limit the amount of differential pressure between opposite sides of the pump. Ordinarily, such a spring pressed valve in a bypass limits the maximum pressure which is capable of being produced on the outlet side of the pump and this is the primary reason why such valves are provided. The reason why such valves ordinarily control the maximum pressure thus built up is that ordinarily such pumps have a constant suction head against which they must operate, and in such case a simple spring pressed valve is quite adequate for the purpose of closely regulating the maximum pressure. However, it will be apparent that where the suction head against which the pump must operate is liable to vary over a considerable range, the maximum pressure produced at the outlet side of the pump will likewise be varied for the reason that it is the differential of pressures between the inlet and outlet sides of the pump, rather than the pressure on the outlet side of the pump, that governs the opening of the spring pressed check valve. This variation in the maximum pressure developed on the pressure side of the pump caused by varying the head of liquid against which the pump must draw its supply becomes particularly disadvantageous where such pumps are employed in connection with aircraft wherein the angle of incidence of

the plane may cause the suction head on the pump to vary between materially different values, and in view of the fact that when the angle of incidence of the airplane is increased during a climb the suction head against which the pump must operate is simultaneously increased, the pressure on the fuel at the discharge side of the pump is decreased at the very time that a maximum supply of fuel is required. Conversely, the pressure of the fuel on the discharge side of the pump will be increased when the plane is descending and at a time where a maximum pressure on the fuel is of considerably lesser importance.

It will, of course, be understood that the effect of variation of the suction on the pump of the type described is of major importance only in those cases where the pressure of the liquid on the discharge side of the pump is limited to a relatively small value such, for instance, as ten pounds to the square inch or less, as where the pump is employed for delivering fuel to the carburetor of an internal combustion engine, as in such cases a variation of a few ounces in pressure of the fuel on the discharge side of the pump may have a very definite effect on the proper carburetion of the engine, particularly where the carburetor may be of the floatless type.

The embodiment of the present invention disclosed in the drawing is in the form of a pump particularly designed to deliver fuel to the engine of an airplane and includes a bypass passage between the inlet and outlet sides of the pump provided with a spring pressed check valve in the same general manner as above described. In accordance with the present invention, however, the check valve is so constructed and arranged that the effect of variations of the suction head on the pump on the operation of the valve may be eliminated entirely or minimized to any desired degree.

Referring to the drawing and particularly to Fig. 1, an internal combustion engine is indicated generally at 14 as being equipped with a carburetor indicated generally as at 16 which may be either of the float or floatless type, and a fuel pump indicated generally as at 18 suitably secured to and driven from the engine 14 in a manner which will hereinafter be more fully described. The discharge side of the pump 18 is connected by a suitable fuel line 20 to the carburetor 16. A fuel inlet pipe or tube 22 connected to the inlet side of the pump 18 extends to a suitable fuel reservoir indicated in the present case as the tank 24. It will be understood that the advantages of the present invention become apparent when the assembly indicated in Fig. 1 or its equivalents are so arranged that the effective vertical distance separating the pump 18 and tank 24, and constituting the suction head against which the pump 18 must operate, is liable to materially vary in service.

Referring now particularly to Fig. 2, the pump 18 will be seen to comprise a casing 26 provided at one end thereof with a flange member 28 suitably piloted thereon and secured thereto and through which suitable screws 30 (see Fig. 1) project into threaded relation with respect to the wall 32 of the engine crank case in order to secure the pump 18 in fixed relation with respect to the engine. The casing 18 is centrally provided at its left hand end as viewed in Fig. 2 with a suitably supported drive shaft 34 which is connected by a suitable stub shaft 36 to the shaft 38 of a gear element 40 suitably supported by

bearings 42 and 44 within the crank case of the engine 14 and which gear element 40 lies in mesh with a cooperating gear element 46 suitably formed or mounted on a rotating element of the engine as, for instance, a cam shaft 48. Within the casing 26 a suitable sealing assembly indicated generally as at 50 cooperates with the drive shaft 34 to prevent leakage of fuel from the pump along the axis of the shaft 34. The particular arrangement and construction of driving parts between the shaft 34 and the gear element 36, and of the sealing assembly 50 forms no part of the present invention and, except for noting that rotation of the shaft 48 causes corresponding rotation of the drive shaft 34, no further mention of these parts will be required.

The right hand end of the casing 26 for the pump 18 is of open construction and internally formed to provide a cylindrical chamber 60 therein which is joined at its left hand end with a 20 smaller cylindrical chamber 62 formed within the casing 26. These chambers 60 and 62 are concentric with each other but eccentric to and axially parallel with the shaft 34. The pump rotor 64 is non-rotatably secured to the drive shaft 34 25 within the chamber 62. Because of the fact in the construction shown the casing 26 is considered to be formed of aluminum or other light metal, wear plates 66 and 68 of suitable metal such as cast iron or steel are provided at either 30 end of the rotor 64 and a wear ring 70 is pressed into the housing 26 between the plates 66 and 68 and around the rotor 64.

As illustrated in Fig. 3, the pump rotor 64 is of circular formation and secured in concentric relation with respect to the shaft 34 and is of such diameter that it has substantial line contact at one side with the inner periphery of the wear ring 70 and is spaced therefrom at the opposite side. Further, it is of a thickness to substantially 40 contact simultaneously with both wear plates 66 and 68. A pair of blades or vanes 72 positioned in opposed relation within a diametric slot 74 in the rotor 64 and shaft 34 are constantly pressed outwardly into contact with the inner periphery 45 of the wear ring 70 by means of a spring 76 in accordance with well known practice in pumps of the particular type shown.

As also best indicated in Fig. 3, the housing 26 in transverse alignment with the pump rotor 64 is 50 provided with a pair of separate passages 78 and 80, respectively, which communicate through suitable openings 82 and 84, respectively, in the wear ring 70, with the interior of the pump chamber on opposite sides of the line of contact of the pump rotor 64 with the inner wall of the wear ring 70. The pocket 80 is in open communication 55 with a threaded fuel inlet passage 86 leading to an exterior face of the pump casing 26 and adapted to receive the end of the tube 22 therein, and the pocket 78 is in open communication with the threaded discharge passage 88 in which the end of the tube 20 is adapted to be received. As will be apparent to those familiar with this type of pump, rotation of the rotor 64 in the direction of 65 the arrow 90 indicated in Fig. 3 will cause fuel to be drawn into the pump through the passage 86 into the pump chamber around the rotor 64 and will be forced by the blades or vanes 72 around the rotor in the direction of the arrow 90 70 and out of the pump chamber through the port 82 to the discharge passage 88.

The chamber 60 is lined with a cylindrical shell 92 of relatively hard metal such as cast iron, steel or the like which is firmly pressed into 75

position against the shoulder formed at the junction between the chambers 60 and 62. When in position the outer end of the shell 92 projects outwardly beyond the right hand end of the casing 26 and such projecting end is externally threaded for reception of the cap member 94. A spider member 96 is threaded into the inner end of the sleeve 92 and into abutting relationship with respect to the inwardly turned flange 98 at its inner end. A helical spring 100 is maintained under compression between the center of the spider 96 and the wear plate 68 and constantly urges the wear plate into its normally operative position. The right hand axial face of the rim of the spider 96, as viewed in Fig. 2, is formed to provide a valve seat 102 against which a valve 104 is adapted to seat. The valve 104 thus normally seals the space in the sleeve 92 to the right thereof as viewed in Fig. 2 from the communicating spaces to the left thereof within the sleeve 92 and chamber 62. These latter spaces to the left of the valve 104, as viewed in Fig. 2, communicate with the pocket 78 on the discharge side of the pump through a suitable passage 106 cored in the casing 26. The space within the sleeve 92 to the right of the valve 104, as viewed in Fig. 2, communicates through a suitable passage 108 cored in the casing 26 with the pocket 80 communicating with the inlet side of the pump. The valve 104 is constantly urged toward the seat 102 by means of a coil spring 110 maintained under compression between the valve 104 and a suitable stop member 112 carried by the cap 94, which will hereinafter be more fully described.

It will be apparent that the construction thus far described is the equivalent of certain conventional constructions previously referred to in that the inlet and discharge sides of the pump are connected by a bypass extending around the pump chamber and containing a spring pressed check valve (104) permitting flow of fluid through the bypass in the direction of the discharge side toward the inlet side only, and that unless otherwise provided against the valve would open against its cooperating spring upon a predetermined differential of pressures simultaneously existing at the inlet and outlet sides of the pump. Unless otherwise guarded against, the valve 104 would open and thus limit the maximum pressure capable of being built up on the discharge side of the pump upon a predetermined differential of pressures existing between the inlet and outlet sides, and as previously described such differential of pressures would necessarily vary in accordance with variations of the suction head on the pump regardless of a predetermined pressure on the discharge side of the pump which it is desired to maintain. Accordingly, the following described mechanism is provided for limiting the effect of the suction pressure on the pump on the opening of the valve 104. This is accomplished by sealing off from the effects of the suction head on the pump as much of the area of the suction face of the valve 104 as is necessary to obtain the desired result. As will hereinafter be apparent, all of the suction face of the valve 104 may, by this construction, be sealed from the effects of the suction head on the pump, but in some cases it is desirable to have a small area of the suction face of the valve exposed to the suction head of the pump and the embodiment of the present invention shown is constructed to permit this. Obviously,

the area thus exposed may be varied in the design of the pump to obtain any effect desired.

Referring now to Fig. 2, it will be noted that the valve 104 adjacent its periphery and on the suction face thereof is provided with an annular axially extending flange 114. It will also be observed that an annular plate 116 is clamped and sealed between the right hand end of the sleeve member 92 and the inner wall of the cap 94 and that a metal bellows 118 is sealed at opposite ends to the flange 114 and plate 116 respectively. By this means the area of the valve 104 within the flange 114 is sealed from the effects of the suction head of the pump as transmitted through the passage 108, and the area of the valve 104 exposed to the effects of the suction head on the pump tending to lift it from its seat is that area thereof radially outwardly spaced from the flange 114 and which in the present case constitutes a small proportion only of the total area of the suction face of the valve 104. Consequently, in view of the fact that the bellows 118 limits the effects of the suction head on the pump to a relatively insignificant area of the suction face of the valve 104, such suction head on the pump can have but little and relatively inconsequential effect on the pressure at which the valve will open. Accordingly, by this means the discharge pressure on the pump is to all intents and purposes the sole governing factor in controlling the opening of the valve 104 against the force of the spring 110 and, accordingly, may be kept at a predetermined maximum value regardless of any variations in the suction head on the pump, thus obviating the disadvantages of conventional constructions in this respect.

In order to provide adjustment for varying the maximum pressure capable of being built up by the pump to suit various conditions of installation and service, the cover 94 is provided with an inwardly projecting hollow boss 120 which is encompassed by the stop member 112 for the spring 110. A plug 124 threaded into the interior of the boss 120 threadably receives in turn a threaded plug 126 which is adapted to control the axial position of the stop member 112 and therefore the tension of the spring 110 which controls the maximum pressure capable of being built up on the discharge side of the pump. Suitable means shown but not described are provided for locking the plug 126 in axially adjusted position.

Formal changes may be made in the specific embodiment of the invention described without departing from the spirit or substance of the broad invention, the scope of which is commensurate with the appended claims.

What I claim is:

1. In a pump mechanism, in combination, a hollow casing open at one end, a pump rotor in one end of the interior of said hollow casing, means for driving said rotor, a movable wall associated with one end of said rotor whereby to form that portion of the interior casing in which said rotor is positioned into a pumping chamber, and that portion of the interior of said hollow casing outwardly of said member into a valve chamber, said casing having inlet and outlet passages connecting with said pump chamber and an additional pair of passages connecting said inlet and said outlet with said valve chamber at points therein spaced from each other axially of said pump element, a spider sealed to the walls of said valve chamber intermediate its points of connection with said additional pair of passages, spring means maintained under com-

pression between said spider and said movable wall to maintain said movable wall in operative position, said spider being formed to provide a valve seat, a valve adapted to engage said seat, 5 spring means constantly urging said valve toward seated position, a cap removably associated with the open end of said casing, and a metal bellows connected at opposite ends to said valve and cap respectively and sealing off a material 10 area of the corresponding face of said valve from the effects of pressure existing in the corresponding portion of said valve chamber.

2. In a pump structure of the type adapted to supply fuel to the fuel supply line of an airplane 15 having an engine and a fuel supply tank in which the position of these parts is such that the vertical distance separating the pump and tank is subject to material variations due to changing the angle of incidence of the airplane, the combination of a hollow casing open at one end, a 20 driven pump rotor in the casing, a movable wall associated with one end of the rotor forming one portion of the casing into a pump chamber and another portion into a valve chamber, said casing 25 having an inlet and an outlet communicating with the pump chamber, a cap for the open end of the casing, said casing having a passage connecting said valve chamber with said outlet and a second passage connecting said inlet with 30 said valve chamber at a point spaced axially of said casing from its point of connection with the first mentioned passage, a valve seat between the points of connection of said passages and said valve chamber, a substantially flat substantially 35 unguided valve seating on said valve seat, spring means constantly urging said valve toward seated position, and a bellows closed at one end by said valve and at the opposite end by said cap whereby to prevent variations in the suction head on said 40 pump caused by changes in said angle of incidence from affecting said valve and accordingly the discharge pressure of said pump.

3. In a pump mechanism, in combination, a hollow casing open at one end, a pump rotor in one end of the interior of said hollow casing, means for driving said rotor, a movable wall associated with one end of said rotor whereby to 5 form that portion of the interior casing in which said rotor is positioned into a pumping chamber, and that portion of the interior of said hollow casing outwardly of said member into a valve 10 chamber, said casing having inlet and outlet passages connecting said pump chamber and an additional pair of passages connecting said inlet and said outlet with said valve chamber at points therein spaced from each other axially of said 15 pump element, a cylindrical shell lining the interior of the valve chamber, communicating with said pair of passages, projecting beyond the open end of the casing and threaded externally, a spider member threaded into the inner end of said shell intermediate its point of connection 20 with said additional pair of passages, spring means maintained under compression between said spider and said movable wall to maintain said movable wall in operative position, said spider being formed to provide a valve seat, a 25 valve engaging said seat, spring means constantly urging said valve toward seated position, a screw cap threadedly engaging the outer end of the cylindrical shell, a metal bellows connected at opposite ends to said valve and cap respectively and 30 sealing off a material area of the corresponding face of said valve from the effects of pressure existing in the corresponding portion of said valve chamber whereby to eliminate variations in the suction head on said pump from affecting 35 the discharge pressure of said pump as governed by said valve, and means for regulating the tension of said spring means on said valve whereby the maximum pressure capable of being built up on the discharge side of the pump may be controlled. 40

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