

April 30, 1940.

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2,198,722

PUMP

Filed Nov. 17, 1936

3 Sheets-Sheet 1

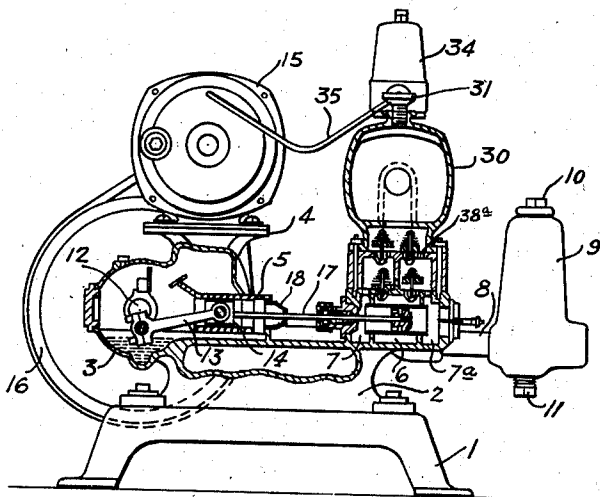


Fig. 1.

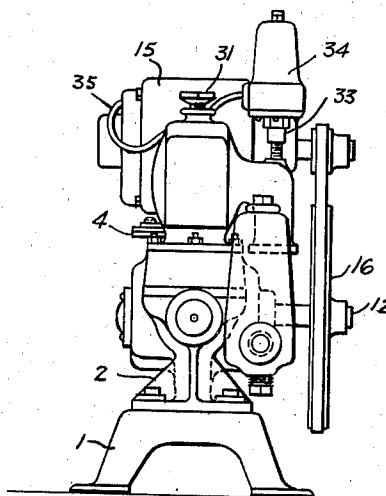


Fig. 2

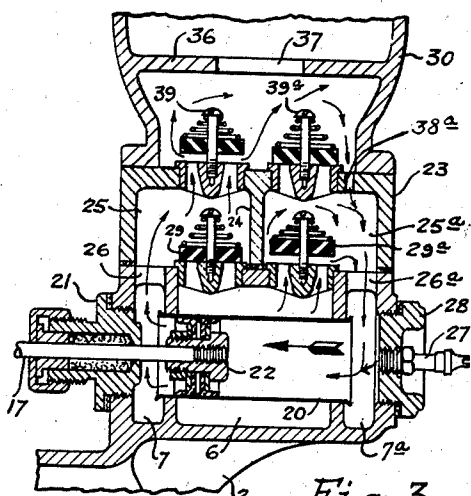


Fig. 3

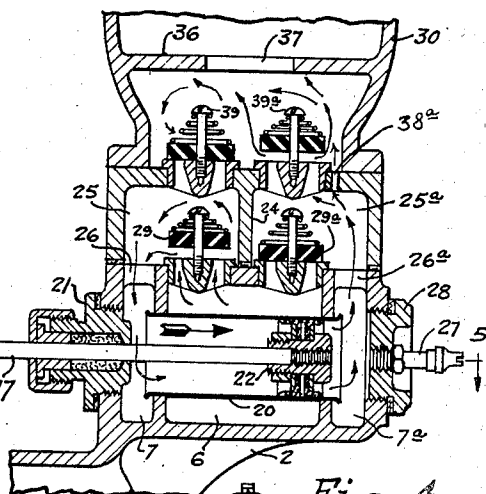


Fig. 4

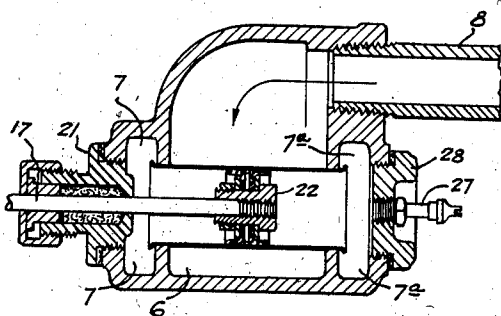


Fig. 5

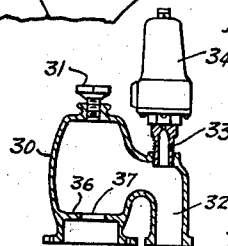


Fig. 6

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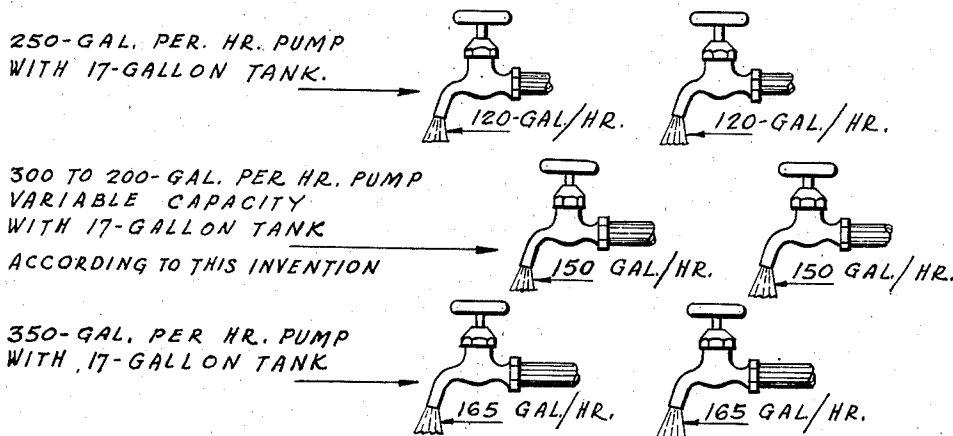
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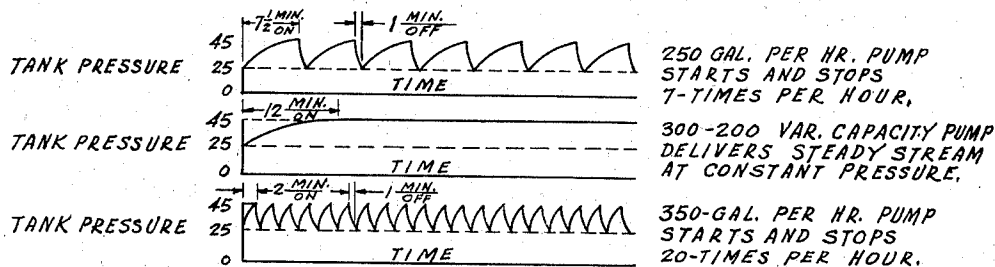
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3 Sheets-Sheet 3

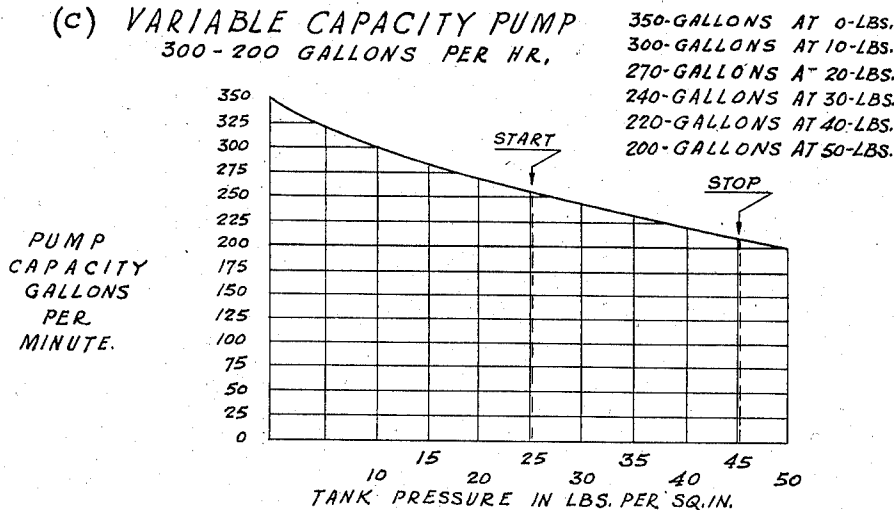
Fig. 11 (a) RELATIVE DISCHARGE OF TWO FAUCETS WITH VARIOUS PUMP SYSTEMS



(b) OPERATION OF VARIOUS PUMP SYSTEMS MOUNTED ON A 17-GALLON TANK EACH THROTTLED TO DELIVER 210-GALLONS PER HOUR AT THE SERVICE FAUCET.



(c) VARIABLE CAPACITY PUMP 300-200 GALLONS PER HR.



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Application November 17, 1936, Serial No. 111,265

6 Claims. (Cl. 103—37)

This invention relates to a variable delivery pump.

It is an object of this invention to provide a constant speed variable delivery pump.

It is a further object of this invention to provide a pump wherein the capacity is varied directly by the pressure in the tank and indirectly by the quantity of fluid in the tank.

It is a further object of this invention to provide such a pump wherein starting and stopping is reduced to a minimum and wherein there is a constant pressure on the delivery end of the pump irrespective of the variation in the quantity of fluid supplied by the pump.

It is a further object of this invention to provide by-pass means between the pressure chamber and the air chamber.

It is a further object of this invention to provide such by-pass means as will connect the air chamber and one of the pressure chambers of a double acting pump having two chambers.

It is a further object of this invention to provide such by-pass means as will connect the air chamber with one of the pressure chambers of the double acting pump having two such chambers and to provide pressure responsive means between the air chamber and the other pressure chamber which will vary the capacity of the air chamber during the operation of the pump.

It is a further object of this invention to provide such means which will vary the fluid delivery inversely with the delivery pressure.

It is a further object of this invention to provide pressure responsive means between the air chamber and both pressure chambers in order to vary the capacity of the air chamber of a double acting pump having two pressure chambers.

It is a further object of this invention to provide such means which will periodically vary the capacity of the pump, which means is responsive to the pressure differential between the air chamber pressure and the respective pressure chamber pressures in order to vary the fluid delivery of the pump inversely with the delivery pressure.

It is a further object to provide means whereby a part of the fluid from a pressure chamber to the air chamber is by-passed to the other pressure chamber and the return of this by-passed fluid is controlled or varied according to the amount of air pressure in the air chamber whereby, when the pressure in the air chamber is decreased, the amount of this by-passed fluid is decreased and vice versa.

It is a further object of this invention to provide means for varying the capacity of the air

chamber directly with the pressure at the pump delivery whereby the quantity of fluid delivered by the pump will be varied inversely with the pressure at the pump delivery.

It is a further object of this invention to provide a pump wherein the amount of fluid returned from the air chamber to the pressure chamber on the suction stroke varies according to the pressure in the tank.

It is a further object of this invention to provide a pump adapted for constant operation during delivery with a minimum of starting and stopping and with a wide range of supply without starting or stopping and a high gallonage of delivery per hour per horsepower.

It is a further object of this invention to provide an air cushion, a combined air and water cushion and means of relieving the fluid pressure delivery and the starting and stopping operations with a consequent saving on the pump and motor.

These and other advantages will appear from the following description taken in connection with the drawings.

In the drawings:

Figure 1 is a side elevational view, partly broken away, of a pump according to my invention;

Figure 2 is an end elevational view of the pump shown in Figure 1;

Figure 3 is a fragmentary sectional view of the structure shown in Figure 1, with the parts in one position;

Figure 4 is a similar view with the parts in another position;

Figure 5 is a plan sectional view taken along the line 5—5 of Figure 4;

Figure 6 is a sectional view of the air chamber of the pump showing the attached pressure switch partly in section;

Figure 7 is a fragmentary sectional view similar to Figure 3, but showing a modified form of my invention;

Figure 8 is a view similar to Figure 7, but showing the parts in another position;

Figure 9 is a fragmentary sectional view similar to Figures 3 and 7, but of a second modified form of my invention;

Figure 10 is a view similar to Figure 9, but showing the parts in another position; and

Figure 11 is a diagrammatic view showing at (a) the relative discharge of two faucets with various pump systems, in one of which this invention is incorporated, at (b) showing the operation of various pump systems throttled to de-

liver 210 gallons per hour, in graphic form, and at (c) showing, in graphic form, the operating characteristics of the pump of my invention with relation to pump capacity in gallons per minute and tank pressure in pounds per square inch, wherein the pressure switch is so regulated as to stop operation of the pump when the tank pressure reaches 45 pounds per square inch and to again start the pump when the tank pressure has been reduced to 25 pounds per square inch.

Referring to the drawings in detail, and in particular to Figures 1 and 2, 1 designates a pump sub-base upon which is secured a pump casting 2, in which is integrally formed at one end thereof of crankcase 3, motor platform 4 and crosshead guide cylinder 5. At the other end of the casting, integrally formed therein, is a suction inlet chamber 6 having a pair of intermediate chambers 7 and 7a disposed at opposite sides thereof. Provision is made for the attachment of suction inlet 8 at one side of the suction chamber 6. The suction inlet is also attached to a primer vacuum chamber 9 which is equipped with suitable interior suction strainer screen (not shown) and at the top with a priming plug 10 and at the bottom with a clean-out plug 11.

Suitable bearings are provided in the crankcase portion of the casting 2 for support of crankshaft 12 which is operatively connected by means of connecting rod 13 to the crosshead 14 which is mounted for reciprocation in the crosshead guide cylinder 5. Disposed on the motor platform 4 is a motor 15 or other suitable prime mover 15, which is operatively connected to the pulley 16 which is rigidly attached at one end of the crankshaft 12. By this means the crosshead 14 is caused to reciprocate in the crosshead guide cylinder 5 during operation of the prime mover.

Attached at one end to the crosshead 14 and disposed axially thereof is the piston rod 17, which passes through a fluid deflector 18 at the end of the crosshead guide cylinder 5, which deflector prevents the entry of fluid on the piston rod 17 into the crosshead guide cylinder 5 and thence to the crankcase. Extending across the suction chamber 6 is an open ended cylinder 20 which has its opposite ends opening into the respective intermediate chambers 7 and 7a. A stuffing box 21 is threadedly attached to the outer wall of the intermediate chamber 7 and the piston rod 17 which is axially disposed with respect to the stuffing box 21 and the cylinder 20 extends through the stuffing box and has the piston assembly 22, which is adapted to reciprocate in the cylinder 20, attached to the threaded end thereof. The casting 2 terminates above the suction chamber 6 and intermediate chambers 7 and 7a in a flat wall, to which is attached the casting 23 forming the pressure chamber as a whole, which is divided into two parts or pressure chambers 25 and 25a respectively by the dividing wall 24. The pressure chamber 25 is connected by means of port 26 with the intermediate chamber 7 and the pressure chamber 25a is connected by means of port 26a with intermediate chamber 7a. A piston plug 28 equipped with a "Schrader" valve 27 and of a diameter suitable to provide easy access to the cylinder and piston assembly is threaded into the outer wall of the intermediate chamber 7a. The pressure chamber 25 is connected by means of suction valve assembly 29 with the suction chamber 6. The pressure chamber 25a is connected by means of suction valve assembly 29a with the suction chamber 6. The casting 23 has a top wall upon

which is suitably secured a casting forming an air chamber 30 having a priming plug 31 screw-threadedly attached at the top thereof and having a delivery outlet 32 offset therefrom, which is adapted to be connected to a conventional tank in a fluid system in which the pump is connected.

Screw-threaded in the air chamber 30 and disposed above the outlet 32 is a choker nipple 33 which supports a conventional pressure switch 34, which is connected by means of cable 35 with motor 15 and which responds to pressure in the air chamber to stop and start the motor 15 in a known manner. The interior of the air chamber 30 is equipped with a horizontal wall 36 having a constricted port 37 therein. The air chamber 30 is connected to the pressure chamber 25 by means of discharge valve assembly 39. The air chamber 30 is connected to the pressure chamber 25a by means of discharge valve assembly 39a and by-pass orifice 38a.

The valve assemblies 29, 29a, 39 and 39a are identical comprising apertured plates cooperating with resilient valve plate members resiliently urged thereagainst by means of springs, the resilient valve plates being guided by vertical posts attached at one end to the apertured plates and having the upper headed end thereof adapted for abutment with the upper end of the spring which has its lower end in contact with the resilient valve plate. Suitable gaskets are provided between the air chamber and the casting 23 and between the casting 23 and the casting 2 as well as between the stuffing box 21 and the latter casting and between the piston plug 28 and the latter casting so that the escape of fluid at all joints is effectively prevented.

The suction chamber is connected through the primer vacuum chamber 9 to a source of fluid supply and fluid is pumped from the suction chamber 6 through the suction valves 29 and 29a to the pressure chambers 25 and 25a and thence through orifice 38a and discharge valves 39 and 39a to the air chamber 30 and thence through outlet 32 to a suitable tank or, if desired, directly to the fluid system. While an electric motor is shown and described as the prime mover, it is, of course, to be understood that the principles of my invention may be practiced by the use of other desired prime movers and that the principles thereof may be incorporated in pumps of other constructions than that shown and described, the constructions of which may vary widely and it is, therefore, to be understood that the description and illustration of the particular pump is made for purpose of illustration only and is in no wise to be considered as limiting.

Operation

With reference particularly to Figures 3, 4 and 5, illustrating the first embodiment of my invention, it will be seen that fluid enters the suction chamber 6 from the suction inlet 8 and from thence the path of the fluid is as follows: when the piston is moving toward the left in the cylinder 20, as shown by the arrow in Figure 3, compression is placed upon the fluid in intermediate chamber 7 and it travels thence through pressure chamber 25 and through discharge valve 39 which is opened by the fluid into the air chamber 30, whence the main part of the fluid is discharged through outlet 32, a part thereof passing through the by-pass orifice 38a to the chamber 25a which is then under suction. The amount of this fluid passing through by-pass orifice 38a

varies directly with the difference in pressure between the air chamber 30 and the chamber 25a. Simultaneously, fluid is drawn into chamber 25a through suction valve 29a because of the suction in intermediate chamber 7a caused by the leftward movement of the piston in the cylinder 20.

When the piston is traveling in the reverse or rightward direction, as indicated by the arrow in Figure 4, compression is placed upon the fluid in chamber 7a and in pressure chamber 25a and the fluid flows from chamber 25a into the air chamber 30 through valve 39a and also through the by-pass orifice 38a. The by-pass orifice, on this stroke of the pump, thus aids the valve 39a.

The pressure in the air chamber 30 is equal to the pressure in the tank to which the outlet 32 is connected. The pressure switch 34 is responsive to this pressure. As will be clear from the above description of the operation, the difference between the pressure in the air chamber 30 and the pressure in the chamber 25a, during leftward travel of the piston in cylinder 20, determines how much fluid will be returned from the air chamber 30 through the by-pass orifice 38a during operation of the pump. Thus, when the pressure in the air chamber 30 is relatively low, the proportion of the fluid pumped from a pressure chamber to the air chamber on a particular leftward piston stroke will be greater than when the pressure is relatively higher. The effectiveness of the by-pass orifice to reduce the rate of delivery varies, therefore, directly with the pressure in the air chamber 30. Thus it will be seen that, when a relatively large quantity of fluid is being drawn from the tank, the pressure in the air chamber will be correspondingly reduced and a relatively greater proportion of the total fluid pumped per stroke from the pressure chamber to the air chamber will flow out through the delivery outlet 32. Likewise, when a relatively small quantity of fluid is being drawn from a system, the reduction in pressure in the air chamber will be correspondingly less and a correspondingly smaller proportion of the fluid pumped per piston stroke from the pressure chambers to the air chamber will flow through the outlet 32.

As shown at (a) in Figure 11, the flow between two faucets in a comparison of various systems shows that a 300 to 200-gallon per hour pump of variable capacity, due to the application of this invention thereto, will deliver 150 gallons per hour to each of the two faucets, while a 250-gallon per hour pump, in which the practice of this invention is not followed, will pump only 120 gallons per hour to each of the two faucets, and further a 350-gallon per hour pump, which is not equipped for the practice of this invention, will deliver only 165 gallons per hour to each of the two faucets, which amounts to a mere fifteen gallons per hour more of capacity per faucet over the capacity of the smaller 300 to 200-gallon per hour pump, variable capacity, as equipped according to this invention. It will thus be clear that the capacity of the pumps is materially increased by the application of the principles of this invention thereto.

As shown at (b) in Figure 11, wherein the operation of the various pump systems, each throttled to deliver 210 gallons per hour at the service faucet, is graphically represented, a 250-gallon per hour pump starts and stops seven times per hour and in each of these cycles runs for seven minutes and stops for one minute, while a 300 to 200-gallon per hour variable capacity pump,

in which are incorporated the principles of this invention, delivers a steady stream of fluid at constant pressure. A 350-gallon per hour pump would start and stop twenty times per hour and in each cycle would run for two minutes and stop for one minute.

At (c) is illustrated the operating characteristics of a variable capacity pump of 300 to 200 gallons per hour capacity, in which is incorporated this invention. It will be noted that, when the tank pressure is zero, the capacity is 350 gallons per hour, that when the tank pressure is ten pounds per square inch, the capacity is 300 gallons per hour, that when it is twenty-five pounds per square inch, the capacity is 260 gallons per hour and that when the tank pressure is forty-five pounds per square inch, the capacity is 210 gallons per hour, and that when the tank pressure in pounds per square inch is fifty, the capacity of the pump is 200 gallons per hour. As indicated in the graph in dotted lines, the pressure switch is preferably so adjusted that, when the pressure in the tank drops to twenty-five pounds per square inch, the pump will be started and will continue to run until the tank pressure reaches forty-five pounds per square inch, when the switch will shut off the pump.

It will thus clearly appear that, besides producing a variable capacity in a constant speed pump, I have produced a new method of operation, by which the starting and stopping of the pump is reduced to the minimum which amounts to a great saving in power consumed and in wear upon the respective parts due to the well recognized fact that frequent starting and stopping produces a relatively greater amount of wear than does uniform operation. It will further clearly appear that by the incorporation of the principles of this invention in a pump, the capacity thereof will be substantially increased whereby a smaller pump may be used for a predetermined load than has hitherto been possible and likewise a more economical operation may be achieved due to the fact that a smaller prime mover will be necessary than otherwise.

In Figures 7 and 8, I have illustrated a modified form of my invention, in which the structure is similar to that of the modification disclosed in Figures 1 to 5 inclusive, save, that in addition to the by-pass orifice 38a, which is interposed between the air chamber 30 and the pressure chamber 25a, I have utilized a diaphragm mechanism, generally designated 40, which is interposed between the air chamber and the pressure chamber for the purpose of modifying the effect of the above described by-pass orifice 38a.

The diaphragm mechanism, as disclosed, comprises an externally threaded cylindrical body portion 41 which is threaded into the top wall casting 23 to communicate with both the pressure chamber 25 and the air chamber 30. At each end of the body portion 41 is attached a cap member 42 which is provided at its inner side with a guide adapted to engage and support one end of a coil spring. The cap members 42 are provided with centrally arranged apertures, by means of which communication of the respective cup washers 43, hereinafter described, with the air chamber and pressure chamber is achieved. The cup washers 43 are arranged for reciprocatory movement in the central bore of the body portion 41 and are separated by a metallic plate 44. The cup washers have their flanges disposed outwardly toward the opposite ends of the

body member 41. Between each of these cup washers 43 and the adjacent cap 42 is interposed a compression spring.

The lower of these compression springs is disposed at the end of the body portion opening into the chamber 25 and is designated 45; the other, or upper spring, is designated 45a. The upper spring 45a is substantially weaker than the lower spring 45 and is normally overbalanced by the lower spring 45, as shown in Figure 7. The cup washers and disk 44 are thus retained in the position shown in Figure 7 when the chamber 25 is under pressure and also when the difference in pressure between the air chamber 30 and the pressure chamber 25 is equal to, or less than, the difference in strength between the springs 45a and 45. In other words, whenever the sum of the fluid pressure and the spring pressure on the top cup washer 43 is less than or equal to the sum of the fluid pressure and the spring pressure on the lower cup washer 43, the parts remain in the position shown in Figure 7, whereby the effective volume or capacity of the chamber 30 is unchanged by the diaphragm 40.

The upper springs 45a are, in effect, merely shock absorbers and other means, such as a rubber stop or the like, may be substituted therefor. It will thus be seen that the springs 45a and 45 may be so balanced that the diaphragm will not act to increase the effective volume or capacity of the chamber 30 until a predetermined pressure is produced in the system (and in the air chamber 30, which is connected thereto). Other adjustments are, of course, comprehended by me in the practice of the principles of my invention.

As shown in Figure 7, when the pump piston is traveling to the left and the parts are in the position therein shown, fluid passes through the valve assembly 39 from the pressure chamber 25 to the air chamber 30, while a portion thereof, varying directly with the difference in pressure between the chambers 30 and 25, and varying directly with the pressure in the system and in the chamber 30, will pass through the by-pass orifice 38a from the chamber 30 to the chamber 25a. During this stroke, the capacities of the chambers are unmodified by the diaphragm 40.

As shown in Figure 8, in which the difference in pressure between the air chamber 30 and the pressure chamber 25 is taken as great enough to cause compression of spring 45, and in which the parts are in the position shown in Figure 4 and the piston is traveling to the right, the pressure chamber 25a is under compression, while the pressure chamber 25 is under suction. Fluid flows from the pressure chamber 25a through valve assembly 29a and through by-pass orifice 38a to the air chamber 30. The cup washers of the diaphragm 40 are depressed against pressure of the spring 45, whereby the volume of the air chamber 30 is increased and the volume of the pressure chamber 25 is decreased. Considered in another way, the diaphragm has then temporarily increased the pressure in the pressure chamber 25 and has decreased the pressure in the air chamber 30.

When desired, I may omit the orifice 38a between the air chamber 30 and the pressure chamber 25a, in which case the effect of the diaphragm 40 will be to increase the capacity or volume of the air chamber 30, when the pressure chamber 25 is under suction, while at the same time decreasing the amount of fluid entering the chamber 25 due to the temporary decrease in the permanent effective volume thereof. Likewise, when

the chamber 25 is under pressure, the diaphragm 40 will be ineffective to modify the capacities of the respective chambers.

Likewise, when desired I use, in addition to the diaphragm 40 interposed between the air chamber 30 and the pressure chamber 25, a similar diaphragm 40a similarly disposed between the air chamber 30 and the pressure chamber 25a, as shown in Figures 9 and 10. As shown diagrammatically in these figures, when the parts are in the position illustrated in Figure 9, and the pump piston is traveling to the left, the diaphragm 40 will be ineffective to decrease the pressure in the chamber 25, which is then under pressure, or to decrease the pressure in the air chamber 30, while the diaphragm 40a is simultaneously decreasing the pressure in the chamber 30 by increasing the effective volume or displacement thereof, while increasing the pressure, or decreasing the vacuum, in the chamber 25a which is then under suction by tending to decrease the volume or capacity thereof, whereby to decrease the amount of fluid drawn therein during the suction stroke. As shown in Figure 10, on the reverse stroke of the piston, the same action occurs, save that the functions of the respective diaphragms 40 and 40a are, in that case, reversed.

As explained above, in the description of the embodiment disclosed in Figures 7 and 8, as the mean effective pressure in the air chamber 30 increases upon increase of pressure in the pump system, the mean effective volume, displacement or capacity of the chambers 25 and 25a decreases. Thus, the mean effective capacities or volumes of the chambers 25 and 25a vary inversely with the mean effective pressure in the air chamber 30. As the spring 45 of each diaphragm follows Hooke's law, the compression thereof will vary directly as the pressure in the air chamber 30 because the spring overbalancing pressure will vary directly therewith.

As will be clearly understood, the effects of the orifice 38a and diaphragm 40 in the embodiment illustrated in Figure 7 will be dependent upon the pressure differential between the air chamber 30 and the respective pressure chambers 25 and 25a. The particular characteristics of the pump operation are further dependent upon the sensitivity or strength of the opposed springs 45 and 45a in the diaphragm. Likewise, the strengths of the opposed springs 45 and 45a may be varied to secure further modification of the operating characteristics of the pump. In any event, both in the embodiment disclosed in Figures 7 and 8 and in the modification thereof (which, though not illustrated, has been described as being similar to that disclosed in Figures 7 and 8, save that the orifice 38a has been omitted), the pressure differential between the air chamber 30 and the chamber 25 will be decreased by the diaphragm 40 when the pressure differential exceeds a predetermined value. Thus, when the pressure in the air chamber 30 is increased, the amount of fluid passing into this chamber from the chamber 25 is decreased.

Likewise, in the embodiment illustrated in Figures 9 and 10, the pressure differential between the air chamber 30 and both pressure chambers 25 and 25a will be decreased by the diaphragms 40 and 40a by an amount which will vary directly with the pressure in the air chamber. The amount of fluid passing into the air chamber on each reciprocation of the pump piston will likewise be lessened by an amount varying directly with the pressure in the air chamber 30. Thus,

in each of the embodiments described, the delivery of the pump will vary inversely with the pressure in the air chamber 30. The pressure in the air chamber 30 being identical with the delivery chamber or tank pressure of the pump, the delivery rate of the pump will, therefore, vary inversely with the delivery pressure of the pump.

While I have illustrated only one form of diaphragm, it is, of course, to be understood that various other types of diaphragms may be used for the same purpose. Likewise, if it is desired to unbalance the deliveries of fluid from the respective chambers 25 and 25a, this may be accomplished by suitable variation of the spring pressures on the respective diaphragms 40 and 40a, by variation of the size of the by-pass orifice 38a and/or the use of more than one diaphragm where one has been illustrated and/or the use of diaphragms of different sizes and/or characteristics. For instance, in the embodiment illustrated in Figures 9 and 10, two diaphragms may be substituted for one of the diaphragms there shown. The same result might be accomplished by the substitution for one of the diaphragms shown of a diaphragm having greater cross sectional area. Likewise, the connection of the diaphragm between the air chamber and one of the pressure chambers may be made through exterior means and by suitable associated valves these diaphragms may be made selectively operable.

When a pump constructed according to the principles of my invention is applied to a fluid pressure system including an air pressure tank, withdrawal of fluid from the system causes entry of air into the tank. After the entry of air into the tank, the air intake valve remains closed. If unequipped according to the principles of my invention, the pump would tend to deliver its full capacity until the pressure in the tank and in the system were raised sufficiently to cause the pressure switch 34 to shut down the motor. However, due to the incorporation in the pump of the principles of my invention, the delivery of the pump will be progressively decreased with increase of pressure in the system whereby to prevent undue starting and stopping of the motor and undue wear upon the pump and upon the motor. This is due to the provision of the by-pass orifice 38a in the embodiment disclosed in Figures 1 to 6 inclusive, to the provision of the diaphragm 40 and by-pass orifice 38a in the embodiment illustrated in Figures 7 and 8, to the provision of the diaphragm 40 alone with the by-pass orifice 38a eliminated in the above described unillustrated modification, and to the provision of both diaphragms 40 and 40a in the embodiment illustrated in Figures 9 and 10.

By the provision of these means, the pump is given a capacity which varies inversely with respect to the pressure of the system, because of the above described lessening of the intake in the pressure chambers 25 and 25a and/or the

return from the air chamber 30 of a quantity of fluid through the by-pass orifice 38a (when utilized), which quantity varies directly with the pressure in the system. The incorporation of the above described features in a pump permits a greater increase of displacement without loss of prime than is otherwise possible.

It will be understood that the above described structure is merely illustrative of the manner in which my invention may be carried out and that I desire to comprehend within my invention such modifications as come within the scope of the claims and the invention.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a pump having an air chamber and a pumping chamber adapted to supply fluid thereto, constantly operative means comprising a passage of predetermined size between said air chamber and said pumping chamber for automatically varying the delivery of the pump inversely with the pressure in said air chamber.

2. In a pump having an air chamber and a pumping chamber adapted to supply fluid thereto, means for varying the delivery inversely with the pressure in said air chamber comprising fixed by-pass means connecting said air chamber to said pumping chamber internally of the pump.

3. In a pump having an air chamber and a pumping chamber adapted to supply fluid thereto, means disposed interiorly of the pump for bypassing from said air chamber to said pumping chamber a portion of said fluid directly proportional to the pressure in said air chamber.

4. In a constant speed pump having an air chamber and a pumping chamber adapted to supply fluid thereto, means responsive to the pressure in said air chamber for varying the delivery of said pump at constant speed by returning from said air chamber to said pumping chamber a portion of said fluid varying directly with the pressure in said air chamber.

5. In a constant speed pump having an air chamber and a pair of pumping chambers adapted to supply fluid thereto, one of said chambers having air intake means, means for controlling the delivery of said pump by returning from the air chamber to the pumping chamber having air intake means, a portion of said fluid varying directly with the pressure in said air chamber.

6. In a pump having an air chamber, a pumping chamber adapted to supply fluid thereto, and valve means adapted to provide communication between said pumping chamber and said air chamber in one direction, means for varying the delivery of said pump in inverse ratio to the pressure in said air chamber comprising by-pass means disposed interiorly of said pump and connecting said pressure chamber and said air chamber.

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