July 14, 1942. J. N. GILMAN ET AL 2,289,772

CONVERTIBLE PUMPING SYSTEM

Filed March 9, 1940

Fig. 1.

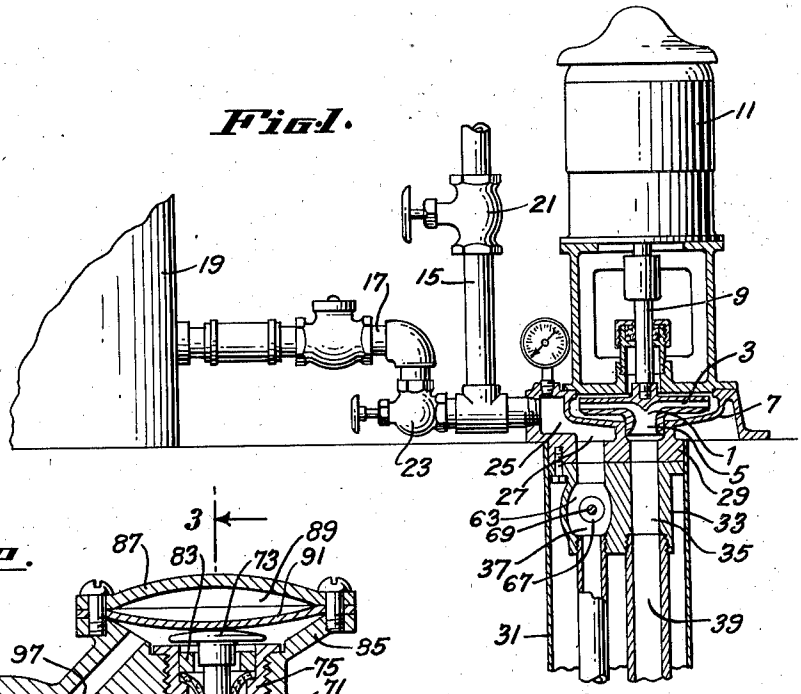


Fig. 2.

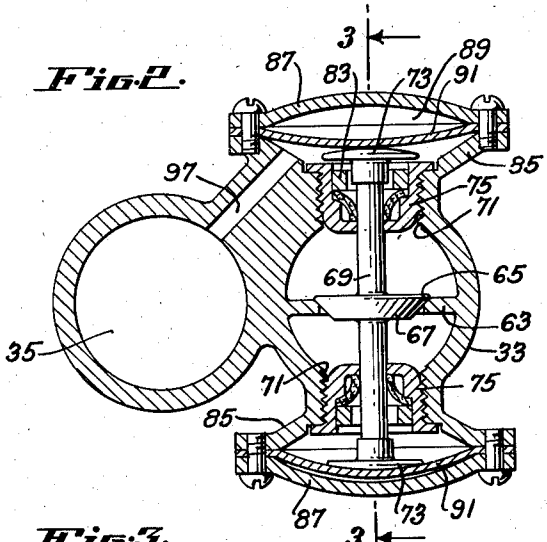
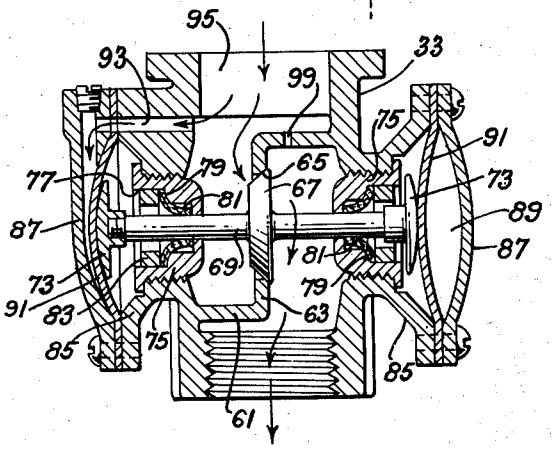
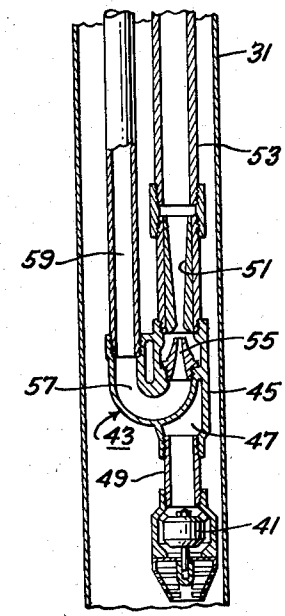


Fig. 3.





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CONVERTIBLE PUMPING SYSTEM

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10 Claims. (Cl. 103—10)

Our invention relates to pumping systems, and more particularly to those of the hydro-ejector type.

Among the objects of our invention are to provide an improved pumping system capable of being converted from a high pressure-low capacity system to a low pressure-high capacity system, and vice versa, from a low pressure-high capacity system to a high pressure-low capacity system; to provide an improved pumping system of the hydro-ejector type, enabling conversion of the same from high pressure operation to low pressure operation in a very simple and convenient manner; to provide improved valve means for converting a high pressure-low capacity pumping system of the hydro-ejector type to a low pressure-high capacity system; and to provide a hydro-ejector pumping system, capable of conversion to low pressure-high capacity operation, which embodies but a slight departure in construction from conventional hydro-ejector pumping systems.

Additional objects of our invention will be brought out in the following description of the same taken in conjunction with the accompanying drawing wherein—

Figure 1 is a vertical view of our improved system, with portions thereof in section.

Figure 2 is a view, in section, of a valve assembly comprising an important component of our improved system as shown in Figure 1.

Figure 3 is a view, in section, of the same valve assembly, taken along the line 3—3 of Figure 2.

A pumping system of the hydro-ejector type is essentially a high pressure system. A system of this character comprises a motor driven ejector pump capable of low pressure-high capacity operation, and accordingly will be hereafter designated as a low pressure unit or the like. The inlet to this unit is connected by means of a suction pipe to a foot valve located at the bottom of a well casing. In the suction pipe there is mounted a booster component involving an ejector nozzle or jet and an injector tube or venturi positioned adjacent the jet opening. The jet is connected by means of a pressure pipe, to the discharge side of the low pressure pump unit, and in the operation of the system, a portion of the output of the pump unit is by-passed down the pressure pipe and through the jet and venturi, to create a vacuum condition at this point in the suction pipe, and thereby build up pressure to the input of the pump unit.

In accordance with our invention, we have modified such a system, whereby the system may be operated in the conventional manner as a high pressure system, or its characteristics may be altered to cause the same to operate as a low pressure system, in which case the output of the system is increased at such low pressure. We have been able to accomplish this by automatic valve means placed in the pressure line, the valve element thereof being retained in its open or unseated position when the pump unit discharges above a minimum pressure, which is considered high pressure operation. When the output pressure of the pump unit drops to a value within the range considered low pressure operation, this valve will automatically close and block the pressure line, whereby the effectiveness of the booster unit will be destroyed, and the operation of the system will be due entirely to the low pressure pump unit, and without the assistance of the booster.

The conversion of the system from high pressure-low capacity output to low pressure operation with high capacity output, or vice versa, may be controlled by means enabling an operator to arbitrarily change the pressure of the discharge from the pump unit. Such means involves the provision of a valve in the low pressure line. Thus, if it is desired to operate the system for low pressure operation, the valve in the low pressure line will be opened; whereas, if it is desired to convert the system back to high pressure-low capacity output operation, the valve in the low pressure line should be closed, and this will quickly raise the back pressure on the low pressure unit sufficiently to cause the valve in the pressure line to open automatically.

For a more detailed description of our improved system, reference will be made to the accompanying drawing wherein we have disclosed our invention as applied to a particular system of the hydro-ejector type, known in the art as the "Advance hydro-ejector type pump." Such system comprises a centrifugal pump in the form of an impeller unit 1 having a plurality of radial tubes 3 emanating from a common inlet 5. This impeller unit is by itself capable of low pressure-high capacity operation. It is rotatably mounted within a housing 7 and driven by a motor (not shown) connected thereto by a vertical drive shaft 9. The motor is enclosed in a housing 11, supported upon a standard 13 which in turn is carried by the pump casing 7.

In this system, the output of the impeller unit is connected to a low pressure discharge line 15 and a high pressure discharge line 17, the latter being in turn connected to a pressure tank 19,

The flow of the discharged liquid from the impeller unit to either the low pressure or high pressure lines is controlled by a valve 21 in the low pressure line of any conventional design, and a needle valve 23 inserted in the high pressure line. This needle valve enables adjustment of the pressure in the high pressure line when the low pressure line is blocked off. The impeller unit casing 7 has formed therein a by-pass channel 25 terminating in an opening 27 adjacent the inlet opening 5 to the pump unit, thus providing for the by-passing of a portion of the discharge from the pump unit.

That much of the system thus far described represents the components which are mounted above ground level in an installation of the system for the pumping of water from wells or the like.

The impeller unit casing 7 is formed with a flange 29, and this flanged portion fits within the mouth of a well casing 31. To this flange there is bolted a valve assembly casing 33 having parallel passages 35 and 37 therethrough. One of these passages 35 is unobstructed and in alignment with the inlet opening 5 to the impeller unit 1, to constitute a portion of the suction line 39 from the impeller unit to a foot valve 41 at the lower end of the well casing. Such foot valve may be of any conventional design and need not be described in detail here.

Connected for operation in the suction line 39 is a booster unit 43 of the hydro-ejector type, which includes an ejector body 45 having a through passage 47, to constitute a portion of the suction line, one end of the body being connected to a pipe section 49 leading to the foot valve 41, while the other end has threaded therein an ejector tube or venturi 51. The venturi in turn is coupled to an upper pipe section 53 in the suction line. An ejector nozzle or jet 55 is supported within the ejector body suction line passage 47, but without completely obstructing the same, such ejector nozzle or jet being connected by an arcuate passage 57 in the ejector body, to the lower end of a pressure pipe 59 which in turn leads to the by-pass discharge opening 27 of the impeller unit casing, through the other passage 37 in the valve assembly casing 33.

This latter passage 37 in the valve assembly casing is not unobstructed, as is the passage 35 connected in the suction line, but is partitioned by an irregularly shaped partition 61, a section 63 of which lies longitudinally of the passage, and has an opening therethrough to provide a valve seat 65. A valve 67 is provided for cooperation with this valve seat, to enable opening or closing of the passage 37, whereby the pressure line and booster unit will be rendered operative or inoperative to perform their function in the pumping system, depending upon whether the system is to operate as a high pressure-low capacity system, or as a low pressure-high capacity system.

This valve has a valve stem 69 extending in opposite directions and through diametrically disposed openings 71 in the valve assembly casing 33. Beyond these openings, each end of the stem terminates in a contact button 73 threaded thereon. The valve 67 is slidably supported in operative position with respect to the valve seat 65, by a pair of stem supporting nuts 75, one at each end of the stem and threadedly engaging one of the aforementioned openings 71. Each of these nuts 75 is of hollow construction, and is provided with a counter sink 77 which forms a shoulder 79 to receive a flexible sealing washer 81 which rests upon the shoulder 79, and frictionally engages an end of the valve stem. The sealing washer is retained in position by a friction ring 83 or suitable holding element pressed into the counter sink, to clamp the sealing washer 81 against the shoulder 79.

Each of the aforementioned openings 71 is bounded by an outwardly flared flange 85 to which is applied a cap 87 to provide an end chamber 89 in which an end of the valve stem terminates. Each end chamber is partitioned by a snap disk 91 clamped between an outwardly flared flange 85 and its associated cap 87. These disks are similarly distorted in the same direction when assembled, and are in engagement with the contact buttons 73 which have been mounted on the ends of the valve stem 69.

A port 93 connects the inlet end 95 of the passage 37 with the cap side of that end chamber 89 toward which the valve moves in closing, while a second port 97 connects the suction passage 35 through the valve assembly casing, with the stem side of the other end chamber.

For high pressure operation of the system, the low pressure line is blocked off by the valve 21, and the needle valve 23 is adjusted to build up the back pressure on the discharge end of the impeller unit 1. The discharge pressure in the by-pass 25 and port 93 is always equal to such back pressure, and when this pressure reaches the threshold value, which is understood to be the value at which a desired change occurs, it is sufficient to overcome the suction effect upon one of the disks 91 which is due to the port connection 97 with the suction line, and causes the other snap disk, against which the pressure is transmitted, to snap and force the valve 67 off its seat 65, thereby opening a passage to the pressure pipe 59 from the discharge end of the impeller unit. The liquid thus by-passed under pressure is forced through the ejector nozzle or jet 55 and venturi 51, whereby a vacuum condition is created at this point in the suction line, causing the pressure to be increased in the pumping system. Under these conditions, the system will operate in its conventional manner as a high pressure-low capacity system.

When it is desired that the system be converted to a low pressure-high capacity system, the valve 21 in the low pressure line 15 may be opened to bring about a drop in the pressure at the discharge end of the impeller unit 1, sufficient to permit the valve opening snap disk to be restored to its original position, enabling the valve to seat. Such seating of the valve is effected by the suction produced on the inside half of the end chamber connected to the suction passage 35 via the port 95. With the valve in its closed or seating position, the booster unit 43 is rendered inoperative, and the pumping operation of the system will be attributed entirely to the action of the impeller unit 1, and this functioning as a low pressure-high capacity unit, the system will operate as a low pressure-high capacity system.

To permit the satisfactory operation in accordance with the above description, it is essential to provide a vent opening 99 through the partition 61 in the valve assembly, which makes possible the ready priming of the pump, by enabling the escape of any air which would otherwise be trapped in the pressure pipe during priming. This vent also will permit the release of air which

might conceivably be sucked in through the foot valve 41.

It will thus be apparent that the system which we have described will fulfill all the objects of our invention as set forth previously, and while we have disclosed and described our invention in detail in connection with one specific type of pumping system, it will be apparent that the invention may be applied to other systems of the same general character, and that modifications and alterations may be made in the structure described by us, without departing from the spirit of our invention.

For example, in lieu of snap disks for actuating the valve, flexible diaphragms of rubber or similar material might be employed, as they will respond to pressure and suction in a manner similar to that of the disks, though without the snap operation, which is not essential in converting the pumping system from one mode of operation to the other. When flexible diaphragms are utilized, the valve will be partially unseated when the system is not in operation. This will provide the necessary venting during priming and thus enable the elimination of the vent 99, resulting in a slight increase in efficiency of the system during operation.

We, accordingly, do not desire to be limited in our protection to the specific details disclosed and described by us, except as may be necessitated by the prior art and the appended claims.

We claim:

1. In a pumping system adaptable for operation as a high pressure or low pressure system, a centrifugal pump, a suction pipe connecting to the inlet to said pump, a pressure jet booster in said suction pipe, a pressure pipe connecting the discharge passage from said centrifugal pump to said booster, and valve means normally blocking said pressure pipe to render said booster ineffective and cause said system to function as a low pressure system, said valve means being responsive to a predetermined minimum pressure in said discharge passage for unblocking said pressure pipe and rendering said booster operative as such, to thereby cause said system to change from low pressure operation to high pressure operation.

2. In a pumping system adaptable for operation as a high pressure or low pressure system, a low pressure assembly comprising a low pressure pump unit, a suction line connecting to the inlet to said pump unit and including a jet and venturi assembly adaptable, when activated, to cooperate with said low pressure pump unit to obtain high pressure operation, and valve means normally rendering said jet and Venturi assembly ineffective during low pressure operation of said system as a low pressure system but responsive to a rise in pressure at the output of said system to a predetermined value for enabling activation of said jet and Venturi assembly to cause said system to operate as a high pressure system.

3. A valve assembly for converting a pumping system from high pressure operation to low pressure operation and vice versa, comprising a casing forming a valve chamber and having an inlet and an outlet opening connecting therewith, a valve seat partition dividing said chamber and including a valve seat, a valve in operative position with respect to said seat and having a valve stem extending axially in opposite directions from said valve with each end of said stem terminating within an end chamber, means sealing off each of said end chambers from said valve chamber, a flexible disk partitioning each of said end chambers and contacting an end of said stem, and a port extending through said casing to one side of one of said disks and another port extending through said casing to the other side of said other disk.

4. A valve assembly for converting a pumping system from high pressure operation to low pressure operation and vice versa, comprising a casing forming a valve chamber and having an inlet and an outlet opening connecting therewith, a valve seat partition dividing said chamber and including a valve seat, a valve in operative position with respect to said seat and having a valve stem extending axially in opposite directions from said valve with each end of said stem terminating within an end chamber, means sealing off each of said end chambers from said valve chamber, a flexible disk partitioning each of said end chambers and contacting an end of said stem, a port extending through said casing to one side of one of said disks and another port extending through said casing to the other side of said other disk, and a vent opening through said valve seat partition.

5. In a pumping system comprising a pump, a suction line to said pump including a jet and Venturi assembly and a pressure line from said pump to said jet, a valve assembly for converting said pumping system from high pressure operation to low pressure operation and vice versa, comprising a casing forming a valve chamber and having an inlet and an outlet opening connecting therewith, a valve seat partition dividing said chamber and including a valve seat, a valve in operative position with respect to said seat and capable of moving to and from seating position on said seat, said valve assembly being connected in said pressure line with said valve in a partially unseated condition in the absence of pump operation but exposed to pressures developed in said pressure line during pump operation, in a direction to completely unseat the same, and means responsive to the vacuum condition developed in said suction line during pump operation for seating said valve until such pressures in said pressure line reach a predetermined minimum value.

6. In a pump system adaptable for operation either as a low pressure-high capacity system or a high pressure-low capacity system, a low pressure pump unit having a suction end and a discharge end, a suction line to said suction end including a jet and Venturi assembly, a pressure line from said discharge end of said pump unit to said jet and including a valve exposed to the discharge pressure of said pump unit in a direction to open the same, means for normally holding said valve closed during operation of said system as a low pressure-high capacity system, said valve being adapted to be maintained in open position when the discharge pressure of said pump unit is above a predetermined minimum value sufficient to predominate over said means for normally holding said valve closed and thus render said jet and Venturi assembly active to boost the pressure of said system, and means for arbitrarily adjusting the discharge pressure of said pump unit to increase such pressure to a predominating value to convert said system from a low pressure-high capacity system to a high pressure-low capacity system.

7. In a pump system adaptable for operation either as a low pressure-high capacity system or a high pressure-low capacity system, a low pressure pump unit having a suction end and a dis-

charge end, a suction line to said suction end including a jet and Venturi assembly, a pressure line from said discharge end of said pump unit to said jet and including a valve exposed to the discharge pressure of said pump unit in a direction to open the same and to the reduced pressure in said suction line in a direction to close the same, said valve being adapted to be maintained in open position when the discharge pressure of said pump unit is above a predetermined minimum value sufficient to predominate and thus render said jet and Venturi assembly active to boost the pressure of said system, and means for arbitrarily adjusting the discharge pressure of said pump unit to increase such pressure to a predominating value to convert said system from a low pressure-high capacity system to a high pressure-low capacity system.

8. In a pump system adaptable for operation either as a low pressure-high capacity system or a high pressure-low capacity system, a low pressure pump unit having a suction end and a discharge end, a suction line to said suction end including a jet and Venturi assembly, a pressure line from said discharge end of said pump unit to said jet and including a valve exposed to the discharge pressure of said pump unit in a direction to open the same and to the reduced pressure in said suction line in a direction to close the same, said valve being adapted to be maintained in open position when the discharge pressure of said pump unit is above a predetermined minimum value sufficient to predominate and thus render said jet and Venturi assembly active to boost the pressure of said system, and means for arbitrarily adjusting the discharge pressure of said pump unit to increase such pressure to a predominating value to convert said system from a low pressure-high capacity system to a high pressure-low capacity system, said means including a pair of discharge lines leading from the discharge side of said pump unit, one of said lines constituting a low pressure-high capacity line and including a manually operated valve, the other of said discharge lines constituting a high pressure-low capacity line and including a manually adjustable pressure regulating valve.

9. A pumping system comprising a pump unit having an input end and a discharge end; a suction line leading to the input end of said pump unit; a booster assembly connected in said suction line and including a jet and Venturi; a pressure line leading from said pump unit to said booster unit and including said jet; a valve in said pressure line; means biasing said valve in a direction tending to block flow of liquid through said jet to cause operation of said pump unit independently of said booster, said biasing means being adapted to become ineffective by pressure of liquid in said pressure line above a predetermined minimum value whereby to render said booster active, and means for arbitrarily shifting the value of pressure in said pressure line to either side of said predetermined value.

10. In a pumping system adaptable for operation as a high pressure or low pressure system, a low pressure assembly comprising a low pressure pump unit, a suction line connecting to the inlet to said pump unit and including a jet and Venturi assembly adaptable when activated, to cooperate with said low pressure pump unit to obtain high pressure operation, and pressure responsive means normally rendering said jet and Venturi assembly ineffective during low pressure operation of said system as a low pressure system but responsive to a rise in pressure at the output of said system to a predetermined value for enabling activation of said jet and Venturi assembly to cause said system to operate as a high pressure system.

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