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HIGH-PRESSURE DIAPHRAGM PUMP

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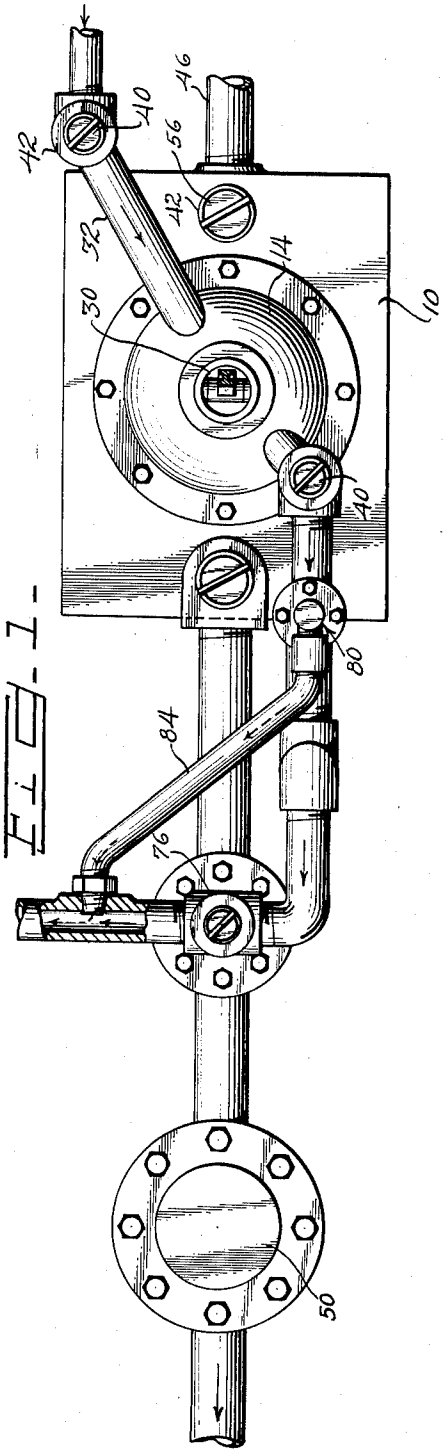


FIG. 1

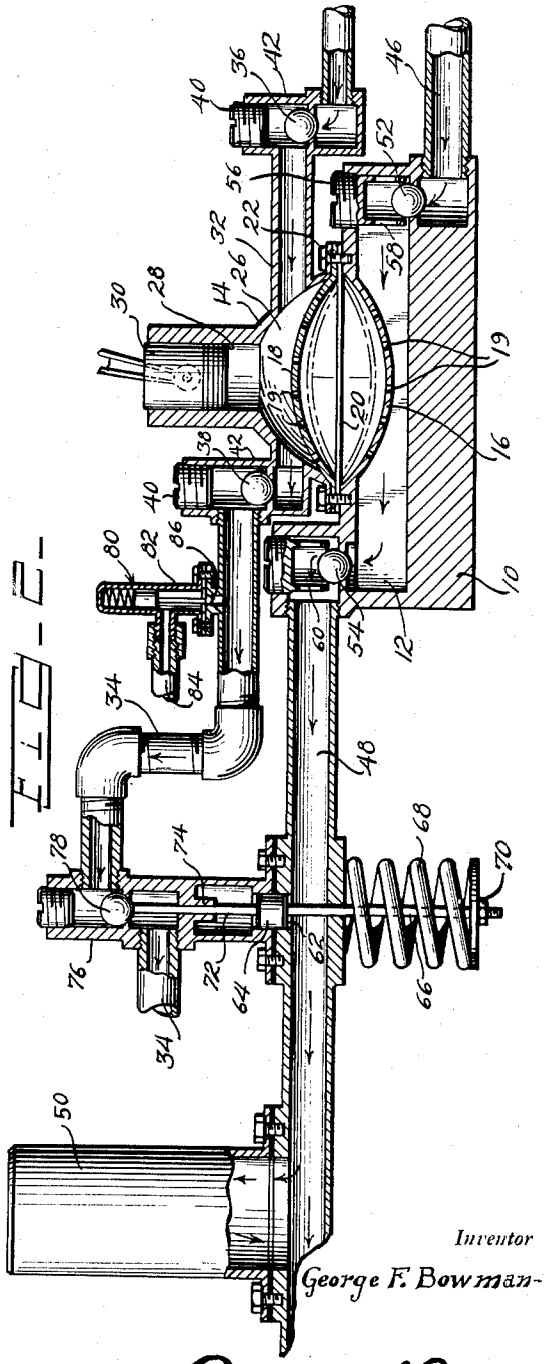


FIG. 2

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HIGH-PRESSURE DIAPHRAGM PUMP

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4 Claims. (Cl. 103—11)

1

The present invention comprises novel and useful improvements in a high pressure diaphragm pump and more specifically pertains to an improved pump for handling abrasive or corrosive liquids at high pressures, for use in spray nozzles or the like, together with a hydraulic actuating system therefor.

The principal objects of this invention reside in the provision of a high pressure pump having all the moving and rubbing parts exposed to friction protected from contact with the pump impelled corrosive liquid or abrasive liquid; to provide a novel hydraulic actuating system for operating the impeller of the pump with uniformly distributed load thereon; to improve the efficiency of the hydraulic system by maintaining a continuous uni-flow circulation therein; to minimize strain upon the actuating system by venting the pressure thereof when the pump delivery pressure reaches and exceeds a predetermined value; and to provide a pump admirably adapted to handle abrasive, viscous and corrosive liquids with minimum deleterious effects therefrom.

These, together with various ancillary objects of the invention which will later become apparent as the following description proceeds, are realized by my invention, one embodiment of which has been illustrated by way of example only in the accompanying drawings, wherein:

Figure 1 is a diagrammatic top plan view of one embodiment of the device; and,

Figure 2 is a schematic view in vertical longitudinal section, the hydraulic storage tank being omitted in both views for the sake of convenience of illustration.

Attention is now directed more specifically to the accompanying drawings, wherein like numerals indicate similar parts throughout the several views, and wherein 10 indicates a casing or body member which is formed with a chamber therein constituting a pump chamber indicated at 12. An upper member 14 is mounted above the members 10 and 12. The upper portion of the casing 10 forming an upper wall for the pump chamber 12 is at its central portion downwardly bowed or convexed as at 16 to form a foraminous and perforated shield or stop while a similarly shaped and perforated upwardly bowed or convexed shield or stop 18 is provided in complementary relation to the element 16. As shown at 19, both the shields 16 and 18 are provided with series of apertures or bores for the purpose of permitting free liquid communication through these elements for a purpose to be later set forth.

The bowed shields 16 and 18 enclose and secure a diaphragm member 20 therebetween, suitable fastening means 22 being provided for rigidly securing the upper member 14, the shield 18, the diaphragm 20, and the lower casing or body 10 into a unitary and rigid assembly.

2

The member 14 has formed therein a pressure actuating chamber 26 in open communication by means of apertures 19 with the upper surface of the diaphragm 20, while the lower side of the diaphragm is in free communication with the pump chamber 12 by means of the apertures 19 in the shield member 16. Extending upwardly from the upper member 14 and in free communication with the chamber 26, is a cylindrical bore 28 within which is reciprocated a piston 30 by any suitable means such as a connecting rod or the like from any suitable power source. As will now be apparent, the reciprocations of the piston 30 will be transmitted by a liquid medium within the chamber 26 and through the apertures 19 to the upper surface of the diaphragm 20, causing upward and downward pulsations of the latter, and transmitting these pulsations to the fluid in the chamber 12 through the apertures 19 in the shield member 16. As will be readily apparent, the amplitude of flexing of the diaphragm 20 is limited by engagement of the diaphragm with the upper and lower convex surfaces of the shield members 16 and 18.

The fluid pressure medium for imparting the impulses from the piston 30 to the diaphragm 20 is rendered more efficient in its operation by being constantly circulated upon a fluid storage tank, not shown, to a series of conduits, through the actuating chamber 26 and back to the tank. For this purpose, I provide an inlet passage 32 extending from the fluid source such as a fluid storage tank, not shown, while an outlet passage 34 leads from the pressure chamber 26 eventually returning to the fluid storage tank above mentioned. The fluid inlet and outlet passages 32 and 34 are provided with suitably positioned non-return check valves 36 and 38 respectively. These valves are preferably constructed as ball valves, and are downwardly seated as by gravity and limited as to their upward movement by means of suitable closure plugs 40 positioned in the upper ends of valve casings 42. It will thus be seen, that under the upward stroke of the pump 30 resulting in a suction in the chamber 26, the valve 36 is lifted from its seat whereby fluid is drawn in from the tank, not shown, and through the inlet passage 32 into the actuating chamber 26. During this time, the valve 38 is seated upon its seat both by gravity and by the suc-

tion below the valve induced by the movement of the piston 30.

Upon the downward stroke of the piston 30, the pressure imposed upon the fluid in the chamber 26 assists gravitating and urging the valve 36 to its seat, thereby closing communication through the inlet passage 32 to the storage tank. At the same time, pressure in the chamber 26 is imparted below the valve 38 and serves to lift the latter from its seat and some of the pressure fluid is therefore forced outwardly into the outlet passage 34 as set forth hereinafter.

A fluid inlet conduit 46 communicates with the pump chamber 12 while a fluid outlet or discharge conduit 48 conducts the fluid displaced by the pumping diaphragm 20 to any suitable source of use, such as a spray nozzle or the like, not shown. An air chamber 50 of any suitable construction is connected with the discharge line 48 for the purpose of equalizing any pressure surges occurring therein. A pair of ball check valves 52 and 54 are interposed in the fluid inlet and outlet conduits respectively. These valves preferably take the form of ball type non-return valves, and as shown, control suitable seats in the casing 10, which seats are disposed in the inlet and outlet ports of the pump chamber 12. In order to retain these valves in their operative position, I preferably provide plugs 56 screw threadedly engaging appropriately positioned bores in the upper surface of the base 10, which plugs have downwardly extending sleeves 58 constituting cages adapted to loosely embrace the ball valves 52 and 54 and restrict their movement to a vertical reciprocation within the sleeve portions 58. Suitable apertures or slots 60 are provided in the walls of the sleeves 58 to permit the ready flow of fluid therethrough, while restraining the ball valves from displacement from their seats.

As will be readily understood, when the piston 30 is reciprocated as aforesaid, resulting in a pulsating flexure of the diaphragm member 20, the movement of the latter imparts a series of suction and pressure strokes to the fluid in the chamber 12. Thus, as the diaphragm moves upwardly in synchronization with the upward movement of piston 30, a suction is produced in chamber 12 which lifts the inlet check valve 52 and draws fluid from a storage tank, not shown, through the inlet conduit 46 and into the pumping chamber 12. At the same time, this suction assists gravity in retaining the check valve 54 to its seat, whereby backflow is prevented from the delivery conduit 48. Upon the downward stroke of the piston 30, and resultant downward movement of diaphragm 20, a pressure is created in the pump chamber 12 which assists gravity in biasing the valve 52 to its seat to thereby prevent return flow through the inlet conduit 46. At the same time, this pressure causes an unseating of the valve 54 from its seat, whereby fluid is forcibly ejected from chamber 12 past the valve 54, sleeve 58 and opening 60 into the discharge conduit 48 where under an even pressure maintained by the air chamber 50 it is delivered to any suitable source of use. From the foregoing it will be seen that the reciprocation of the piston 30 through its hydraulic actuating means upon the upper surface of the pump diaphragm 20 creates and maintains a pressure condition in the pumping chamber 12 and the discharge conduit 48.

Whenever the pump pressure reaches a predetermined maximum, I provide automatic means

for releasing the pressure induced by the hydraulic operating system upon the diaphragm 20, to thereby prevent or limit further operation of the diaphragm. For this purpose, a bore 62 is provided in free communication with the discharge conduit 48, and a piston 64 is reciprocably mounted in said bore with its lower surface in open communication with the pressure in the conduit 48. A piston rod 66 depends downwardly from piston 62 and is encircled by a coil spring means 68 suitably tensioned and adjusted by a screw threaded nut 70 upon the lower end of the rod 66. This spring is so adjusted as to have its adjustable pressure opposing the actuation of the piston 62 by the pressure fluid in the discharge conduit 48. At its upper end, the piston 62 is provided with a further rod 72 which extends upwardly to a suitable guide means 74 and into a valve casing 76. The valve casing 76 is interposed in the hydraulic operating fluid discharge line 34, and contains a valve seat which is normally closed by a gravity urged ball check valve 78. The valve 78 is also maintained upon its seat by means of the pressure applied to its upper surface by the discharge conduit 34. The rod 72 is so positioned that its upper end is adapted to lift the check valve 78 from its seat when the pressure in the conduit 48 succeeds in overbalancing the force exerted by the adjustable spring means 68 upon the piston 62. Thus, when the pressure in conduit 48 exceeds a predetermined value, the piston 62 overcomes the spring 68 and opens the check valve 78, thereby releasing the pressure in the actuating chamber 26. By this means, the pumping action is immediately stopped thereby preventing damage to the diaphragm 20 or other parts of the mechanism.

By the foregoing arrangement, it will be seen that the pump diaphragm 20 has been protected from the danger of rupture by excessive pressures in the pump chamber and fluid discharge line. As a further safety device, and in order to protect the diaphragm from excessive pressures originating in the actuating chamber 26, I provide at any suitable point upon the actuating fluid discharge line 34, a pressure relief valve indicated generally at 80 and consisting of a casing 82 communicating with the discharge conduit 34 and having a connection 84 communicating with the pressure actuating fluid storage tank, not shown, and adapted to bypass the control valve casing 76. Within the casing 82 is provided a control valve 86 which is maintained upon its seat by means of a closing spring 88. This spring is so calibrated as to impose a predetermined pressure upon the valve 86, whereby the latter remains seated until the pressure in the discharge conduit 34 exceeds a predetermined minimum value for which the spring 88 is calibrated. At this point, the valve 86 opens and permits the escape of pressure directly back to the storage tank, thus rendering the pumping action of piston 30 ineffective to operate the diaphragm 20.

From the foregoing, it is believed that the method of operation and construction of my invention will be now apparent. As will be readily seen, I provide a novel hydraulic system for operating a diaphragm pump, whereby no parts of the operating mechanism are directly exposed to the corrosive or abrasive properties of various liquids with which my pump may be employed. Further, I provide novel means for protecting the diaphragm pumping element from rupture by

excessive pressures either induced by the pressure of the medium pumped by my device or by excessive operating pressure in my hydraulic system.

I wish it to be distinctly understood that I do not limit myself to the exact construction shown in the drawings, but may employ any suitable modifications falling within the scope of the appended claims.

I claim as my invention:

1. A hydraulically actuated diaphragm pump comprising a diaphragm, a fluid pressure actuating chamber on one side of said diaphragm and a pump chamber on the other side thereof, perforated rigid diaphragm stops on opposite sides of said diaphragm, fluid inlet and fluid outlet conduits connected to said pump chamber, operating fluid inlet and outlet passages connected to said actuating chamber, a piston reciprocable in said actuating chamber, inwardly and outwardly opening check valves in said pump chamber and controlling said inlet and outlet conduits respectively, a by-pass connecting said actuating outlet passage to a source of supply, a pressure relief valve in said by-pass line, a normally closed control valve disposed in said outlet passage, and means responsive to a predetermined pressure in said outlet conduit for opening said control valve, said last means including a further piston, means for applying fluid pressure from said outlet conduit to one side of the further piston, spring means opposing said fluid pressure and a rod carried by the further piston for actuating said control valve.

2. A hydraulically operated pump comprising a housing and a movable wall in the housing dividing the interior thereof into an actuating chamber and a pumping chamber, said wall closing communication between the chambers and being movable in response to pressure differentials between the chambers to vary the volume of the pumping chamber, means for varying the volume of the actuating chamber, inlet and outlet conduits communicating with the pumping chamber, inlet and outlet non-return valves in the respective conduits, and means for limiting the pressure that may be generated in the pumping chamber by the operation of the first mentioned means, said last mentioned means comprising discharge passage means for the actuating chamber, a valve normally closing said discharge passage means, operating means for said valve, and

means for actuating the operating means including a pressure responsive device connected to the outlet conduit at a position opposite the non-return valve from the pumping chamber.

3. A hydraulically operated pump comprising a housing and a movable wall in the housing dividing the interior thereof into an actuating chamber and a pumping chamber, said wall closing communication between the chambers and being movable in response to pressure differentials between the chambers to vary the volume of the pumping chamber, means for varying the volume of the actuating chamber, inlet and outlet conduits communicating with the pumping chamber, inlet and outlet non-return valves in the respective conduits, and means for limiting the pressure that may be generated in the pumping chamber by the operation of the first mentioned means, said last mentioned means comprising discharge passage means for the actuating chamber, a valve normally closing said discharge passage means, and means responsive to pressure in the outlet conduit exceeding predetermined value to open said valve, said last means including a further movable wall so constructed and arranged with respect to the outlet conduit as to be moved in response to pressure exceeding a predetermined amount therein, and a movable member operatively connecting the further movable wall and the valve.

4. The combination of claim 3, wherein said movable wall is a piston, said member being secured to the piston and adapted to engage said valve.

GEORGE F. BOWMAN.

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