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PUMP

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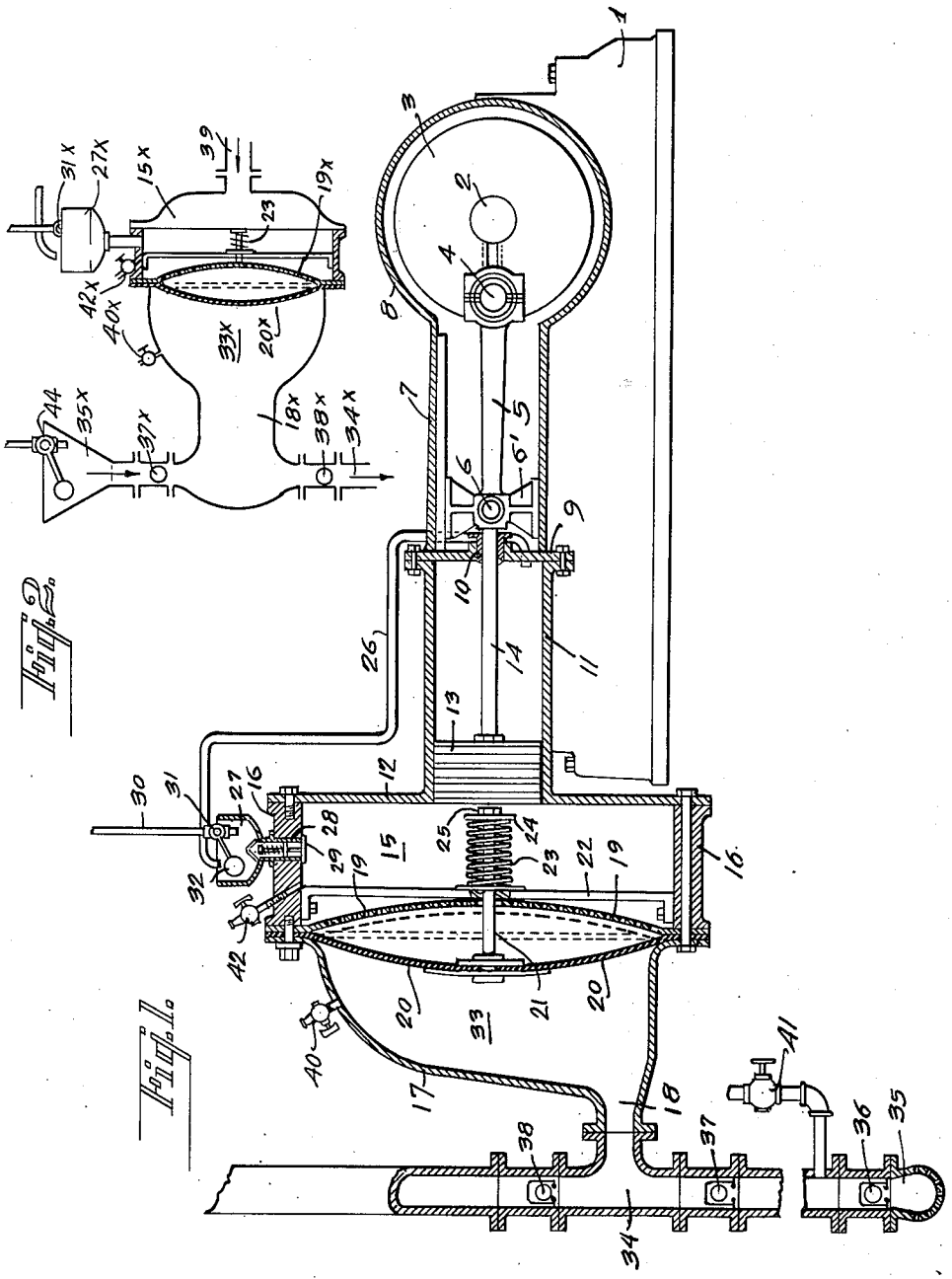

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8 Claims. (Cl. 103—44)

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The present invention relates to pumps and more particularly to combined piston and diaphragm pumps.

In pumping abrasive material centrifugal sand pumps are not effective where the head exceeds 100 to 150 feet. Accordingly when operations require heads in excess of this range it is the usual practice to install intermediate relay pumps but in some instances even these cannot be installed and the so-called "slush pumps" are used wherein the reciprocating pistons come into direct contact with the abrasive materials being pumped. The excessive wear which results in a very short time makes it essential to provide standby units so that operations will not be suspended during the frequent repair periods.

There is among the objects of the present invention the provision of a pump which can handle heads of 100 feet or more without the necessity of relay pumps and their attendant duplication of installation expense and multiplication of operating difficulties.

Likewise it is an object of the invention to maintain the advantages of a piston type pump and at the same time eliminate the serious wear problems resulting from contact with the material being pumped.

It is not necessary to scrap the existing equipment for it is an object of the present invention to provide an auxiliary unit embodying the principles herein disclosed so that existing piston and plunger pumps may be adapted for pumping abrasive materials.

Another object of the present invention is the provision of means for pumping sludge, abrasives and other materials in liquid suspension with minimal wear on the pumping mechanism.

Another object is to improve the responsiveness of the diaphragm to the piston impulse and minimize the flexure of the diaphragm.

A further object is the maintenance of a constant volume of fluid medium between the piston and the flexible diaphragm.

The invention disclosed herein although particularly useful in both withdrawing and elevating granular viscous or coagulated pulps from various kinds of operations and numerous types of equipment accomplishes such useful results with a substantially measured volume. The diaphragm is hydraulically operated by a reciprocating piston or a pulsating pump but since the liquids on both sides of the diaphragm are balanced or controlled the diaphragm is subjected to minimum rupturing conditions.

It will also be observed that the increased area of the diaphragm over that of the piston permits the same pumping or moving force with a short raised positive stroke of the diaphragm thereby greatly reducing the bearing pressures

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and minimizing the length of flexure of the diaphragm.

The present invention contemplates such other and further objects as will appear from the description which follows.

In attaining the foregoing objects, together with such further benefits, advantages and capabilities as may hereafter appear and as are inherently possessed thereby, there is shown in the accompanying drawings a preferred form and alternative form of the invention. However, it is to be understood that these are illustrative only and that the invention is not limited to these forms as they may be embodied in modifications coming within the scope of the invention as defined by the appended claims.

In the drawings:

Figure 1 is a longitudinal vertical section of a pumping assembly constructed in accordance with this invention.

Figure 2 is a modification of the same showing the manner of introducing the diaphragm unit in the pumping line remote from the actuating pump.

In detail the construction illustrated in the drawings, referring first to Figure 1, comprises the base 1, having suitable bearings thereon for the driven shaft 2. The crank disc 3 is fixed on the end of this shaft and has the crank pin 4 mounted in a radial slot in the disc to permit adjustment of the length of the stroke of the crank pin.

The connecting rod 5 engages the pin 6 and is pivoted to the crosshead 6' slidably guided in the forward extension 7 of the enclosing crankcase 8. The forward end of the extension 7 is closed by the head 9 having the axial stuffing box 10 therethrough. The end of the cylinder 11 is bolted to the head 9 and sealed thereto by an intervening gasket in the usual manner. The open end of the cylinder has the annular flange 12 extending outwardly therefrom. The piston 13 reciprocates within the cylinder and is suitably packed by piston rings engaging the walls of the cylinder. The piston rod 14 passes through the stuffing box 10 and is fixed in the crosshead 6'.

The impulse chamber 15 consists of the cylindrical wall 16 of greater diameter than the cylinder 11, bolted to the flange 12 and to the cover 17 having the outlet 18. The circular perforated brace 19 having a dished central area, and the flexible diaphragm 20 divide the impulse chamber and have their peripheries interposed between the wall 16 and the cover 17.

The stem 21 is fixed in the center of the diaphragm 20 and extends through the brace 19 and the reinforcing bar 22 which is fixed to the wall 16. The spring 23 incircles this stem and expands between the bar 22 and the plate 24. Spring 23 insures the return of the diaphragm

20 to the position shown in dotted lines against the perforated brace 19 on the suction stroke. The tension of this spring is adjusted by turning nut 25 threaded on the end of the stem. The reinforcing bar 22 is superfluous if the perforated brace 19 is made of sufficiently rigid material.

The return flow pipe 26 extends through the head 9 and discharges into the feed tank 27 mounted above impulse chamber 15. Feed tank 27 has a feed nipple 28 discharging into the said chamber. The check valve 29 is spring-loaded and is guided in the nipple 28 and closes the discharge end thereof with each forward stroke of the piston 13. The feed tank 27 is fed by the service pipe 30 having the valve 31, controlled by the float 32 floating on the surface of the liquid in the feed tank. The purpose of spring-loading check valve 29 is to prevent the introduction of compensating (piston leakage) fluid until the diaphragm is completely drawn back conformable to the contour of the perforated brace 19.

The pumping chamber 33, being the front compartment of the impulse chamber, is formed by the cover 17 and the diaphragm 20 and has the opening 18 into the flow line 34, the structure of which will be appropriate to the nature of the liquid being pumped. In the present instance the screen intake 35 is suitable for pumping abrasive ore pulps or drilling muds. The check valves 36, 37 are installed in the uptake pipe below the T fitting at 34, with the check valve 38 above.

To start, the pump piston 13 is placed on dead end position at the full end of the suction stroke and vent 40 on the material side of the diaphragm is opened. The space between check valves 36 and 38 and the pumping chamber 33 is filled with water through priming valve 41, to expel the air. The pump is then ready for operation. Vent 42 on the piston side of the diaphragm 20 is opened and chamber 15 is likewise filled with water or other fluid.

The invention operates substantially as follows: In Figure 1, the piston is shown at full discharge stroke, with the chamber 15 full of clean water or a suitable fluid lubricant flowed in through the replenishing assembly 27—32. The next half revolution of the shaft 2 will retract the piston 13 and suck the diaphragm 20 back against the screen brace 19, the displacement of the diaphragm being equal to the displacement of the piston relative to the chamber 15. The retraction of the diaphragm 20 is completed by the expansion of the spring 23, so that it conforms to the contour of brace 19 and any leakage of fluid past the piston is drawn into the piston chamber 15, through valve 29, therefore maintaining a constant volume of fluid in the piston chamber. Thus the diaphragm is never distorted.

Retraction of the diaphragm 20 causes a suction in the flow line 34 to refill the pumping area 33 of the chamber 15, partially evacuated by the preceding forward stroke of the piston 13. The head pressure in the flow line normally closes the check valve 38. The suction stroke of the piston 13 opens the check valves 36, 37 and refills the pumping chamber 33. The succeeding forward stroke of the piston advances the diaphragm 20 by exerting a hydrostatic pressure displacing the liquid in the chamber 33 in a substantially metered amount and closes the check valves 36, 37. The pumped liquid discharged through the opening 18, lifts the check valve 38 and the head pressure liquid above it, completing one cycle of operation.

Any leakage from the pulsation chamber 15, past the piston 13 is pumped on the suction stroke through the return flow pipe 26 back to the feed tank 27. The replenishing assembly including valve 29 may be placed below the pulsating chamber instead of on top thereby eliminating the necessity of spring loading valves 29.

The modification shown in Figure 2, differs only in that the pulsating chamber 15*x* is remote from the piston pump, not shown, and there is only the discharge pipe 39 (from the piston pump) connecting with the pulsating chamber 15*x*. The discharge valve of the piston pump is removed and the suction valve closed or plugged. The impulse transmitted from the cylinder and piston of any pulsating type of circulating pump will flow forward through the pipe 39 to the impulse chamber 15*x* and advance the diaphragm 20*x*, as previously described. The replenishing assembly at 27*x* for the operating fluid being similar to that at 27—32, Figure 1, previously described. On the suction stroke of the piston pump, the diaphragm 20*x* is drawn back as the fluid in chamber 15*x* is sucked back into the valve chamber of the piston pump because its discharge valve has been removed and the suction valve closed. The compression spring completes the backward return of the diaphragm against the perforated brace 19*x* and any fluid that has leaked by the piston on the pressure stroke is replenished through valve 31*x* of the replenishing assembly 27*x*. By this arrangement a plurality of diaphragm pulsating units such as 15*x*, 33*x*, previously described, can be operated from a single pumping source. In Figure 2 the feed line is reversed in that the source of supply originates in the hopper 35*x*, flows by gravity through the check valve 37*x* and opening 18*x* into the pumping chamber 33*x*, from which it is ejected through the check valve 38*x* and into the discharge line 34*x*.

The float controlled valve at 44*x* insures a supply of liquid through the hopper 35*x* to maintain the pumping chamber 33*x* full to capacity at all times, should the supply of sludge or pulp to this hopper fail or be interrupted. This is merely a control to prevent the diaphragm unit from going on "air".

This invention is particularly advantageous in pumping ore pulps, drilling muds and corrosive or abrasive materials against high heads. The diaphragm 20 effectively intervenes to prevent such substances entering the actuating mechanism connected with the pulsating chamber 15.

The piston-diaphragm pump of the present invention and the modification illustrated show that the diaphragm 20 separates the working material in pumping chamber 33 from the reciprocating piston 13 and that the diaphragm 20 is never subjected to strain to the point of rupture, regardless of head, thus insuring long operating life and minimum wear on the moving parts.

In the preferred embodiment there is shown only a single cylinder pump. It is apparent that duplex or multistage models are entirely practical especially where it is necessary or desirable to smooth out the pulsations or increase the capacity.

I claim:

1. In combination with a pulsating pump including a cylinder and a piston operating therein,

an impulse chamber, a pumping chamber having an inlet and an outlet, a flexible diaphragm of substantially greater area than the means supplying the pulsating pumping force separating said impulse chamber from said pumping chamber intermediate said pump and said inlet and outlet, a conduit connecting the portion of the cylinder back of the piston with the impulse chamber for returning to the impulse chamber liquid leaking past the piston, said liquid being pumped by the piston as it moves away from the impulse chamber, a brace in said impulse chamber, an automatic replenishing valve for said impulse chamber and a stem on said diaphragm extending through said brace and having a resilient tension member thereon bearing against said brace.

2. In combination with a pulsating pump including a cylinder and a piston operating therein, an impulse chamber, a pumping chamber having an inlet and an outlet, a flexible diaphragm of substantially greater area than the means supplying the pulsating pumping force separating said impulse chamber from said pumping chamber intermediate said pump and said inlet and outlet, said diaphragm acting over its entire area on each pulsation, a conduit connecting the portion of the cylinder back of the piston with the impulse chamber for returning to the impulse chamber liquid leaking past the piston, said liquid being pumped by the piston as it moves away from the impulse chamber, a screen brace interposed between the walls of said chambers in juxtaposition to plane of said diaphragm, and a stem on said diaphragm extending through said screen and having a resilient tension member thereon bearing against said brace.

3. In combination with a pulsating pump having a cylinder with a reciprocating piston therein, an impulse chamber open to said cylinder, a pumping chamber having an inlet and an outlet, a flexible diaphragm dividing said pumping chamber and said impulse chamber and intermediate said pump and outlet, a replenishing tank discharging into said impulse chamber between said cylinder and diaphragm, a check valve in the discharge outlet from said tank, a service pipe discharging into said tank, and a valve in said pipe controlled by a float in said tank.

4. In combination with a pulsating pump having a cylinder with a reciprocating piston therein, an impulse chamber open to said cylinder, a pumping chamber having an inlet and an outlet, a flexible diaphragm separating impulse chamber from said pumping chamber and intermediate said pump and outlet, a replenishing tank discharging into said impulse chamber between said cylinder and diaphragm, a check valve in the discharge outlet from said tank, a service pipe discharging into said tank, a valve in said pipe controlled by a float in said tank, and a bypass pipe connecting the head of said cylinder and said tank.

5. In combination with a pulsating pump having a cylinder with a reciprocating piston therein, an impulse chamber open to said cylinder, a pumping chamber having an inlet and an outlet, a flexible diaphragm separating said impulse chamber from said pumping chamber and intermediate said pump and outlet, a perforated screen-brace secured between the walls of said chambers in juxtaposition to the plane of said diaphragm, a stem on said diaphragm extending through said brace and having a resilient tension member thereon bearing against said brace and an adjustable plate on said stem, a replenishing tank discharging into said impulse chamber between said cylinder and diaphragm, a check valve in the discharge outlet from said tank, a valve in said pipe controlled by a float in said tank, and a bypass pipe connecting the head of said cylinder and said tank.

6. In combination with a pulsating pump having a cylinder with a reciprocating piston therein, an impulse chamber open to said cylinder, a pumping chamber having an inlet and an outlet, a flexible diaphragm separating said impulse chamber from said pumping chamber and intermediate said pump and outlet, a brace across the diameter of said chamber, a stem on said diaphragm extending through said brace and having a resilient tension member thereon bearing against said brace, a replenishing valve discharging into said impulse chamber, and a line connecting the head of said cylinder and said replenishing valve.

7. An auxiliary pulsating pumping unit, comprising in combination a chamber, a flexible diaphragm dividing said chamber into two non-communicating compartments, one being an impulse compartment and the other being a pumping compartment having an inlet and an outlet, a brace extending across the diameter of said chamber, a stem on said diaphragm extending through said brace and having a resilient tension member thereon bearing against said brace and an adjustable plate on said stem, means for connecting said impulse chamber to a remote pulsating pump, a replenishing valve for maintaining the liquid on the impulse side at a predetermined volume, and an outlet from said pumping compartment and a remote pulsating pump operating in conjunction with said pumping unit to apply pulsations to said diaphragm.

8. An auxiliary pulsating pumping unit, comprising in combination a chamber, a flexible diaphragm dividing said chamber into two non-communicating compartments, one being an impulse compartment and the other being a pumping compartment having an inlet and an outlet, a preforated screen-brace conforming to the form of said diaphragm at the limit of the intake impulse positioned between the walls of said chamber on the impulse side of said diaphragm, a brace extending across the diameter of said chamber, a stem on said diaphragm extending through said brace and having a resilient tension member thereon bearing against said brace and an adjustable plate on said stem, means for connecting said impulse chamber to a remote pulsating pump, a replenishing valve for maintaining the liquid on the impulse side at a predetermined volume, and an outlet from said pumping compartment and a remote pulsating pump operating in conjunction with said pumping unit to apply pulsations to said diaphragm.

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