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B. STEVENS

HYDRAULICALLY OPERATED DIAPHRAGM PUMP

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Fig. 1.

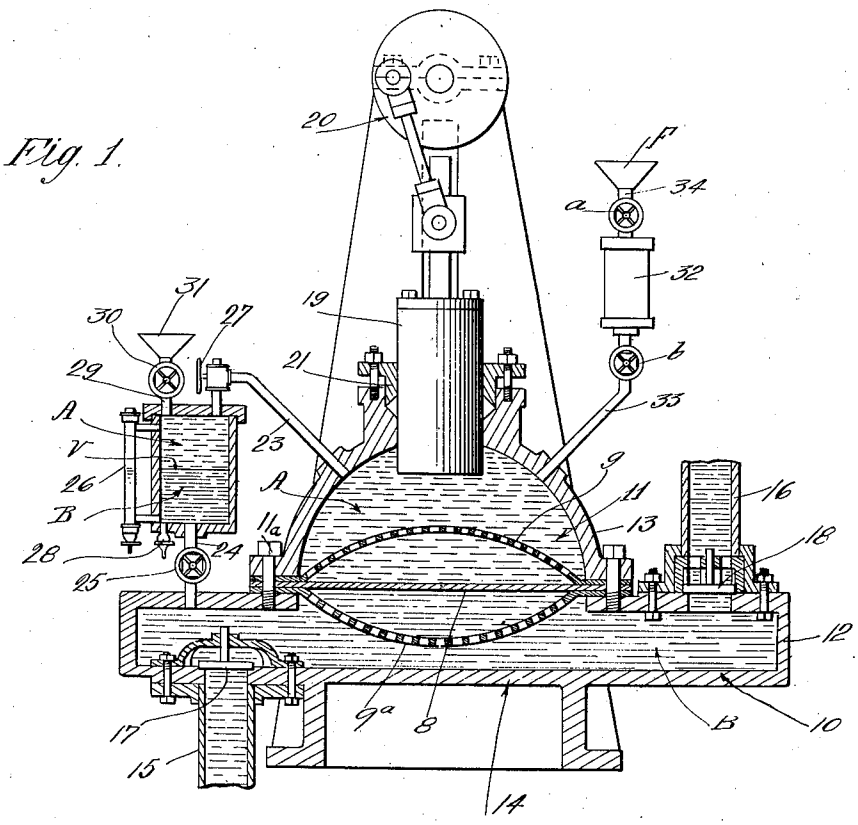
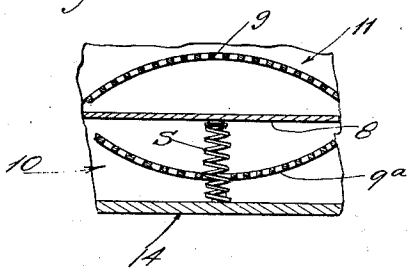


Fig. 1a



Inventor.
Blamey Stevens.

Attorney

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BLAMEY STEVENS, OF TEMASCALTEPEC, MEXICO.

HYDRAULICALLY-OPERATED DIAPHRAGM PUMP.

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This invention has to do generally with pumps, and is more particularly concerned with hydraulically operated diaphragm pumps.

As distinguished from the usual type of diaphragm pump wherein mechanical force is directly applied to the diaphragm for vibrating it, my pump is so devised that the actuating force is transmitted to the diaphragm through a body of fluid, which I choose to term "actuating fluid." The vibrations of the diaphragm, as set up by the variable pressure of the actuating fluid, cause pulsations of the fluid to be pumped and, by the movement of suitable valves, cause the periodic flow of the last named fluid in a single direction.

Generally described, my pump includes a main chamber having inlet and outlet valves for the fluid to be pumped, a second chamber containing actuating fluid, a flexible wall or diaphragm separating the two fluids, and means for varying the pressure of, or setting up pulsations in the actuating fluid. An increase in actuating fluid pressure causes displacement of the diaphragm and a consequent displacement of a certain amount of main chamber fluid, the displaced fluid lifting the outlet valve and passing from the main chamber. At the same time, the increased pressure of the main chamber fluid holds the inlet valve seated. Upon subsequent pressure drop in the actuating fluid and the consequent return of the actuating fluid body and diaphragm to their initial positions, suction is created in the main chamber, closing the outlet valve, opening the inlet valve, and drawing a new charge of fluid into said main chamber.

Water, oil or air may be utilized as the actuating fluid, though oil is preferably used when a piston is employed for producing the fluid pulsations, in order that said piston and its associated parts may be self-lubricated.

Any means for producing pulsation of the actuating fluid may be used, and while I show a plunger working in the actuating fluid it will be understood that the invention is not thereby limited. However the actuating fluid is subjected to pulsation, there is always liability of leakage with an attendant change of normal position of the diaphragm. My invention provides automatic means for compensating such leakage and thus for keeping the diaphragm in its proper operating position.

Other features of novelty and objects of the invention will be set forth in the following detailed description, reference being had to the accompanying drawings, in which:

Fig. 1 is a medial cross-section through a pump embodying my invention;

Fig. 1ª is a fragmentary view of Fig. 1 but showing the addition of a diaphragm operating spring.

In Fig. 1, main or valve chamber 10 and secondary or actuating chamber 11 are defined by sections or housings 12 and 13, respectively, of pump casing 14. Housing 13 is in the nature of a dome secured to housing 12 by bolts 11ª.

A movable barrier or diaphragm 8 serves as a partition between chambers 10 and 11. Preferably, this diaphragm is marginally anchored, for instance, by being clamped between housings 12 and 13. This diaphragm may be of any suitable material (rubber, for instance) having the requisite quality of elasticity and preferably, resiliency. In its broader aspects, however, the invention includes the embodiment of a movable wall or separator plate entirely unattached to the side walls of the pump casing, though preferably (but not necessarily) in fluid tight engagement therewith.

In order to limit the extent of diaphragm movement, so said diaphragm may not be over-stressed, I may provide grids or perforated stop plates 9 and 9ª above and below the diaphragm, respectively, both said plates being spaced from the diaphragm when the latter is unflexed. Preferably, the plates are of arcuate cross-section, as clearly illustrated in Fig. 1, in order that they may be fully complementary to the diaphragm when the latter is flexed in either direction.

Pipes 15 and 16, respectively, lead to and from chamber 10, usual inlet valve 17 and

outlet valve 18 serving as movable closures for pipes 15 and 16, respectively.

A piston or plunger 19 is adapted to be reciprocated through chamber 11 by any suitable mechanism, for instance, crank arrangement 20 which is adapted to be actuated from any suitable power source or prime mover (not shown). Piston 19 enters chamber 11 through a usual stuffing box 21.

Disregarding, for the time being, the particular means provided for introducing and replenishing the supply of actuating fluid A in actuating chamber 11, I will describe the operation of the pump. Fluid B which is to be pumped (and which may be water, slime, acid, etc.) normally fills chamber 10; while actuating fluid A, oil, for instance, completely fills chamber 11. When oil is used as the actuating fluid, it performs the additional function of lubricating the piston and stuffing box. On the other hand, since diaphragm 8 holds fluid B from direct contact with the piston and stuffing box, the device is capable of pumping such fluids as are destructive or detrimental to said piston and stuffing box. In order to more clearly differentiate between the actuating fluid and the fluid to be pumped, I will hereinafter refer to fluid A as "oil" and to fluid B as "water," though these references to particular fluids are not to be considered as inferences that the pump does not function equally well to handle fluids having characteristics different from those named.

As before stated, and contemplated as being included within the scope of my claims, I may employ any one of a number of suitable means for producing pulsations in or surges of fluid A, but in Fig. 1, I have chosen to illustrate reciprocatory piston 19 as a convenient and satisfactory pulsation producing means, and I will describe the operation of the device by referring to the mechanism of Fig. 1, whereupon its operation in connection with other forms of pulsation producing means will be readily understandable.

Assuming piston 19 is at the limit of its up-stroke, that chamber 10 is filled by fluid B, and that chamber 11 is filled by fluid A, the down-stroke of the piston causes displacement of fluid A and a consequent displacement or downwardly directed flexure of diaphragm 8. In its downward movement, the diaphragm 8 displaces a certain amount of fluid B, valve 18 lifting to allow the displaced water to pass into pipe 16.

Upon a subsequent up-stroke of the piston, oil A and diaphragm 8 are drawn back to their initial position, tending to create a vacuum within chamber 10 and hence closing valves 18 (the valve closing action may be aided by spring means, not shown, or gravity, if desired) opening valve 17 and admitting or drawing a replenished charge of water from pipe 15 into chamber 10. When diaphragm 8 is resilient as well as flexible, it aids in the return of fluid A to its initial position.

In some situations it is of advantage to provide springs S (Fig. 1[a]) beneath diaphragm 8 to create a differential pressure in fluids A and B as exerted on the diaphragm. Thus, when air under pressure is used as the actuating fluid and the pump is to function as a suction or vacuum pump, the spring, normally under compression, would be on the vacuum side of the diaphragm.

Thus, repeated pulsation or surges of fluid A bring about the alternate admission and expulsion of fluid B to and from chamber 10, the inlet and outlet valves serving to direct the flow in a constant direction.

Of course, there will be some loss of fluid A through stuffing box 21. Now, if the device is operating as a force pump, this loss of fluid will result in a gradual change in the mean position of the diaphragm, that it, said means position will gradually approach plunger 19 to compensate for the loss of oil. However, I provide means whereby the lost fluid is automatically replaced without shutting down the pump. This means comprises a reservoir 22 containing a replenishing supply of oil, pipe 23 providing a communication between said reservoir and chamber 11. Now as the mean position of the diaphragm tends to rise, said diaphragm will strike grid 9 before the plunger completes its upstroke, and were it not for the provision of compensating means, the remainder of the upstroke would merely create a vacuum in chamber 11 and would be ineffective, as far as the pumping action of the pump is concerned, with a consequent loss of pump efficiency. With reservoir 22 connected to chamber 11, however, this tendency of the piston to create a vacuum results in drawing into chamber 11 a new charge of oil to replace the lost oil, and the diaphragm will be maintained with its mean position substantially constant.

It is, of course, desirable and sometimes necessary that reservoir 22 be filled at all times, that is that oil withdrawn therefrom be immediately replaced either by a new charge of oil or auxiliary fluid. A convenient means for accomplishing this is to connect the bottom of the reservoir with chamber 10, for instance by pipe 24, which is valved at 25. As the oil in reservoir 22 passes to chamber 11, it is replaced by fluid from chamber 10, and a sight-glass 26 may be provided so the operator may have constant visual evidence of the amount of oil remaining within the reservoir. When it becomes necessary to replenish the supply of oil within the reservoir, valves 25 and 27

(the latter being in pipe 23) may be closed, the surplus fluid B in the reservoir being withdrawn through drain cock 28, and a new supply of oil is admitted through inlet pipe 29 which is valved at 30 and preferably has an integral filling funnel 31. Or, with the pump still in operation, valve 25 may be closed and valves 28 and 30 opened so replenishing oil may pass from funnel 31 into the reservoir to replace fluid B as it passes out through drain 28.

With valves 25 and 27 open during pump operation, the oil-water level V in reservoir 22 fluctuates in a manner similar to diaphragm 8. The extent of level fluctuation, however, may be reduced below that of the diaphragm by proper regulation of either or both valves 25, 27. The operator may, of course, watch the level fluctuation in glass 26 to ascertain whether or not diaphragm 8 is functioning properly.

When the device is operating as a suction pump, the oil lost from chamber 11 through stuffing box 21 is replaced by air entering through said box. This air may be extracted by such means as "lock" L consisting of a reservoir 32 (which may have a gauge glass or may be made up of a glass cylinder or bulb) connected to chamber 11 by pipe 33 and to filling funnel F by pipe 34. Valves *a* and *b* are provided in pipes 34 and 33, respectively. With valve *b* closed and valve *a* open, the lock is filled with oil. Valve *a* is then closed and valve *b* opened so the air trapped in chamber 11, bubbles up into reservoir 32 and is replaced by reservoir oil. By proper arrangement and adjustment of pipe 23 and valves 24, 27 and 30, tank 22 may be utilized as a lock for the extraction of air trapped within chamber 11; or, with both reservoirs 22 and 32 in use, pipe 23 may be the common line of communication between said chamber and the two reservoirs.

Should water be used as the actuating fluid, reservoir 22 may be eliminated and pipe 23 may lead directly to chamber 10.

It is to be understood that the drawings and description are to be considered merely illustrative of and not restrictive on the broader claims appended hereto, and therefore I do not wish to be limited to the construction of the pump as illustrated and described except for such limitations as a fair interpretation of the appended claims may import.

Having described a preferred form of my invention, I claim:

1. In a pump, a casing defining a chamber for the fluid to be pumped, inlet and outlet valves for the chamber, a body of actuating fluid within the casing, means for producing pulsations in the actuating fluid; the actuating fluid and the chamber contained fluid to be pumped being so associated that the forces of pulsations set up in said actuating fluid are transmitted to the fluid to be pumped; and an auxiliary reservoir in communication with the body of actuating fluid and the chamber-contained fluid in a manner whereby fluid pulsations in chamber and casing are transmitted to fluid within the auxiliary reservoir.

2. In a pump, a casing defining a chamber for the fluid to be pumped, inlet and outlet valves for the chamber, a body of actuating fluid within the casing, means for producing pulsations in the actuating fluid; the actuating fluid and the chamber contained fluid to be pumped being so associated that the force of pulsations set up in said actuating fluid are transmitted to the fluid to be pumped; and an auxiliary reservoir in communication with the body of actuating fluid and the chamber-contained fluid in a manner whereby fluid pulsations in chamber and casing are transmitted to fluid within the auxiliary reservoir, and means for independently controlling the degree of pulsation in the last named fluid.

3. In a pump, a casing defining a chamber for the fluid to be pumped, inlet and outlet valves for the chamber, a body of actuating fluid within the casing, means for producing pulsations in the actuating fluid; the actuating fluid and the chamber contained fluid to be pumped being so associated that the forces of pulsations set up in said actuating fluid are transmitted to the fluid to be pumped; an auxiliary reservoir in communication with the body of actuating fluid and the chamber-contained fluid in a manner whereby fluid pulsations in chamber and casing are transmitted to fluid within the auxiliary reservoir, and a sight glass for the reservoir whereby fluid pulsation in said reservoir is viewable.

4. In a pump, a casing defining two chambers, a movable barrier between the chambers, a body of actuating fluid confined in one of the chambers, inlet and outlet valves adapted to control the passage of the fluid to be pumped into and out of the other chamber, means for producing pulsation in said actuating fluid in a manner to reciprocate said barrier, and means for replenishing the supply of actuating fluid to compensate leakage losses thereof and thereby being adapted to maintain the median position of the diaphragm substantially constant; said last mentioned means embodying an auxiliary reservoir having communication with both the body of actuating fluid and the fluid in the other chamber.

5. In a pump, a casing defining two chambers, a movable barrier between the chambers, a body of actuating fluid confined in one of the chambers, inlet and outlet valves adapted to control the passage of the fluid to be pumped into and out of the other chamber, means for producing pulsation in

said actuating fluid in a manner to reciprocate said barrier; and means for replenishing the supply of actuating fluid to compensate leakage losses thereof and thereby being adapted to maintain the median position of the diaphragm substantially constant; said last mentioned means embodying an auxiliary reservoir having valved connection with both the body of actuating fluid and the fluid in the other chamber.

In witness that I claim the foregoing I have hereunto subscribed my name this eighteenth day of October, 1924.

BLAMEY STEVENS.