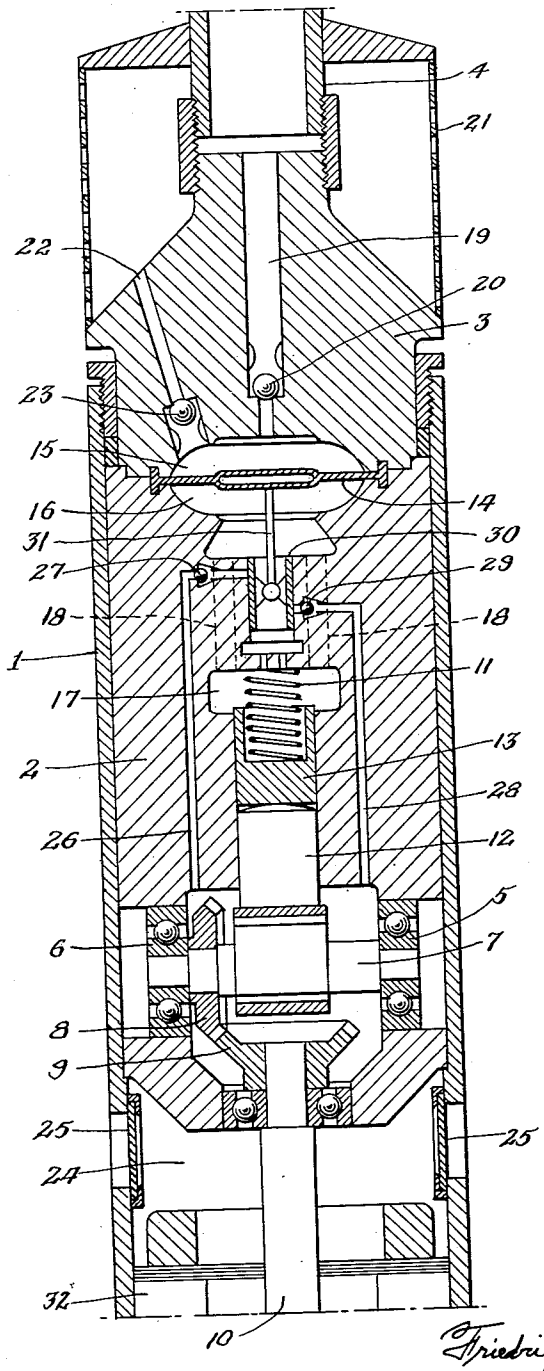
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DIAPHRAGM PISTON PUMP

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DIAPHRAGM PISTON PUMP

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This invention relates to pumps and is especially concerned with submersible deep well pumps of the type wherein a flexible pumping diaphragm divides a pumping chamber from a working chamber filled with hydraulic fluid and wherein the diaphragm is flexed by means of a piston which acts upon the fluid in the working chamber.

In pumps of the character described it is important that the volume of fluid in the working chamber be constantly maintained. For instance, if leakage from the working chamber occurs, such loss must be compensated for. Heretofore, it has been known in the art to effect this compensation by feeding additional hydraulic fluid to the working chamber through suitable check valves during the suction stroke of the piston. However, this procedure has involved certain disadvantages. For instance, an increase of the normal volume of the hydraulic fluid in the working chamber due, for example, to heat or to uncontrolled operation of the check valves, could, heretofore, be reduced only through losses due to seepage or leakage. Under such conditions the diaphragm may have to flex excessively over relatively long periods of operation which undesirably increases the stains imposed upon it. In extreme cases, this may well result in permanent damage to the diaphragm and may even involve a degree of deflection which is sufficient to block the flow of the liquid through the pumping chamber of the pump.

The principal object of the present invention is to avoid the difficulties and disadvantages just referred to by providing improved means for equalizing the volume of the hydraulic liquid in pumps of the character described and to accomplish this promptly and reliably as well as to constantly relate the equalization directly to the working position of the diaphragm.

How the foregoing objects together with such other objects as may appear hereinafter or are incident to our invention are attained is illustrated in preferred form in the accompanying drawings wherein:

The figure is a somewhat schematic axial section through a submersible deep well pump.

In the embodiment illustrated in the drawing a pump casing **1** contains a cylindrical body **2**. A head piece **3** connects the body to the discharge pipe **4**. The head piece is secured to the body **2** in any desired manner (not shown) and a suitable gland and packing are provided for fluid tightness as shown.

In a crossbore in the body **2** an eccentric shaft **7** is mounted in ball bearings **5** and **6** which shaft is driven through bevel gears **8** and **9** by shaft **10** of an electric motor **32**, likewise enclosed within the pump casing **1**.

An eccentric shaft **7** drives the pumping piston **13** through a tappet **12** against the effect of a spring **11**. Pumping piston **13** transmits its movements through hydraulic fluid to the pumping diaphragm **14** which latter is clamped between the body **2** and the headpiece **3**. The diaphragm **14** separates the pumping chamber **15** from the chambers **16** and **17** which are interconnected by passages **18**, the chambers **16** and **17** and the passages **18** being filled with hydraulic fluid. The diaphragm **14** protects the working parts of the pump and the pump drive from contamination by the liquid being pumped. The pumping chamber **15** is connected with the discharge pipe **4** through a bore or passageway **19**

under the control of foot valve **20** which prevents back flow. The liquid being pumped enters through a strainer **21** and passes through the suction passage **22** under the control of suction valve **23** which latter is a check valve adapted to close on the discharge stroke of the diaphragm.

Chamber **24** serves as a reservoir and equalization tank for the hydraulic fluid, all of the parts which drive the pumping piston **13** being arranged to operate in this reservoir. The equalizing flexible membranes **25** transfer the surrounding pressure to the hydraulic fluid stored in the reservoir.

Two lines, namely, **26** and **28**, are provided to connect the hydraulic fluid reservoir **24** with the working chamber. These lines terminate at their upper ends in ports which are controlled by a suitable valve **30** which in the present instance takes the form of a piston or slide valve which valve is coupled by a stem **31** to the pumping diaphragm **14** although it will be understood that any suitable interconnecting means may be employed for this purpose such, for example, as a compensating linkage.

A plurality of lines **26** and **28** may be employed if desired, although only two are illustrated in the present embodiment. One line, i.e., the line **26** in the present embodiment is provided with a check valve **27** which permits flow only from the reservoir into the work chamber. In the other line, a check valve **29** permits flow only from the working chamber into the reservoir.

The terminal ports of the two lines **26** and **28** are so constructed and arranged in the path of the control piston **30** that one end of the piston will uncover the port of line **26** and allows hydraulic fluid to flow past the check valve **27** into the working chamber whereas the other end is arranged to uncover the port of line **28** and permit hydraulic fluid to flow out of the working chamber past the check valve **29** into the reservoir **24**.

When the pump is in operation the eccentric shaft **7** drives the tappet **12** against the piston **13** forcing this piston against the compression of the spring **11** and the hydraulic fluid contained in the chambers **16** and **17** (constituting the working chamber) thereby forcing the fluid against the pumping diaphragm **14** to flex the latter in a direction away from its medial position between the chambers **15** and **16**. Since the control piston valve **30** is coupled to the diaphragm **14**, it will be obvious that the valve will move with the diaphragm. However, under normal conditions of operation the valve will not uncover the ports of lines **26** and **28** and will keep the working chamber isolated from the hydraulic reservoir.

Any reduction in the volume of the hydraulic fluid in the chamber and passages between the piston and the diaphragm **14**, due to leakage losses through the tappet and piston clearances, will serve to displace the diaphragm from its medial position and cause flection thereof to a point further down into the working chamber **16**. Since the control piston **30** will be simultaneously displaced to the same degree, it will uncover the port of line **26** and make it possible for the hydraulic fluid contained in the reservoir **24** which is subject to the external pressure through the membranes **25** to open the check valve **27** and permit entry of the hydraulic fluid from the reservoir into the working chamber to compensate for the reduction of the volume thereof due to the leakage. In like manner, the control piston **30** will uncover the port of line **28** as soon as the diaphragm **14** shifts its medial position and amplitude of flection toward the pumping chamber **15** due to the increase of the volume of hydraulic fluid in the working chamber **16—17**. Undesired overfilling of the working chamber is then compensated for by passage of said excessive hydraulic fluid past the check valve **29** through the passage **28** into the reservoir **24**.

Adjustment of the hydraulic fluid volume in the working chamber occurs instantly and constantly as soon as the diaphragm **14** shifts its amplitude of flection upward or downward sufficiently far to bring the control valve or piston **30** into a position in which it will uncover one or the other of the ports **26** or **28**. Likewise, the communication between working chamber **16—17** on the one hand and the hydraulic reservoir **24** on the other hand is immediately shut off when the diaphragm returns to its normal medial position after the hydraulic fluid volume in the working chamber has been suitably adjusted. In this way, any positive or negative variation in the volume of the hydraulic fluid is compensated for without delay which protects the diaphragm against intolerable flection and excessive strain over any considerable period of time. At the same time the arrangement is such as to prevent the diaphragm from shifting its range of flection too far into the pumping chamber **15** and thus blocking the suction and discharge lines of the pump.

We should like to add that the controlling device for the hydraulic fluid can be operated by the diaphragm either directly or indirectly as, for example, by hydraulic, electrical or other means just so long as the equalization process is initiated and terminated under the direct control of the diaphragm itself. The embodiment illustrated is a preferred arrangement because of its simplicity and effectiveness.

We claim:

1. A submersible, deep-well pump comprising a housing enclosing a pumping chamber having an inlet and an outlet for the well fluid to be pumped, a discharge pipe connected to the pumping chamber, a constant volume working chamber, a flexible pumping diaphragm separating said chambers, said working chamber being filled with hydraulic operating fluid, a reservoir of hydraulic operating fluid, said reservoir having in an external wall thereof a flexible membrane adapted to respond to the pressures in the reservoir and in the well,

a pumping piston with an operating face forming a portion of the wall of the working chamber, a motor for reciprocating the piston, a hydraulic fluid line connecting the reservoir and the working chamber and adapted to deliver fluid from the reservoir to the working chamber, a hydraulic fluid line connecting the reservoir and the working chamber and adapted to deliver fluid from the working chamber to the reservoir, valve means closing both of said fluid lines during normal operation of the pump, and means responsive to the physical position of the diaphragm for actuating said valve means to effect opening of the line which delivers to the working chamber when the diaphragm is insufficiently flexed toward the pumping chamber and to effect opening of the line which delivers to the reservoir when the diaphragm is flexed too greatly toward the pumping chamber.

2. A pump according to claim 1 wherein the valve means controlled by the diaphragm is a valve coupled directly to the diaphragm.

3. A pump according to claim 1 wherein a check valve is provided in each of the fluid connecting lines.

4. A pump according to claim 1 wherein the valve means controlled by the diaphragm includes a slide valve and an actuating rod directly interconnecting the valve and the diaphragm.

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