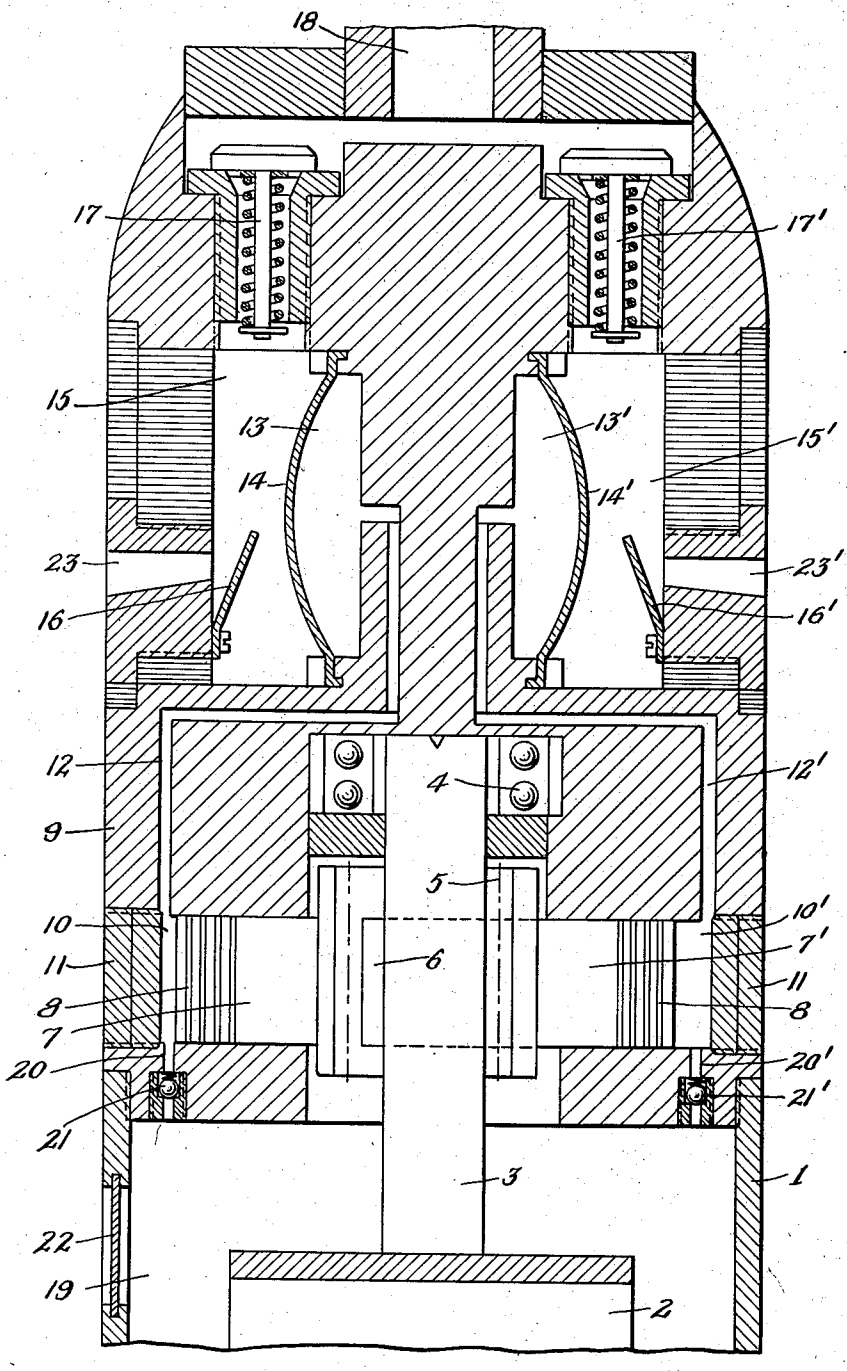
Nov. 25, 1958 F. W. PLEUGER 2,861,518

DIAPHRAGM PUMP

Filed Feb. 14, 1956



INVENTOR
Friedrich Wilhelm Pleuger
BY
Synnestvedt & Lechner
ATTORNEYS

United States Patent Office 2,861,518
Patented Nov. 25, 1958

2,861,518

DIAPHRAGM PUMP

Friedrich Wilhelm Pleuger, Hamburg, Germany

Application February 14, 1956, Serial No. 565,465
Claims priority, application Germany February 17, 1955
8 Claims. (Cl. 103—44)

This invention relates to submersible pumps for deep well pumping, and more particularly, to a diaphragm pump for submersion in an oil well in order to pump from great depths.

In petroleum drilling it is often necessary to pump off brine lying underneath the petroleum deposit before commencing the pumping of the oil itself. In such operations it is not uncommon to encounter pressures at the bottom of the oil deposit of the order of several hundred atmospheres. When it is attempted to operate a pump under such high pressures, leakage problems are encountered with respect to the pump packing.

The invention provides for minimizing such leakage problems by equalization of the pressure inside and outside of the pump. Briefly, the invention involves the provision of a plurality of pistons operating through sealed hydraulic pressure chambers on flexible diaphragms which are exposed to an act upon oil in pumping chambers. In the preferred form of the invention the pistons are provided in paired opposing relation and operate within a liquid-filled pressure compensation chamber.

The primary object of the invention is the provision of a diaphragm pump capable of sustained operation even when submerged to the bottom of the oil deposit in an oil well.

A further object of the invention is the provision in a diaphragm pump of a hydraulic pressure transfer chamber (adapted to exert the force generated by a reciprocating piston on a flexible diaphragm) and an associated liquid-filled pressure compensation chamber whereby the pressure of oil from the surrounding strata is balanced by the pressure of the incompressible liquid within the pumping unit.

Still further, the invention has as an object the provision of a pump which can be used during prolonged operation at various temperatures, the object here in question being to provide automatic compensation for expansions and contractions of the volume of the pressure liquid resulting from fluctuations in temperature.

Yet another object of the invention is the provision, in a diaphragm pump having a plurality of pistons acting to distort flexible diaphragms, of means for automatically compensating for liquid which leaks out of the pressure transfer chambers between the pistons and cylinder walls.

How the foregoing and other objects and advantages of the invention are attained will appear more clearly from the following description, taken together with the accompanying drawing showing a vertical section of a diaphragm pump according to the invention.

An electric motor, preferably of the squirrel cage type, is mounted within the tubular housing **1**, the rotor thereof being schematically shown at **2**. The motor shaft **3**, conveniently arranged concentrically of the pump housing **1**, is journalled at its free end in the ball bearing **4**. An eccentric or cam **6** (together with a surrounding needle bearing **5**) is mounted on the motor shaft **3** and drives a yoke or other similar member interconnecting the pistons **7**—**7'** for conjoint reciprocation.

While the drawing illustrates an embodiment having two radially aligned and opposed pistons, it is contemplated that any convenient number of pistons may be used, the preferred forming involving an even number of pistons arranged in opposed pairs and generally radially disposed around the eccentric.

Piston rings **8** are provided on the pistons **7** and **7'** to minimize leakage of pressure liquid between the pistons and cylinder walls. The cylinders are preferably formed as bores in a common cylinder housing **9**. The portions of the cylinders ahead of the pistons provide working spaces **10** and **10'** which may be sealed by means of removable plugs **11**.

The working spaces **10** and **10'** of the pistons are in communication, via the passageways **12** and **12'** with pressure chambers **13** and **13'**, respectively.

Flexible diaphragms **14** and **14'** separate the pressure chambers **13** and **13'** from the pumping chambers **15** and **15'**, respectively. The pressure chambers **13** and **13'**, the passageways **12** and **12'**, and the cylinders in which the pistons **7** and **7'** act are all filled with gas-free pressure liquid.

The pumping chambers **15** and **15'** are adapted to draw from the well through inlet passages **23** and **23'** provided with one-way inlet valves **16** and **16'**, and to deliver to the well riser **18** via one-way outlet valve means **17** and **17'**.

The piston and cylinder devices with their associated parts (the pressure chambers **13** and **13'**, pumping chambers **15** and **15'**, diaphragms **14** and **14'**, passageways **12** and **12'**, working spaces **10** and **10'**, etc.) are arranged symmetrically with reference to a plane containing the vertical axis of the housing.

The space surrounding the motor, eccentric, yolk, pistons and bearings forms a liquid-filled pressure compensation chamber **19** within the housing **1**.

In order to compensate for liquid which leaks past the pistons from the working spaces **10** and **10'** into the compensation chamber **19**, ducts **20** and **20'** are provided through the bottom wall of the cylinder housing **9**. Spring loaded non-return valves **21** and **21'** are arranged in the ducts **20** and **20'** respectively, so as to prevent escape of liquid from the spaces **10** and **10'** and to permit flow of liquid from the compensation chamber into the spaces when the leakage past the pistons has reduced the volume of liquid in the system to the point where sufficient suction is built up during the suction stroke of the piston to overcome the seating force of the valve springs. Thus, there is provided a communication between the pressure compensation chamber **19** and the pressure chambers **13** and **13'** through non-return valve means.

In order to insure an additional pressure compensation of the compensation chamber **19** with the outside pressure, and also for the compensation of possible volume displacements resulting from the piston movements, the external flexible diaphragm **22** may be disposed in the housing wall **1**. The external diaphragm or compensation diaphragm **22** may be arranged at any convenient place in the housing, the drawing showing it in the side wall near the top of the motor. However, it is also possible to arrange the diaphragm **22** below the motor in the bottom cap (not shown) of the housing **1**.

According to one aspect of the invention, the external diaphragm **22** may even be eliminated, that is, when the pistons are arranged so as to avoid displacement of any appreciable volume of the liquid in the compensation chamber during a cycle of the pistons. In other words, when one piston extends into the compensation chamber, the other piston will be advanced into its cylinder and vice versa. Thus, the actual volume of the compensation chamber remains substantially constant. With such an arrangement the external diaphragm **22** may not be necessary.

The embodiment of the invention shown in the drawings operates in the following manner:

After the electric motor has been connected with the power supply line, the rotor 2 rotates in the compensation chamber 19 and imparts to the double piston arrangement 7—7' a reciprocating movement by means of the eccentric 6 and the yoke interconnecting the pistons. Since the two pistons are of the same shape and size, their displacements are equal and the backward and forward movement causes no change of volume in the pump housing.

The pressure liquid within the passageways and pressure chambers flows, in response to motion of the pistons, alternately through the passageways 12 and 12' and into the pressure chambers 13 and 13', thus alternately distending and relaxing the diaphragms 14 and 14'. The periodic changing of the volume of the pressure chambers 13 and 13' correspondingly increases and decreases the volume of the working chambers 15 and 15'. The change in volume of the working chambers effects an alternate intake of oil through passage 23 or 23' and check valve 16 or 16' and an outflow of oil through outlet valve 17 or 17' and into the well riser 18.

Pressure liquid which leaks between the pistons and cylinder walls during operation is automatically compensated for on each piston stroke in the suction direction by intake of pressure liquid from the compensation chamber through the passages 20 or 20' and spring loaded non-return valves 21 or 21'. If the volume of the liquid in the pressure chambers and connected spaces increases due to a rise in temperature, the diaphragms 14 and 14' will bulge slightly and assume a new equilibrium position. The pressure inside and outside the pump is thereby maintained in balance and no excessive strain is placed on any packings involved.

Thus, even if the volume of the liquid in the pressure chamber increases, the pump operation continues unimpaired because of the distention of the diaphragms 14 and 14' to a new neutral position. If the temperature subsequently drops to normal operating temperature, the diaphragms 14 and 14' will again assume their original neutral position.

While various arrangements of the parts of the invention are possible, it is preferred to arrange the diaphragms generally vertically within the housing and to arrange the pistons generally radially in horizontal position below the diaphragms. Such an arrangement of the pistons facilitates a rotating cam or eccentric drive of the kind shown and also insures that the lengths of the passageways from the cylinders to the respective pressure chambers will all be substantially equal and therefore have substantially equal pressure drops. The radial type arrangement in effect provides for driving of the pistons in phase opposition and for symmetrical arrangement of the parts.

As will be seen from the drawing, the structure of the pump according to the invention is arranged in several major sections which are mounted one on top of another axially. Thus, the bottom section or portion houses the electric motor, the next section contains the piston and cylinder devices, the next the pumping chambers and pressure chambers, the next the pressure outlet valves and finally the connection with the pump riser or delivery pipe. This structural arrangement makes for ready assembly and also for ease of replacement and repair of various parts of the invention, without a complete disassembly.

I claim:

1. For the withdrawal of liquids upwardly through the riser of a deep well, a pump submerged in the liquid, said pump comprising, a plurality of piston and cylinder devices each in communication with a pressure chamber, pressure transfer liquid filling the cylinders and pressure chambers, a pumping chamber adjacent each pressure chamber, a flexible diaphragm separating each pressure chamber from

the adjacent pumping chamber, each pumping chamber being adapted to draw from the well through first passage means and deliver to the well riser through second passage means, one-way inlet valve means in said first passage means and one-way outlet valve means in said second passage means, means for driving the pistons, a liquid-filled compensation chamber, the open ends of said cylinders being in communication with the compensation chamber, and a flexible compensation diaphragm in the wall of the compensation chamber, said compensation diaphragm being exposed to the pressure in the well outside the pump on one side and to the pressure of the liquid in the compensation chamber on the other side.

2. A deep well pump according to claim 1 in which the liquid filled compensation chamber is in communication with each of said pressure chambers via conduit means, and in which non-return valve means are provided in said conduit means to prevent flow into the compensation chamber.

3. A pump according to claim 1 in which the means for driving the pistons is located within the compensation chamber, and in which each of the piston and cylinder devices is paired with an opposing device, whereby the volume of the compensation chamber remains substantially constant.

4. A pump according to claim 1 in which the cylinders are arranged in a common cylinder housing.

5. A pump according to claim 1 in which the pressure chambers and pumping chambers are arranged above the piston and cylinder devices and the means for driving said devices.

6. A construction according to claim 2 in which the non-return valve means are spring-loaded.

7. For the withdrawal of liquids upwardly through the riser of a deep well, a pump submerged in the liquid, said pump comprising, a pump housing, a plurality of pumping chambers within said housing, each pumping chamber being adapted to draw from the well through first passage means and deliver to the well riser through second passage means, one-way inlet valve means in said first passage means and one-way outlet valve means in said second passage means, a pressure chamber opposed to each pumping chamber, a flexible diaphragm separating each pressure chamber from its pumping chamber, said diaphragms being generally vertically disposed within said housing, a generally horizontally disposed piston and cylinder device for each pressure chamber, a passageway connecting each cylinder with its pressure chamber, pressure transfer liquid filling the cylinders, passageways and pressure chambers, a liquid-filled compensation chamber, means within the compensation chamber for driving the pistons in phase opposition, the open ends of the cylinders being in communication with the compensation chamber, and a flexible compensation diaphragm in the wall of the compensation chamber, said compensation diaphragm being exposed to the pressure in the well outside the pump on one side and to the pressure of the liquid in the compensation chamber on the other side.

8. For the withdrawal of liquids upwardly through the riser of a deep well, a pump submerged in the liquid, said pump comprising a housing having a generally vertical axis, a pair of piston and cylinder devices each in communication with a pressure chamber, a pumping chamber opposed to each pressure chamber, a flexible diaphragm separating each pressure chamber from its pumping chamber, said piston and cylinder devices and pumping and pressure chambers being arranged symmetrically with reference to a plane containing said axis of the housing, pressure transfer liquid filling the cylinders and pressure chambers, the pumping chambers being adapted to draw from the well and deliver to the well riser, a liquid-filled compensation chamber, means within the compensation chamber for driving the pistons in phase opposition, the open ends of the cylinders being in communication with

the compensation chamber, and a flexible compensation diaphragm in the wall of the compensation chamber, said compensation diaphragm being exposed to the pressure in the well outside the pump on one side and to the pressure of the liquid in the compensation chamber on the other side.

References Cited in the file of this patent

UNITED STATES PATENTS

1,301,485	Mueller	Apr. 22, 1919
1,851,666	Evans	Mar. 29, 1932
2,343,962	Dodson	Mar. 14, 1944