June 29, 1954 F. O. LUENBERGER 2,682,229

PRESSURE SYSTEM FOR SUBMERSIBLE STRUCTURES

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Fig. 1.

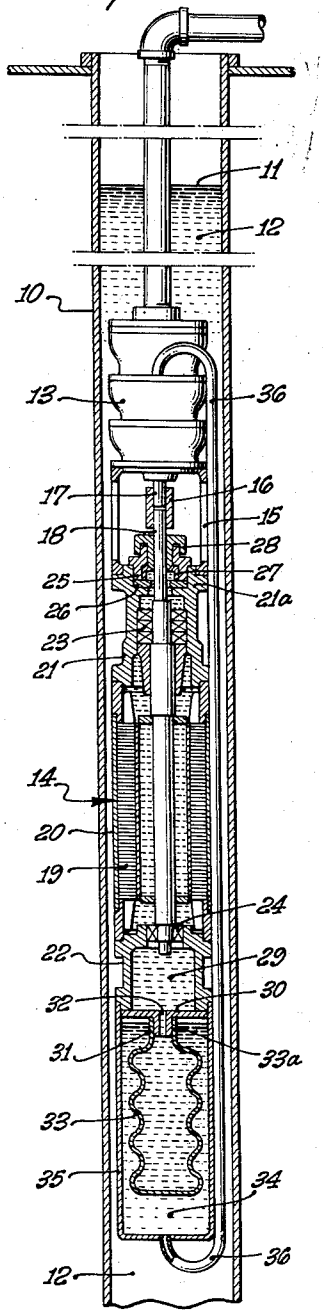


Fig. 2.

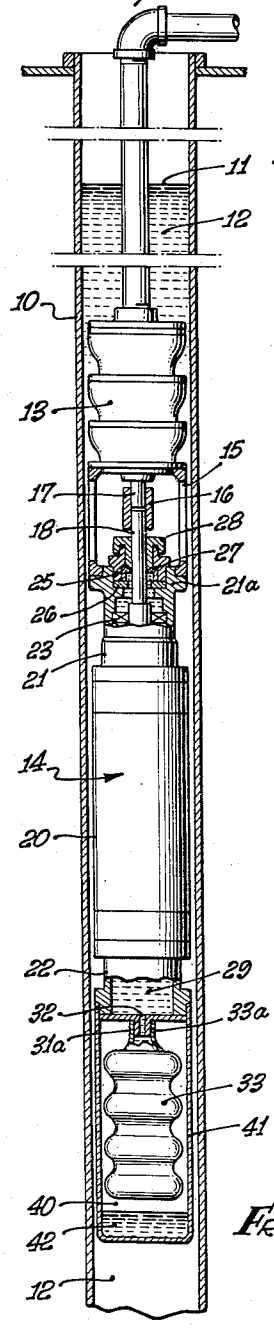
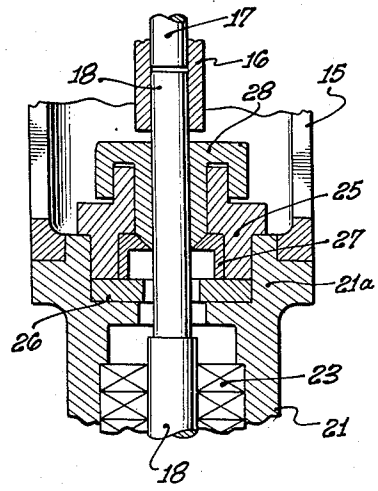


Fig. 3.



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PRESSURE SYSTEM FOR SUBMERSIBLE STRUCTURES

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6 Claims. (Cl. 103—87)

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This invention relates to submersible structures, such as a motor-pump unit adapted to operate in a well.

In such submersible structures, it is of fundamental importance to prevent entry of well fluid into the motor casing. The well fluid in which the unit is designed to operate ordinarily carries suspended particles of grit, as well as other foreign matter that is likely to harm the stator windings and the rotating parts of the motor.

But for the rotating shaft that necessarily extends beyond the motor casing for cooperation with the pump, it is a simple matter to provide a fluid-tight casing for the motor. Many types of running seals have been proposed, such, for instance, a pair of relatively rotatable cooperating members carried respectively by the motor shaft and the motor casing. It has been found that such seals may be effectively used, provided that there exists within the motor casing a fluid having a pressure exceeding that of the well fluid on the outside of the seal. The internal motor fluid that is often used is inert oil, or the like. The function of this increased pressure is to insure that the leakage that may exist, however small, is outwardly of the casing through the running seal, thereby maintaining the purity of the motor fluid within the casing.

It is an object of this invention to provide an improved system for maintaining a substantial excess pressure of the internal motor fluid, whereby effective operation of the seal is achieved to exclude the well fluid.

It is another object of this invention to provide a compact submersible unit in which a reservoir of motor fluid is provided as a part of the submersible structure itself, together with novel means for elevating the pressure of the motor fluid within the reservoir.

The excess pressure necessary for effective operation of the seal is dependent upon the rotational speed of the appartus. It is accordingly another object of this invention to provide a system that will supply an excess pressure in an amount dependent upon the rotational speed of the apparatus.

It is still another object of this invention to utilize the velocity or pressure head developed by a pump in a submersible motor-pump unit to supply an excess pressure to the motor casing fluid in an amount dependent upon the rotational speed of the apparatus.

It is still another object of this invention to utilize the vapor characteristics of a volatile material to produce an excess pressure in the internal motor casing fluid in order to secure an effective operation of the sealing means to prevent ingress of well fluid into the motor casing.

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This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several embodiments of the invention. For this purpose there are shown a few forms in the drawings accompanying and forming part of the present specification. These forms will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a diagrammatic view, mostly in section, illustrating a motor-pump unit in operative position in a well, and embodying one form of this invention;

Fig. 2 is a view similar to Fig. 1, but illustrating a modified form of this invention; and

Fig. 3 is an enlarged fragmentary sectional view illustrating, by way of example, a seal that may be used in the structure.

In the drawings, there is illustrated a submersible unit in a well casing 10, the unit being disposed below the level 11 of the well fluid 12 therein. The unit comprises a pump 13, which may be of the centrifugal type, and a motor 14. The motor 14 is coupled to the pump 13 structurally by a frame 15, and rotatively by the coupling 16 that is connected to the pump shaft 17 and the motor shaft 18 respectively.

The motor stator windings 19 are enclosed by a casing 20, together with upper and lower end brackets 21 and 22 that are secured in fluid tight relation to the casing 20. These brackets 21 and 22 house suitable bearing structures 23 and 24 for the motor shaft 18. Fluid, such as oil, having insulating properties completely fills the motor casing.

As the shaft 18 extends through the upper end bracket 21, it is necessary there to provide a sealing structure to prevent entry of well fluid 12. A sealing structure that may be used is illustrated in Fig. 3.

The seal comprises, in essence, a stationary member mounted on the casing 20 and a rotary member mounted on the shaft 18. A sleeve 25, together with ring 26, accommodates the rubbing stationary element 27 that is provided with a frusto-conical surface. The stationary sealing elements 25, 26, and 27 are insertable into a tubular extension 21a of the upper end bracket 21

in fluid-tight relation therewith. The element 27 may be of special wear-resistant material. A rotating element 28 is carried by the shaft 18. This rotating element 28 has a surface mating with the frusto-conical surface of the stationary element 27, and in rubbing rotational contact therewith.

The effectiveness of the seal in preventing entry of well fluid 12 into the motor casing 20 along the motor shaft 18, for a given rotational speed, is dependent upon a minimum excess pressure of the internal motor fluid as compared with the pressure of the well fluid 12 at the seal. By providing such an excess pressure, any leakage, however small, that may occur is of motor fluid outwardly of the casing 20. Accordingly, the purity of the internal motor fluid is maintained, insuring against contamination of the operating parts of the motor 14.

A reservoir for the internal motor fluid is conveniently provided as a part of the submersible structure. For this purpose, the lower end bracket 22 may be of inverted cup-shaped configuration, providing a motor fluid chamber 29 immediately beneath the bearing 24. A plate 30 extends across the end of the bracket 22. Depending from the plate 30 is a boss 31 having a through aperture 32 leading to chamber 29. A flexible metal bellows 33 has a mouth 33*a* circumscribing the boss 31 and is secured thereto. Accordingly, the interior of the flexible bellows 33 is in communication with the chamber 29 and the interior of the motor casing 20 by way of the aperture 32.

Any pressure exerted on the exterior of the bellows 33 will necessarily be communicated to the internal motor fluid, the bellows 33 forming a part of the internal motor fluid reservoir. It is not sufficient, merely, that the exterior of the bellows 33 be subjected directly to the well fluid; substantially more pressure is necessary in order to achieve the desired operation of the seal while the unit is in operation.

To supply such pressure to the external portion of the bellows 33 and, thereby, to the motor fluid, there is illustrated in Fig. 1 a pressure chamber 34 formed by a supplementary rigid housing 35 carried by bracket 22. This housing 35 substantially circumscribes the bellows 33, but is out of fluid-conducting relation with the interor of the bellows 33.

The chamber 34 is filled with well fluid 12. A conduit 36 communicates the pressure developed within the pump 13 to the chamber 34. Accordingly, when the unit is operating, the pressure of the pump, or a portion thereof, is communicated to the fluid within the pressure chamber 34. The pressure of the fluid in chamber 34 is transmitted to the internal motor fluid through the flexible bellows 33 forming a part of the reservoir therefor.

The effectiveness of the seal is dependent upon the rotational speed of the device. By utilizing the pressure developed by the pump 13 to supply such excess pressure, the requirements for the effective operation of the seal are satisfied, since the pressure communicated by the conduit 36 is the pressure developed by the pump, in turn dependent upon the speed of rotation of the apparatus.

In Fig. 2 there is illustrated a modified form of this invention, which accomplishes the result of supplying an excess pressure to the internal motor fluid. In this instance, a pressure chamber 40 is provided by a supplementary rigid housing 41 attached to the bracket 22. The chamber 40 is in this instance sealed.

In the pressure chamber 40 there is provided a small quantity of volatile fluid 42. The vapor pressure due to the fluid 42 is communicated to the internal motor fluid through the flexible bellows 33, thereby maintaining such excess of pressure as is necessary for successful operation of the seal.

Ordinarily, the conditions under which the submersible structure can, between limits, be anticipated. Accordingly, the fluid may be chosen which best fulfills the requisites of the system, giving due regard to the temperature, the depth at which the system operates, and the desired minimum pressure differential required for the particular type of seal. Fluids such as methyl chloride, butane, and propane may be used.

The amount of fluid 42 used, while small, is such that for all limits of operation, sufficient fluid 42 is available to supply the necessary pressure.

The inventor claims:

1. In a submersible structure adapted to operate in a well or the like: a motor having a casing and a shaft extending beyond said casing; a pump operated by said motor and coupled to said shaft; rotary and non-rotary elements carried by the shaft and the casing respectively, said elements being in engagement with each other to form a seal between said motor casing and said shaft to exclude well fluid from said casing; means forming a reservoir in communication with the interior of said casing, including a flexible bellows; means forming a pressure chamber contiguous with said bellows, but out of fluid conducting relation with the interior thereof; a liquid completely filling the casing and the reservoir; and conduit means connecting said pressure chamber and the outlet side of said pump for elevating the pressure of said internal liquid to create a presure drop across said seal from the interior of the casing.

2. In a submersible structure adapted to operate in a well or the like: a motor having a casing and a shaft extending beyond said casing; rotary and non-rotary elements carried by the shaft and the casing respectively, said elements being in engagement with each other to form a seal between said motor casing and said shaft to exclude well fluid from said casing; said casing being adapted to contain internal fluid; means forming a reservoir for said internal fluid, and in communication with the interior of said casing, including a flexible bellows; means forming a sealed pressure chamber contiguous with said bellows, but out of fluid conducting relation with the interior thereof; and a volatile fluid in said pressure chamber for exerting a pressure on said bellows to elevate the presure of said internal fluid to create a pressure drop across said seal from the interior of the casing; the amount of volatile fluid being such with respect to the size of the pressure chamber as to provide both a vapor and a liquid phase in said pressure chamber.

3. In a submersible structure: a motor having a shaft; a substantially cylindrical casing surrounding said motor; a first bracket for one end of said casing, said shaft extending through said bracket; means carried by said first bracket forming a seal between said shaft and the exterior of said first bracket; a second bracket for the other end of said casing, said second bracket being of cup shaped configuration facing longi-

tudinally outwardly of said casing, said second bracket being adapted to carry a bearing structure for the end of the shaft, said second bracket forming a space beyond said shaft and aligned therewith, said space being in communication with the interior of said casing; a plate accommodated on the open portion of said second bracket, said plate having an apertured boss extending outwardly of said space and aligned with said shaft; a flexible bellows accommodated on said boss, the interior of said bellows being in communication with said space; said bellows, said casing, and said space being adapted to contain an inert fluid; a housing surrounding said bellows and secured to said second bracket, said housing forming a pressure chamber for said bellows; and means for supplying pressure to said pressure chamber for elevating the pressure of said fluid.

4. In a submersible structure: a motor having a shaft; a substantially cylindrical casing surrounding said motor; a first bracket for one end of said casing, said shaft extending through said bracket; a pump operated by said motor and coupled to said shaft; means carried by said first bracket forming a seal between said shaft and the exterior of said first bracket; a second bracket for the other end of said casing, said second bracket being of cup shaped configuration facing longitudinally outwardly of said casing, said second bracket being adapted to carry a bearing structure for the end of the shaft, said second bracket forming a space beyond said shaft and aligned therewith, said space being in communication with the interior of said casing; a plate accommodated on the open portion of said second bracket, said plate having an apertured boss extending outwardly of said space and aligned with said shaft; a flexible bellows accommodated on said boss, the interior of said bellows being in communication with said space; said bellows, said casing, and said space being adapted to contain an inert fluid; a housing surrounding said bellows and secured to said second bracket, said housing forming a pressure chamber for said bellows; and conduit means connecting said pressure chamber and the outlet side of said pump for elevating the pressure of said fluid.

5. In a submersible structure adapted to operate in a well or the like: a motor having a casing and a shaft extending beyond said casing; rotary and non-rotary elements carried by the shaft and the casing respectively, said elements being in engagement with each other to form a seal between said motor casing and said shaft to exclude well fluid from said casing; means forming a reservoir in communication with the interior of said casing, including a flexible bellows; means forming a sealed pressure chamber contiguous with the bellows, but out of fluid conducting relation with the interior thereof; a liquid completely filling the casing and the reservoir; and a volatile fluid in said pressure chamber for exerting a pressure on said bellows to elevate the pressure of the liquid in said casing and said reservoir to create a pressure drop across said seal from the interior of the casing; the amount of volatile fluid being such with respect to the size of the presure chamber as to provide both a vapor and a liquid phase in said pressure chamber.

6. In a submersible structure: a motor having a shaft; a substantially cylindrical casing surrounding said motor; a first bracket for one end of said casing, said shaft extending through said bracket; means carried by said first bracket forming a seal between said shaft and the exterior of said first bracket; a second bracket for the other end of said casing, said second bracket being of cup shaped configuration facing longitudinally outward of said casing, said second bracket being adapted to carry a bearing structure for the end of the shaft, said second bracket forming a space beyond said shaft and aligned therewith, said space being in communication with the interior of said casing; a plate accommodated on the open portion of said second bracket, said plate having an apertured boss extending outwardly of said space and aligned with said shaft; a flexible bellows acocmmodated on said boss, the interior of said bellows being in communication with said space; said bellows, said casing, and said space being adapted to contain an inert fluid; a housing surrounding said bellows and secured to said second bracket, said housing forming a sealed pressure chamber for said bellows; and a volatile fluid in said pressure chamber for exerting a pressure on said bellows to elevate the pressure of said inert fluid to create a pressure drop across said seal from the interior of the casing; the amount of volatile fluid being such with respect to the size of the pressure chamber as to provide both a vapor and a liquid phase in said pressure chamber.

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