March 26, 1940. F. M. MASON 2,194,561

SUBMERSIBLE STRUCTURE

Filed Dec. 6, 1937

Fig. 3

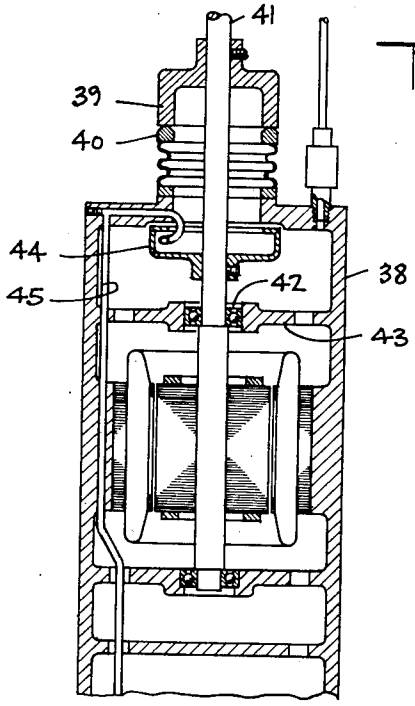


Fig. 1

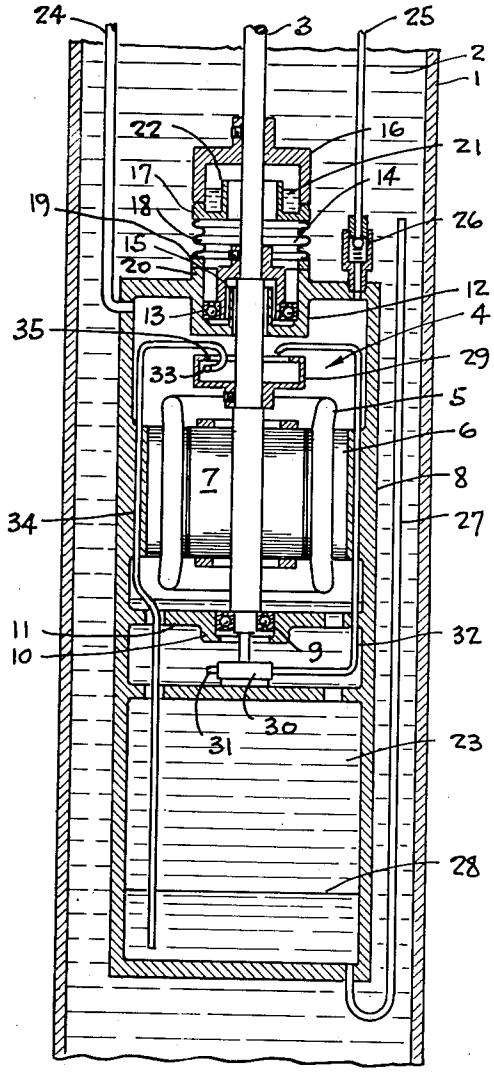
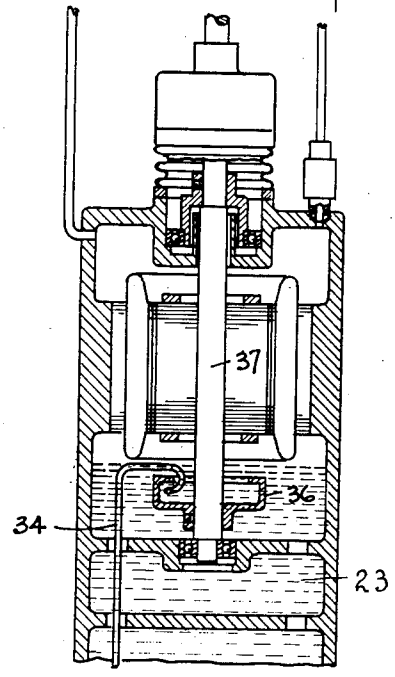


Fig. 2



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SUBMERSIBLE STRUCTURE

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Application December 6, 1937, Serial No. 178,197

10 Claims. (Cl. 172—36)

This invention relates to a structure adapted to be submerged in a well; for example, an electric motor that is adapted to operate a directly connected pump for raising the well liquid, usually water.

Such a submersible structure often carries a filling of neutral liquid; for example, oil. In several prior applications, assigned to the same assignee as this application, there are described and claimed a number of forms of submersible motors in which means are provided for replenishing the oil, and to depress the oil level during energization of the motor. These applications may be identified as follows:

Applicant: Frank M. Mason, Ser. No. 178,198, filed December 6, 1937, for "Submersible electric motor";

Applicant: George T. Pfleger, Ser. No. 178,249, filed December 6, 1937, for "Submersible electric motor".

The above applications claim a submersible motor having a casing adapted to be filled with neutral liquid during periods when the motor is deenergized, and having means to supply gas or air to the motor casing to depress this liquid below the operating parts of the motor, when the motor is energized. Such an arrangement is shown but not claimed in the instant application.

The present invention also deals with submersible casings in which oil is present. It has been found that leakage of well liquid, or water, around or neighboring the seal may not be entirely prevented. The water entering into the casing by this or other means, readily emulsifies, due to the beating action of the rotating parts. It is undesirable to have any substantial quantity of such an emulsion in the casing, since it replaces the far more inert oil, and further the emulsion does not have as good insulating effect as oil, which it replaces.

It is accordingly one of the objects of this invention to make it possible to prevent the accumulation of any material quantity of emulsion produced by a mixture of the neutral liquid and well liquid.

It is another object of this invention to provide a simple mechanical system for separating the neutral and well liquid, as for example by a centrifugal separator, and for discharging the well liquid.

This invention possesses many other advantages, and has other objects which may be made more easily apparent from a consideration of several embodiments of the invention. For this purpose there are shown a few forms in the drawing 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 drawing:

Figure 1 is a view, mainly in section, illustrating an embodiment of the invention lowered in a well; and

Figs. 2 and 3 are similar fragmentary views, illustrating modifications of the invention.

In the form of the invention shown in Fig. 1 the well is shown as defined by a casing 1. From this casing, well liquid 2 is intended to be pumped, as by the aid of a pump (not shown) directly connected to a shaft 3.

The shaft 3 is adapted to be driven by an electric motor 4, shown as comprising the primary windings 5 on stator 6, and the rotor 7. The motor may be of the usual induction motor squirrel cage rotor type.

In order that this motor may be submerged in the well liquid 2, it is supported within a submersible casing 8 which is so arranged that well liquid 2 is excluded from the motor winding parts or from the parts that rotatably support the motor shaft 3.

In the present instance the motor shaft 3 is shown as supported adjacent its lower end by a ball bearing structure 9, the outer race of which is supported in a boss 10, depending from a perforated partition 11 extending across the casing 8. At its upper end this casing 8 is provided with an inwardly directed bearing supporting boss 12. In this boss is supported the outer race of the upper ball bearing structure 13. The inner race thereof is supported on the inverted cup-like member 14 secured to the shaft 3. The boss 13 has a reentrant inner annular wall 15 defining an annular oil well around the ball bearing structure 13.

In the present instance the motor shaft 3 is directed upwardly and outwardly of the casing 8. In order to prevent well liquid from entering into the casing 8, where the motor shaft 3 extends outwardly therefrom, use is made of a pair of relatively rotary sealing members, one of which is carried by the shaft 3 and the other of which is supported by the casing 8. Thus in the present instance the shaft 3 carries the rotary sealing member 16 having a downwardly directed lower edge. This lower edge is adapted to contact with

the upwardly directed edge of a non-rotary sealing member 17. This non-rotary sealing member is shown as carried, in the present instance, by the metal bellows 18 supported as by the aid of a ring 19, in fluid tight manner upon the upwardly extending annular boss 20 integral with the casing 8. If desired, supplemental means may be provided for resiliently urging the sealing surfaces together.

In the present instance, in order to effect a more perfect seal, use is made of a heavy sealing liquid 21 (such as mercury) disposed within the members 16 and 17 and overlapping the areas of contact. This sealing liquid 21 is accommodated in the annular space defined by the upwardly extending annular flange 22 formed on the non-rotary sealing member 17.

At least during periods of deenergization the motor casing 8 is intended to have a substantially complete filling of a neutral liquid 23, such as oil, which is lighter than the well liquid 2. In the form shown in Fig. 1 the arrangement is such as is described in the co-pending applications hereinabove identified; that is, upon energization of the motor 4 the oil level is depressed so as to obviate the skin friction losses usually encountered when a rotor is revolving in a liquid. When the motor is deenergized the neutral liquid level is permitted to rise within the casing 8.

As a part of the system by the aid of which these results may be obtained, there is indicated a gas supply conduit 24 leading into the top of the casing 8 and extending to the top of the well. There is also shown an oil supply conduit 25 for replenishing the supply of neutral liquid, and a check valve 26 is used to prevent reverse flow of the neutral liquid through the pipe 25. A balance tube 27 is shown. This balance tube extends upwardly for substantially the entire length of casing 8 and is open at the top. It connects with the bottom of the casing 8. This balance tube makes it possible to have the casing 8 substantially filled with oil before it is lowered in the casing, and without any substantial amount of oil being lost due to any pressure differential between the inside and the outside of the casing 8.

In the present instance the well liquid 2 is shown as having a surface 28 in contact with the liquid 23.

It has been observed that when two liquids, such as well liquid 2 and the neutral liquid 23, are in contact, and where there is some agitation of the liquid, an emulsion of the two liquids is apt to form. Accordingly in the casing 8 such emulsion may exist, especially if there be any appreciable leakage of well liquid into the casing through any leakage path. Such an emulsion, of course, should be kept away from the electric windings of the motor, since the emulsion forms a better conducting medium than the oil.

In accordance with the present invention, the liquid filling in the casing is subjected to a mechanical separator operated by shaft 2, whereby any emulsion that has formed is broken down, the heavy well liquid being separated from the light neutral liquid. The heavy liquid is returned to the well, the light liquid rejoining the liquid filling in the casing. In the present instance, this mechanical separator is in the form of a cup 29 carried by the shaft 3 immediately below the downwardly extending boss 12, provisions being made to lift some of the liquid filling of the casing upwardly into cup 29. For this purpose, a pump 30 is provided directly connected to shaft 3 below the boss 10. Pump 30 has an intake 31 and an outlet connected to an upwardly extending discharge conduit 32, which passes the liquid discharged by the pump into cup 29.

As shaft 3 rotated the cup 29, the centrifugal action causes the liquid in the cup to be thrown outwardly against the peripheral wall thereof, where the liquid forms a rotating layer, and if any emulsion is present therein, the heavier liquid is caused to coalesce into drops or larger bodies. The rotary motion of this layer serves to force the liquid into opening 33 of the drain or discharge conduit 34, which discharges the collected liquid below the surface of contact 28, near the bottom of casing 8. There, any drops or bodies of heavy well liquid present unite with the rest of the well liquid, while the light neutral liquid rises and rejoins the liquid filling in the casing.

It is to be noted that the centrifugal separator 29 is provided with an overhanging flange 35 in order to form a somewhat restricted outer annular space in which the separated well liquid may collect.

When the motor stands idle, or while it is operating, leakage of well liquid into casing 8 may occur. Most of this liquid will merely settle through the light liquid in the casing and rejoin the well liquid at the bottom of the casing. However, some of it may unite with the light liquid to form an emulsion. The pump 30 by picking up the liquid about its intake and delivering this liquid to the separator, will cause the emulsion in that part of the liquid to be reduced. This action of pump 30 also causes some circulation of the liquid filling in the casing, whereby various portions of it are pumped to separator 29, serving to decrease the degree of emulsification of the entire filling. The pump inlet 31 may also be appropriately located to best achieve such a result. In some instances, however, such a pump may not be needed, as for example where the centrifugal separator 29 is appropriately located.

For example in Fig. 2 the centrifugal separator 36 is shown as carried by the motor shaft 37 at a place immediately below the windings of the motor.

In this form of the invention, the level of the neutral liquid in the casing is above the cup 36 when the motor is in operation. Thus the liquid filling is subjected to the separator action of the rotating cup and any emulsion present will be reduced, as in the first form.

Should the seal around the rotating shaft permit appreciable leakage of well liquid into the interior of a submersible casing, it is possible by appropriate location of the centrifugal separator to stop the descent of the emulsion through the motor windings. Thus in the form shown in Fig. 3 the casing 38 is provided with the relatively rotary sealing members 39 and 40 constructed substantially as illustrated in the prior figures. In this case the upper end of the motor shaft 41 is shown as supported by a ball bearing structure 42. The outer race of this ball bearing structure is shown as supported in a central boss formed on the perforated wall 43 extending across the casing 38. Above the bearing structure 42 is the centrifugal separator 44. This centrifugal separator is disposed immediately below the top of the casing 38. It is intended that any mixture of oil and well liquid will gravitate into this separator before it has a chance to pass the windings of the motor. The centrifugal separator serves to urge the heavier well liquid outwardly and into the opening of the drain or discharge conduit 45.

What is claimed is:

1. In a submersible structure, a casing adapted to be lowered in well liquid, a neutral liquid in said casing, a rotary shaft extending out of the casing, a seal between the shaft and the casing, and means within the casing for mechanically separating mixtures of the neutral liquid and well liquid.

2. In a submersible structure, a casing adapted to be lowered in well liquid, a neutral liquid in said casing, a rotary shaft extending out of the casing, a seal between the shaft and the casing, and a centrifugal separator in the casing and operated by rotation of the shaft.

3. In a submersible structure, a casing adapted to be lowered in well liquid, a neutral liquid in said casing, a rotary shaft extending out of the casing, a seal between the shaft and the casing, and means ensuring against accumulation of a mixture of well liquid and neutral liquid in the casing, comprising a rotary separator, and means for passing liquid from within the casing upwardly into the separator.

4. In a submersible structure, a casing adapted to be lowered in well liquid, a neutral liquid in said casing, a rotary shaft extending out of the casing, a seal between the shaft and the casing, and means ensuring against accumulation of a mixture of well liquid and neutral liquid in the casing, comprising a rotary separator carried by the shaft.

5. In a submersible structure, a casing adapted to be lowered in well liquid, a neutral liquid in said casing, a rotary shaft extending out of the casing, a seal between the shaft and the casing, means ensuring against accumulation of a mixture of well liquid and neutral liquid in the casing, comprising a rotary separator carried by the shaft, and a drain from the separator for the well liquid.

6. In a submersible structure, a casing adapted to be lowered in well liquid, a neutral liquid in said casing, a rotary shaft extending out of the casing, a seal between the shaft and the casing, and means ensuring against accumulation of a mixture of well liquid and neutral liquid in the casing, comprising a rotary separator located axially of the shaft and directly below the top of the casing, and a drain for the well liquid from the separator.

7. In a submersible structure, a casing adapted to be lowered in well liquid, a neutral liquid in the casing and lighter than the well liquid, said casing having an opening in the bottom to permit contact between the liquids substantially below the top of the casing, a rotary shaft extending upwardly out of the casing, and means ensuring against accumulation of a mixture of well liquid and neutral liquid in the casing, comprising a mechanical separator operated by the shaft, and a drain leading from the separator to below the surface of contact.

8. In a submersible structure, a casing adapted to be lowered in well liquid, a neutral liquid in the casing and lighter than the well liquid, said casing having an opening in the bottom to permit contact between the liquids substantially below the top of the casing, a rotary shaft extending upwardly out of the casing, and means ensuring against accumulation of a mixture of well liquid and neutral liquid in the casing, comprising a rotary centrifugal separator carried by the shaft and located immediately below the top of the casing.

9. In a submersible structure, a casing adapted to be lowered in well liquid, a neutral liquid in the casing and lighter than the well liquid, said casing having an opening in the bottom to permit contact between the liquids substantially below the top of the casing, a rotary shaft extending upwardly out of the casing, and means ensuring against accumulation of a mixture of well liquid and neutral liquid in the casing, comprising a rotary separator operated by the shaft, and a pump for passing liquid into the separator.

10. In a submersible structure, a casing adapted to be lowered in well liquid, a neutral liquid in the casing and lighter than the well liquid, said casing having an opening in the bottom to permit contact between the liquids substantially below the top of the casing, a rotary shaft extending upwardly out of the casing, and means ensuring against accumulation of a mixture of well liquid and neutral liquid in the casing, comprising a rotary separator operated by the shaft, and a pump for passing liquid into the separator, said pump being connected for operation by the shaft.

FRANK M. MASON.