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EXPANSION BAG UNIT FOR LIQUID FILLED SUBMERSIBLE MOTORS

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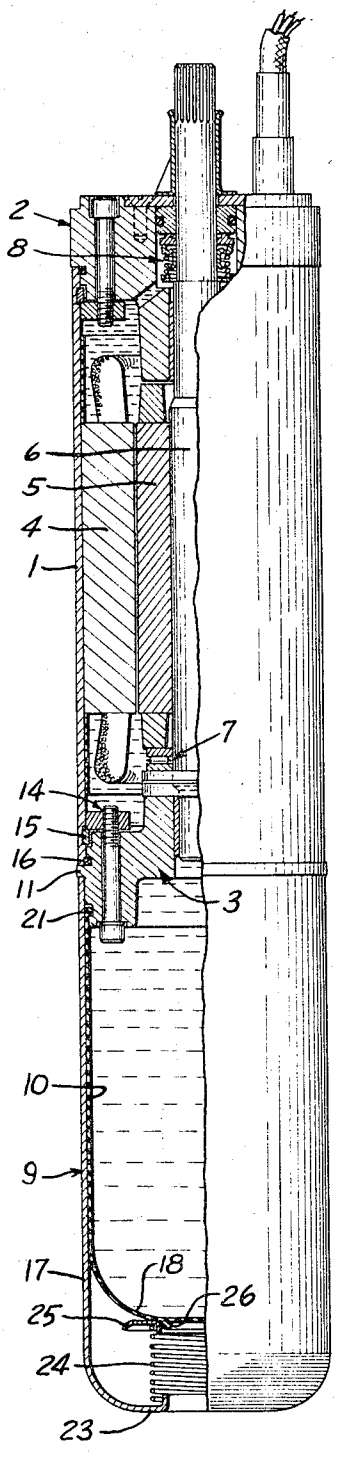


Fig. 1.

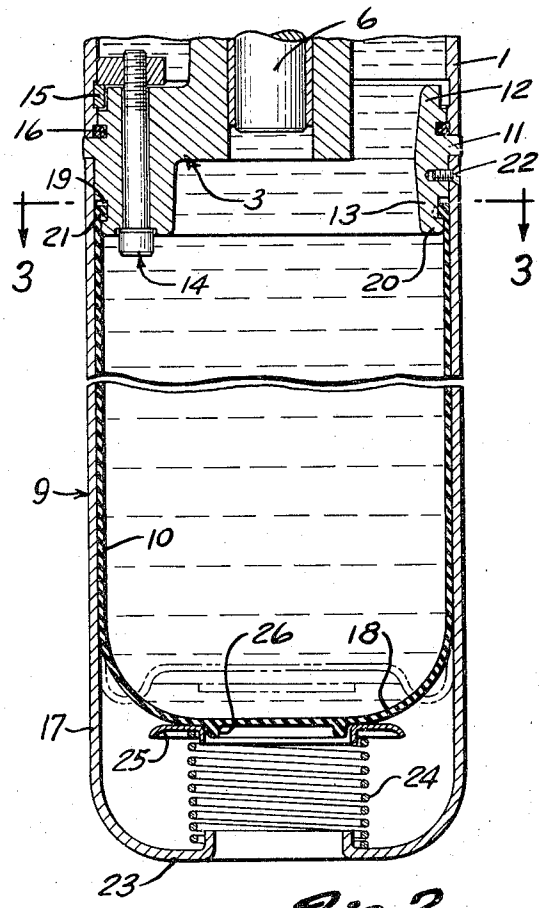


Fig. 2.

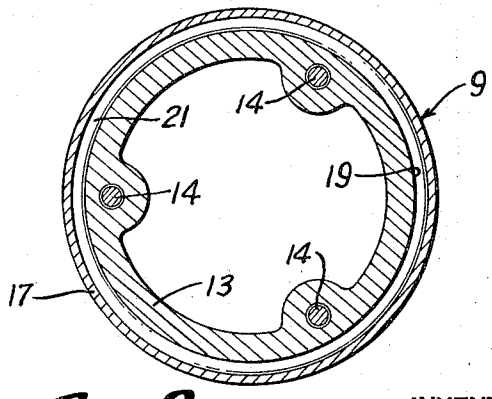


Fig. 3.

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EXPANSION BAG UNIT FOR LIQUID FILLED SUBMERSIBLE MOTORS

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6 Claims. (Cl. 310—87)

This invention relates to liquid filled submersible motors and particularly to an improved construction of a flexible bag or diaphragm unit for maintaining the liquid within a submersible motor under a pressurized condition to prevent leakage of fluid into the motor.

Submersible motors for deep well pumping oprations and the like are normally integrated with a liquid pumping pump unit and mounted within the lower end of the well casing. The upper end of the motor includes a suitable end frame through which the motor shaft projects and is coupled to a pump. The field winding components of the motor must be protected against the well liquid and the other components against sand, grit and other foreign matter within the well liquid. Generally, a potted stator construction or a special liquid filled motor construction is employed in present commercial practice.

In liquid filled motors, suitable rotating seal means are normally provided about the motor shaft where it projects from the motor to confine the liquid. As all practical seals tend to develop some leakage with age, a liquid filled reservoir and expansion unit is connected to the lower end of liquid filled motors to pressurize the liquid within the motor such that all liquid leakage or flow is from the motor through the shaft seal. The temperature of the liquid within the motor will also vary as a result of the intermittent operation of the submersible motor, with a corresponding thermal expansion and contraction of the liquid within the motor which may tend to force the special liquid from the motor and draw the surrounding well liquid into the motor. However, the expansion unit contracts and expands to compensate for the varying liquid volume and to maintain a selected internal pressure which is above that of the surrounding well liquid, such that any leakage will be from the motor into the well.

The present invention is particularly directed to an improved expansion unit construction and to an improved and simplified means of attaching a flexible expansion bag to the lower end of the motor.

Generally, in accordance with the present invention, the expansion bag is formed as an elongated tubular member which is closed at one end and open at the other. The open end includes an enlarged inwardly projecting sealing lip. The lower motor frame is provided with a depending extension of reduced diameter and having a circumferential recess on the exterior. The portion of the extension from the recess to the outer end is further reduced in diameter such that the bag slips over the end frame extension with the enlarged portion within the recess. A tubular protective cover slips over the bag and the end frame extension and compresses the enlarged portion within the recess to provide a liquid tight seal therebetween. The protective cover projects beyond the open end of the bag and is secured to the adjacent frame portion of the extension in any suitable manner.

It has been found that this provides a very reliable and simplified means of interconnecting a flexible bag member to form an integrated part of a submersible motor.

The drawing furnished herewith illustrates a preferred construction of the present invention in which the above advantages and features are clearly disclosed as well as others which are set forth in connection with the following description of the drawing.

In the drawing:

FIG. 1 is a view of a submersible motor with half of the motor shown in elevation and the other in longitudinal section;

FIG. 2 is an enlarged longitudinal section showing the improved bag and bag attachment construction of the present invention; and

FIG. 3 is a transverse section taken generally on line 3—3 of FIG. 2.

Referring to the drawing and particularly to FIG. 1, the illustrated submersible motor is generally an elongated cylindrical construction adapted to be vertically arranged in the lower portion of a well casing, not shown. Generally, a pump, not shown, is secured to the upper end of the motor for pumping of the well liquid within which the unit is immersed.

The illustrated motor includes an outer tubular shell or main frame **1** closed at the upper end by an end frame **2** and at the lower end by a lower end frame **3**. An annular stator **4** is mounted centrally of the main frame **1** with a rotor **5** rotatably aligned with the stator and carried by a rotor shaft **6**. The lower end of the shaft **6** is journalled within the lower end frame **3** which includes a thrust bearing unit **7** to support the rotor **5**. The upper end of the shaft **6** projects through the upper frame **2** and is rotatably supported therein with the outer end of the shaft projecting upwardly from the motor for coupling to the pump. A rotating ring seal **8** is provided within the upper end frame **2** to essentially prevent leakage into and from the motor cavity. Although various types of seals have been employed in the prior art, a spring loaded, face seal such as illustrated is preferably employed to provide a long operating life. The motor cavity is filled with a suitable liquid which is preferably a transformer type oil having a rust inhibitor added thereto. To prevent entrance of the well liquid particularly under the forces established by cooling and heating of the oil, a pressurized oil reservoir unit **9**, which forms the particular subject of this invention, is secured to the lower end of the motor and projects axially downwardly therefrom as an extension of the motor proper. The unit **9** includes an inner flexible bag **10** filled with a corresponding oil and communicating with the rotor cavity through the end frame and particularly the shaft opening. In operation, the bag **10** expands and contracts to maintain the rotor cavity filled with oil and under a sufficient pressure to insure that leakage through seal **8** is from the motor cavity. The life of the motor is thereby prolonged during the period that the oil leaks from the motor.

The stator, rotor and other operating components of the motor as such may be of any suitable or known construction and consequently no further description thereof is given. The present invention is particularly directed to the construction of the lower end frame **3** and the pressurized unit **9**, which is more fully described.

Referring particularly to FIG. 2, the lower end frame **3** generally includes an annular body portion having a diameter corresponding to the internal diameter of the frame **1** and a small centrally located clamping flange **11** divides the frame into a motor portion **12** and bag support portion **13**. The motor portion **12** slidably telescopes into the corresponding end of the main shell or frame **1** with the flange **11** abutting the end thereof. A plurality of clamping bolt and nut units **14** extends through the end frame **3** and cooperates with internal lugs **15** to secure the end frame **3** to the main frame **1**, as more fully disclosed in applicant's copending application entitled Motor End Frame Fastening Apparatus filed on the same date as this application and assigned to the same assignee. An O-ring seal **16** is interposed between

the main frame 1 and the motor portion 12 to seal the junction therebetween.

The opposite or outer portion 13 has a bag mounting unit 9 secured thereto as follows:

Generally, the unit 9 includes the flexible diaphragm or bag 10 having an open top generally corresponding to the diameter of the annular portion 13 and clamped thereto by an outer protective cover or shell 17. The bag 10 includes an integral bottom 18 to contain the oil within the bag and in communication with the rotor chamber through the open end and end frame 3. The flexible bag 10 is formed of a suitable rubber-like material such as that sold under the mark Buna N which is highly resistant to aging and chemical effects and which has an excellent life and flexibility in oil and water.

The frame portion 13 defines a lower frame extension of a reduced diameter with respect to frame 1, generally similar to that of frame portion 12. A circumferential recess 19 is formed in extension 13 and spaced slightly axially upwardly from the outermost end. A lower transverse wall or lip 20 defined by the recess is further reduced in diameter with the reduction with respect to the portion 13 generally corresponding to the wall thickness of the bag 10. The bag 10 has an internal diameter substantially corresponding to the diameter of the lip 20 and is telescoped thereover with a sufficient axial length to maintain a preselected oil reservoir. The outer end of the flexible bag 10 is formed with an inwardly thickened integral portion defining a sealing lip 21 mating with and disposed within the recess 19. The sealing lip 21 is formed of a somewhat greater depth than the corresponding recess 19 and is compressed therein by the cover or shell 17.

Shell 17 is an elongated tubular member having an internal diameter substantially corersponding to the diameter of the extension 13 a thickness substantially corresponding to that of the main frame 1. The shell 17 is telescoped over the bag 10 and the extension 13 with the end abutting the clamping flange 11 to provide a continuous outer surface with the main frame 1 and flange 11. A plurality of radially spaced attachment screws 22 pass through openings in shell 17 and into appropriately tapped openings in frame extension 13 outwardly of bag 10 to secure the shell 17 to frame 3.

The close fit between the extension 13 and the cover 17 compresses the sealing lip 21 within the recess 19 and directly provide a support for the bag and a firm and reliable liquid tight joint about the upper end of the bag. Consequently, the oil in bag 10 can only escape through the motor proper; i.e., upwardly through the lower end frame 3 and the main frame 1.

The tubular cover or shell 17 projects axially outwardly of the bag bottom 18 and includes a centrally apertured integral bottom 23 to subject the exterior of bag 10 to the pressure of the well liquid. A coil spring 24 acts between the inner surface of the cover bottom 23 and the exterior of the bag bottom 18 to pressurize the bag and tend to cause it to collapse inwardly within itself. A suitable pressure distributing ring plate 25 is disposed between the bag 10 and the spring 24 such that the spring force is transmitted evenly over the lower portion of the bag such that it will fold inwardly within itself. The bag 10 may be provided with the illustrated integral molded depending ring 26 mating with the opening in guide plate 25 to maintain proper location thereof.

In operation, the motor assembly with a suitable pump connected to the upper end is disposed within the well casing. The pressure established within the oil filled motor cavity and the flexible bag 10 is slightly in excess of the pressure established by the well liquid. Normally the rotating seal 8 in the upper frame 2 will prevent any leakage in or out of the motor. However, any tendency for leakage through the seal 8 is maintained in an outward direction as long as the pressure within the motor exceeds the pressure of the well liquid. During motor

operation, the motor heats up and the oil expands. The increased volume causes the rubber bag to expand and compress the spring. Conversely, when the motor is shut off, the oil cools and contracts. The bag 10 correspondingly contracts and maintains the motor and reservoir filled with the oil. During the life of the motor, the oil within the motor cavity will eventually slowly leak past the seal 8. The spring 24 expands into the bag 10 and causes it to move inside of itself until it reaches the maximum spring extension.

The telescoped outer shell 17 comprising of sealing lip 20 into recess 19 provides a long and reliable liquid tight joint and bag attachment. Although flexible expansion bags have been employed in connection with submersible motors, the present invention provides a very inexpensive and rapid means for providing a reliable and inexpensive mounting of a flexible bag structure.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. In a submersible motor having a lower end frame permitting communication with the inside of the motor, the improvement comprising

an extension of the lower end frame having a circumferential recess on the exterior surface and spaced slightly from the lower end,

a flexible bag telescoped over the end of the extension and having an integral enlarged portion mating with the recess, and

a protective tubular member encircling the bag and projecting axially over the extension to compress said enlarged portion and provide a liquid tight pressure attachment of the bag to the motor.

2. The submersible motor of claim 1 having said protective tubular member extending outwardly of the bag member and having a lower end closure wall with a central opening,

a coil spring means disposed concentric with said aperture within the tubular member between the lower end of the bag member and the end closure of the tubular member,

a force distributing ring interposed between the spring means and the bag, and

said bag having an integral locating lip projecting into the distributing ring.

3. In a submersible motor having a lower end frame permitting communication with the inside of the motor, the improvement comprising

an integral extension of the lower end frame having a circumferential recess on the extrior surface and spaced slightly from the lower end,

a flexible tubular bag having an open end telescoped over the end of the extension and having an integral enlarged sealing lip on the outermost end mating with the recess, said sealing lip having a normal depth in excess of the recess depth,

a protective rigid tubular member encircling the bag and projecting axially beyond the bag over the extension to compress said enlarged portion, and

securement means connecting the tubular member to the extension outwardly of the open end of the bag.

4. In a submersible motor having a lower end frame permitting communication with the inside of the motor, the improvement comprising

a flexible tubular bag having an integral enlarged internal end lip on the one end,

an extension of the lower end frame having a circumferential recess on its exterior surface and of lesser depth than said internal end lip, said recess being spaced lightly from the lower end of the extension and with the portion between the recess and the outermost end of the extension having a reduced diameter corresponding to the internal diameter of

the bag, said bag being telescoped over the end of the extension with the lip disposed within the recess,

a tubular metal member telescoped over the bag and the extension to compress said enlarged portion, and

securement means connecting the tubular member to the extension outwardly of the bag.

5. A liquid filled submersible motor, comprising

a cylindrical motor frame having a lower end frame telescoped into the housing with a clamping flange abutting the motor frame, said end frame having an outer tubular extension of a diameter corresponding to the internal diameter of the motor frame and with a circumferential recess spaced from the outermost end of the extension and defining a lip between the recess and the end, the radius of the lip being reduced by about half the depth of the recess,

a flexible diaphragm bag having an internal diameter corresponding to the diameter of the lip whereby the bag closely fits about the lip, said bag having an integral internal end enlargement disposed in the recess, and

a tubular cover secured at one end about the extension and having an internal diameter compressing the enlargement to seal the connection of the bag to the extension.

6. A liquid filled submersible motor, comprising

a cylindrical motor housing having upper and lower end frames and an annular stator and a rotor rotatably

supported by a shaft journaled in the end frames, the lower end frame having an extension of reduced diameter with a circumferential recess spaced from the outer end of the extension and defining a transverse lip between the recess and the end of a reduced diameter of about half the depth of the recess,

a flexible diaphragm bag having an internal diameter corresponding to the diameter of the lip whereby the bag closely fits about the lip, said bag having an integral internal end enlargement disposed in the recess,

a tubular cover telescoped over the extension and having an internal diameter corresponding to the extension and serving to compress the enlargement to seal the junction, said tubular cover having an outer diameter corresponding to said housing, and

screw means passing through radial openings in said tubular cover and into tapped openings in the lower end frame extension to secure the cover to the extension.

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