

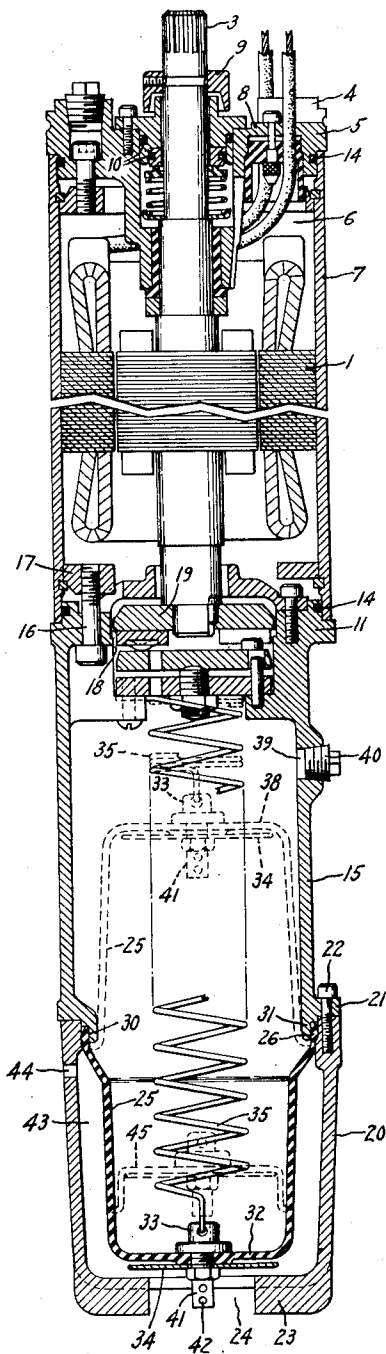
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EXPANSION UNIT FOR LIQUID-FILLED SUBMERSIBLE MOTORS

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EXPANSION UNIT FOR LIQUID-FILLED
SUBMERSIBLE MOTORS

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4 Claims. (Cl. 310—87)

My invention relates to an improvement in the expansion unit for liquid-filled submersible electric motors and is primarily directed to an assembly for use in connection with electric motors employed in deep well pumping operations, where the motor is disposed in the well at the lower end of a well casing.

The fluid-filled reservoir and expansion unit utilized in this type of operation, is normally disposed below the motor, for example, as shown in copending application Serial 370,038 Kalikow, filed July 24, 1953, now Patent 2,752,516, and assigned to the assignee of the present invention. As disclosed in this application, the normal thermal contraction of the fluid in the motor and in the motor expansion unit due to the lowering of the temperature of the motor during periods of shutdown tend to cause the surrounding well liquid to leak into the motor past the shaft seal. Hence, it is necessary for the successful operation of a submersible motor of this type to provide some means for insuring that well liquid such as water containing sand or other contaminants will not enter the motor, with the resulting damage to the motor windings and bearings.

To this end, it has been the practice in the past to provide a collapsible element disposed as a fluid-filled reservoir in communication with the motor cavity, and subjecting the reservoir to a pressure so that the pressure of the fluid within the reservoir is slightly above the pressure of the well liquid surrounding the motor. The aforesaid copending application provides a solution to this problem. In such an arrangement, however, particular care must be taken to insure that the collapsible reservoir does not malfunction while collapsing, so as to render the further reduction of its volume impossible and thereby to reduce the period of time that the motor will operate before being removed from the well and refilled. It is a primary object of my invention to provide means for affording the maximum insurance against the malfunctioning of the reservoir.

Further objects and advantages of my invention will become apparent and my invention will be better understood by reference to the following description and the accompanying drawing, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In accordance with one aspect of my invention, there is provided a motor casing defining a cavity in which the rotor and stator are placed. One end of the rotor shaft extends out of the casing through an end shield thereof and a tightly fitted spring-biased face-type running seal is mounted on the end shield surrounding the shaft to prevent the entrance of well liquid into the cavity. A fluid reservoir of variable volume is provided in communication with the motor cavity at the other end of the motor casing. The fluid reservoir comprises a rigid casing portion which is sealed with respect to the opposite end of motor housing and provides a downwardly depending flange to which a collapsible generally cup-shaped

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bag portion is sealed in axially spaced relation thereto. The flexible bag becomes smaller at its closed end to permit it to turn inside out by entry into the casing portion without fouling or contacting the casing walls. A coil spring is provided within the reservoir to provide the force required to collapse the bag. By eliminating the possibility of malfunctioning, the spring tension can be reduced to a comparatively low value so that the differential pressure tending to force liquid out of the motor past the shaft seal is minimized to result thereby in a longer period of time before refilling the motor with protecting liquid is necessary.

Reference is now made to the drawing in which the single figure is a side elevation view, in section illustrates the improved expansion unit embodying this invention.

In the drawing, there is shown a submersible pump motor generally identified as 1, it being understood that the motor 1 will ordinarily be vertically arranged in a well casing below the pump element, (not shown) which may be driven by shaft 3. The pump bowls (not shown) may be secured to the cylindrical end flange 5 of the motor 1 by suitable means, as for example by means of a rabbet mating with the rabbet 4 on the end flange 5. End flange 5 is provided a radially extending portion forming an end wall 8. A slinger collar 9, mounted to rotate with shaft 3, may be provided to deflect any solid matter in the well liquid, which would otherwise tend to enter the motor cavity 6 past a seal assembly 10. The motor 1 is provided with a second radial end wall 11 spaced axially below end wall 8, which with the lower bearing structure and with the cylindrical casing 7, define cavity 6 of the motor. Seal rings 14, formed of any suitable resilient material, such as rubber or neoprene, are provided to prevent leakage into rotor cavity 6.

The seal assembly 10, which seals wall 8 to shaft 3, prevents the entry of well liquid into rotor cavity 6 past shaft 3, and is more fully explained in the aforesaid copending application. However, because of the varying temperature of the motor 1 between period of operation and shutdown, seal assembly 10 alone is not completely effective in preventing the entry of well liquid into the cavity 6, and therefore the expansion unit now to be described is provided.

The end wall 11 of the motor, which is shown as being formed integrally with a reservoir casing 15, is secured to the bottom of the motor housing by bolts 16 threadedly engaging a locking ring 17 and forms one part of my improved expansion unit. Reservoir casing 15 is in communication with cavity 6 through openings 18 around thrust bearing 19.

A protective shell member 20 of approximately the same diameter as the reservoir casing 15 and located in axial alignment therewith surrounds and is secured to a radial flange 21 of the reservoir casing 15 by any suitable means such as bolts 22. The shell member 20 terminates at its end remote from the motor 1 in an inwardly turned flange portion 23 having an opening 24 therethrough for the purpose of admitting well liquid to its interior. Within member 20, and shielded thereby from mechanical damage, is a hollow tubular bag member 25 formed of a suitable flexible material which is capable of withstanding chemical attacks either by the fluid within the motor or by the well liquid. While any flexible material can be used, I prefer to use rubber or Neoprene because of their long wearing qualities. The upper end 26 of the flexible bag 25 is enlarged and is secured in an annular recess 30 formed between the lip 31 of reservoir 15 and the shell member 20, and is held in sealed relationship therewith by bolts 22 which attach the member 20 to the reservoir casing 15. Bag 25 has a closed flat bottom portion 32 to which a spring connector 33 is secured. A metal plate 34 is positioned

outside the bag 25 to insure that the spring pressure is applied evenly over the closed end of the bag so that the latter will fold inwardly without wrinkles. Within the bag and connected to spring connector member 33 and thrust bearing supporting member 34 is a spring 35 which is operable in tension and is shown in extended form. Because the spring is positioned within the liquid with which the submersible motor is filled during operation, the corrosive effects of the well liquid need not be considered in its design, and thus the motor is more nearly universally applicable in deep well applications.

The bag 25 should preferably be elastic as well as flexible to allow for the volumetric expansion of the liquid in the motor cavity during operation when the reservoir is completely full.

Attention is now directed to the specific design of the bag 25 which is important to prevent the possibility of malfunctioning. It will be observed that the bag 25 is molded to provide a sharply flared portion adjacent end 26 so that it will easily fold around lip 31 without wrinkling when the bag 25 is in a fully collapsed position as shown by the dotted lines 38. Moreover, it will be observed that the walls of flexible bag 25 are tapered toward the closed end so that the bottom 32 of the bag will not foul with the side walls of the bag-25 as the bag begins to turn inside out as indicated at 45. Thus, by utilizing a rigid reservoir casing portion 15 in combination with an arrangement wherein a flexible bag 25 turns completely inside out, as shown by the dotted line 38, the reservoir capacity is double the volume of the flexible bag 25 alone.

To initially fill the motor cavity 6 of the motor 1 and the reservoir with a protecting fluid, a suitable opening 39 which is normally closed with a pipe plug 40 may be provided. As will be observed, the spring connector 33 is provided with a tab 41 having holes 42 through which a pin may be placed to hold the bag in its extended position against the force of spring 35. With the bag 25 thus extended, the oil or other fluid which is used to fill the motor may be placed therein in the opening 39.

In operation, with the motor in a well, the spring 35 insures that the pressure within the casing is slightly greater than that of the well liquid which is in contact with the flexible bag 25 through opening 24 in shield 20. Thus, any tendency for leakage past seal assembly 10 or any of the stationary seals 14 will be in an outward direction. It will be noted that when the motor 1 is completely full of a liquid, there is annular space 43 between the elastic bag 25 and the shield 20 to provide for thermal expansion of the liquid. A hole 44 in the shield 20 prevents air from being trapped in the shield 20 upon submerging the motor in the well liquid. As the fluid in the motor cavity 6 slowly leaks past the seal assembly 10 the spring 35 tends to turn the bag 25 inside out until it reaches the intermediate position shown at 45. In this position, the reinforcing plate 34 contacts the bottom of the bag 25 to insure that wrinkles do not form therein. The spring 35 continues to urge the bottom of the bag upwardly until the bag 25 assumes the completely inside-out position within the casing portion 15 as shown at 38. When this point is reached, it is

necessary to remove the pump from the well to replace the protecting fluid therein. It is to be noted, however, that the total volume change of the reservoir during this period is approximately twice the volume of the bag alone.

It will now be seen that my invention provides an improved expansion unit for a submersible motor which affords greater protection against fouling during operation by the use of a two-part expansion chamber construction combined with a spring located within the liquid filling the motor, utilizing, in the preferred embodiment a flexible expansion bag having a tapered wall to further insure against the possibility of fouling during operation.

While I have shown and described a particular embodiment of this invention, further modifications and improvements therein will occur to those skilled in the art. Therefore, it should be understood that my invention is not limited to the form shown, and the appended claims are intended to cover all modifications which do not depart from the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A device of the class described, comprising a casing defining a cavity therein, a dynamoelectric machine positioned within said cavity, a shaft of said machine extending through said casing, sealing means for sealing said shaft with respect to said casing for preventing the entrance of external fluids into said cavity, an expansion unit in communication with said cavity having a rigid portion and an axially extending flexible portion sealed to said first portion to provide a reservoir, said cavity and said reservoir being adapted to be filled with a protecting fluid, resilient means within said reservoir to urge said flexible portion to turn completely inside out said rigid portion being as long as said flexible portion whereby the volume change of said reservoir is approximately twice the volume of the flexible portion.

2. A device as described in claim 1, wherein the open end of the flexible portion is of larger dimension than the closed end.

3. In a protecting unit for a liquid-filled electric motor assembly adapted to be submerged in a surrounding well liquid for driving a well pump, a closed reservoir for containing a protecting fluid comprising, in combination, a rigid portion in communication with the interior of the motor assembly and a flexible generally bag-shaped portion having its open end connected to said rigid portion in a fluid tight joint, and a spring within said reservoir for urging said flexible bag-shaped portion to turn inside out into said rigid portion, the open end of said flexible bag-shaped portion being of greater dimension than its closed end so that the flexible bag-shaped portion will enter the rigid portion without fouling.

4. An expansion unit as described in claim 3 wherein the rigid portion is elongated to permit the flexible bag-shaped portion to turn completely inside out therein to provide for a total change of volume of the expansion unit of twice the volume of the flexible portion.

No references cited.