June 9, 1936. D. J. CONANT 2,043,236

SUBMERGIBLE MOTOR

Filed June 1, 1934 3 Sheets-Sheet 1

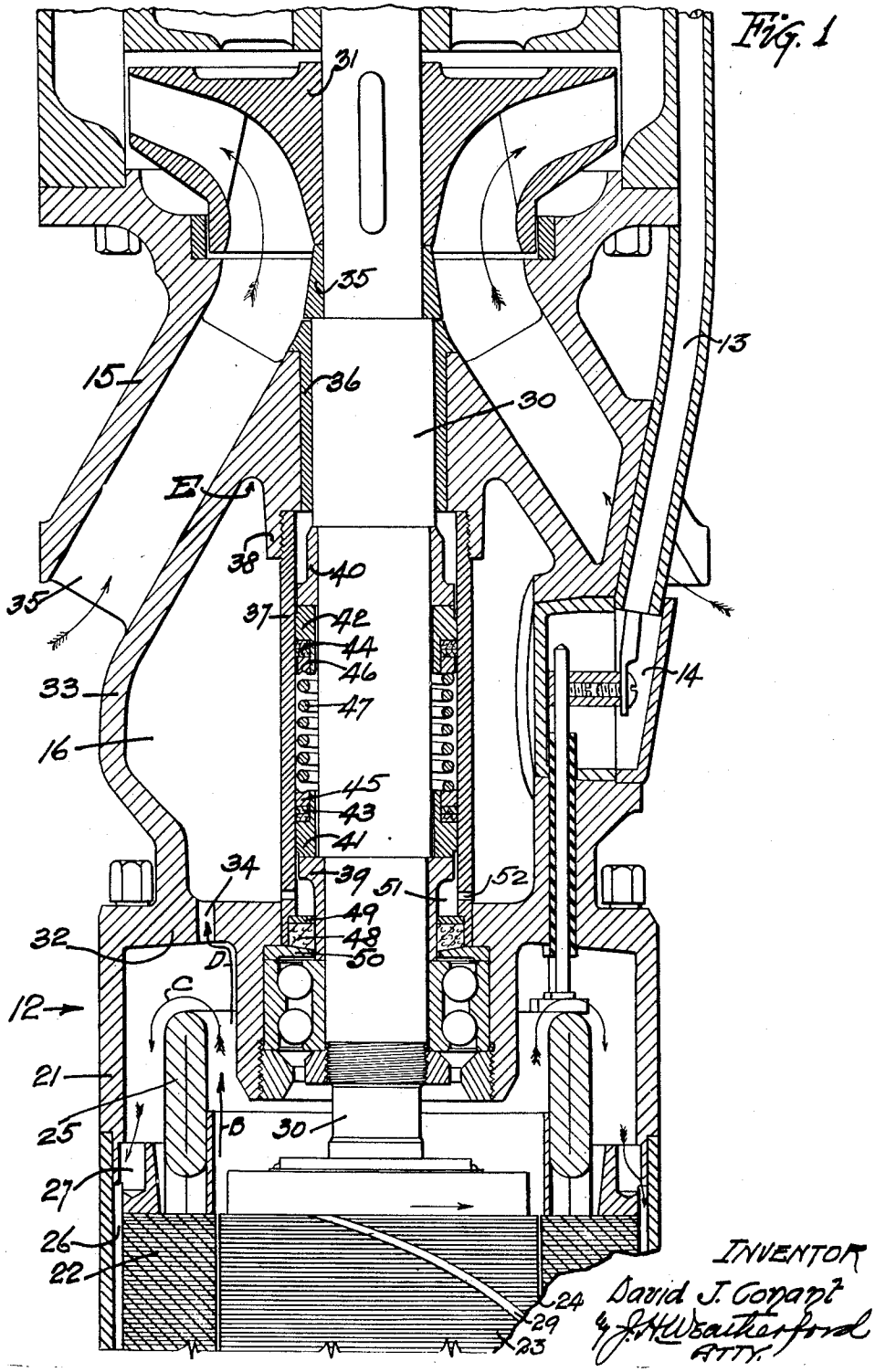


FIG. 1

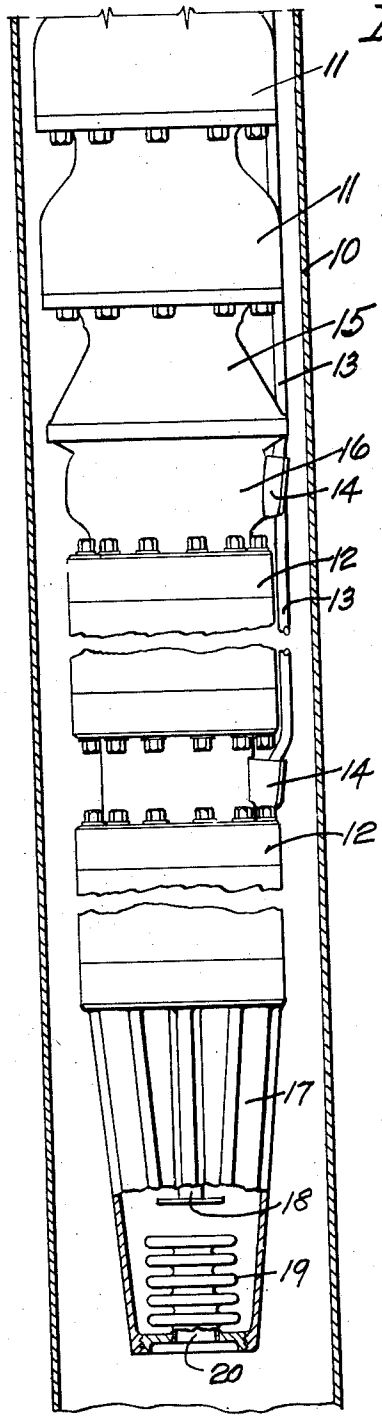
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FIG. 2.



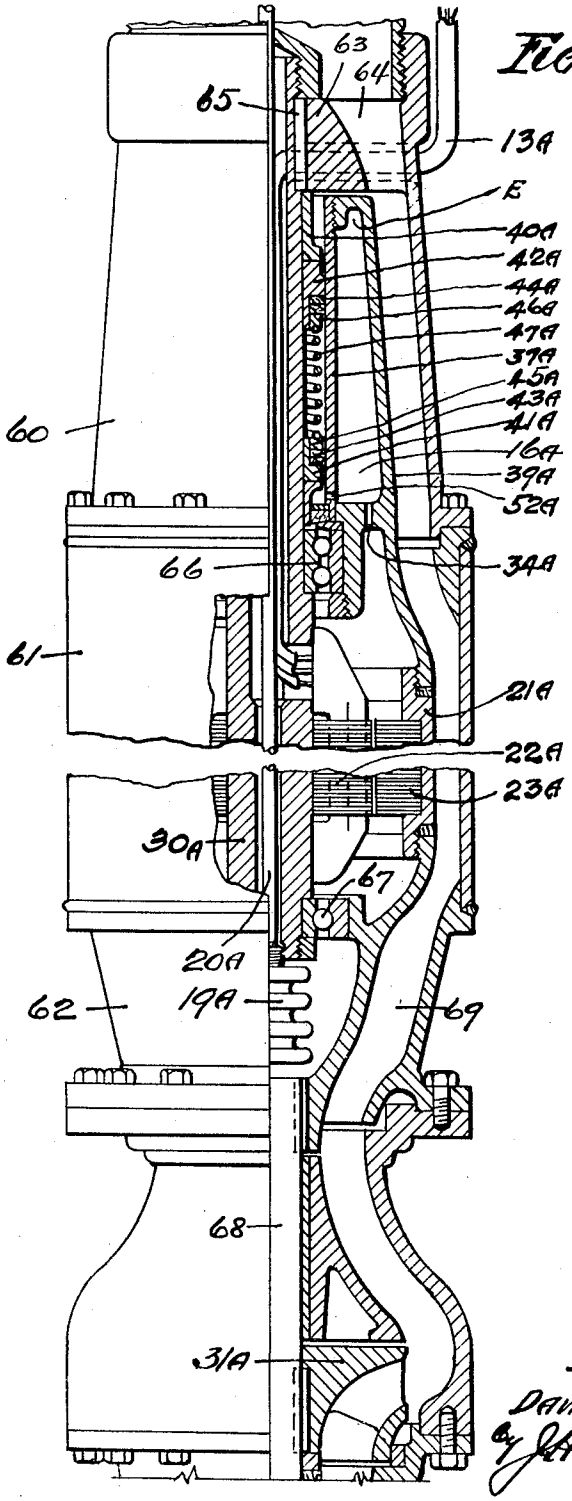
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FIG. 3.



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SUBMERGIBLE MOTOR

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16 Claims. (Cl. 172—36)

This invention relates to motors which are intended to be submerged and operated during submersion. It is often desirable to operate an electric motor completely submerged in a fluid which would be injurious to the working parts of the motor should leakage occur. Such a condition is frequently met, particularly in the pumping art and under numerous other conditions.

It has been found convenient and practicable to entirely fill the casing of motors with oil of high di-electric strength and to almost entirely prevent the replacement of this oil by the surrounding fluid where a difference in specific gravity exists such as that ordinarily existing between water and a lighter than water oil. But even so, difficulties exist in eliminating microscopic quantities of water which if not displaced eventually break down resistance and cause trouble. Also there are oils which are heavier than water, which have such valuable di-electric properties, heat transference properties and lubricating properties as to render their use definitely desirable.

The rapid rotation about an axis of symmetry, of a container filled with two liquids of different specific gravities, will separate the fluids into concentric spaces with the lower specific gravity fluid at the center.

The present invention is directed to means and methods for preventing the ingress of a submerging fluid into a motor filled with oil and for separating out minor quantities of such fluid which may in spite of precautions, or because of unforeseen causes have infiltrated into the motor casing.

The primary object of the present invention is to provide means whereby the pressures within and without a submerged oil filled motor may be equalized without exposing the oil directly to the submerging liquid.

Further objects are:

To provide and arrange in such a motor, a sealing device and an oil chamber extending thereabove in such relation that the sealing device normally prevents the escape of the motor oil rather than the ingress of the submerging liquid;

To provide means for separating out from the oil in an oil filled motor a lighter than oil fluid entrained in such oil; and

To provide means permitting the expansion and contraction of the oil under the effect of changes of temperature.

The means by which the foregoing and other objects are accomplished and the methods of their accomplishment, will readily be understood from the foregoing description on reference to the accompanying drawings, which for purposes of description are shown as applying to a deep well pump of centrifugal type.

In these drawings, Fig. 1 is a sectional elevation of the upper end of an oil filled motor and the lower end of a centrifugal pump driven thereby, and showing a double spring-tensioned packing seal therebetween, together with a closed oil-head chamber.

Fig. 2 is an elevation on a reduced scale showing two motors in tandem, the lower end of the casing being shown in section to disclose a bellows for taking care of expansion.

Fig. 3 is a vertical elevation substantially one-half in section showing application of the seal and oil head chamber to a modified form of motor having a stationary shaft carrying the stator and an annular rotor.

Referring now to the drawings in which the various parts are indicated by numerals, and more particularly to Fig. 2, 10 is a well casing within which is disposed a centrifugal pump having two or more stages 11, the pump being shown driven by two motors 12. 13 are the power cables leading through connection boxes 14, to the motors. 15 is an intake section directly secured to the lower end of the pump through which flow is established from the well to the pump and 16 the oil-head chamber which is shown as integral with the intake section 15. 17 is a cooling chamber, for cooling the oil circulated within the motor casings, and 18 a tube for return of the cooled oil to the motor. 19 is a compressible metal bellows, through which expansion and contraction of the oil may be taken care of, this bellows preferably being entirely housed within and protected by the cooling chamber. It will be noted that the interior of this bellows is open through the passageway 20 to the water within the well and is directly subject to the pressure of the water.

Referring now more particularly to Fig. 1, 21 is the casing of the motor 12, or if two or more motors are employed, of the upper one of such motors. 22 is the stator, preferably of laminated construction and 23 the rotor which is separated from the stator by the necessary gap 24. 25 are the field coils. The stator is provided at intervals around its periphery with vertical grooves 26 which through passageways 27 are in communication with the interior of the casing 21. 28 is an extremely shallow spiral groove in the exterior of the rotor, by which oil is drawn upward as

the rotor turns. 30 is the motor shaft to which the pump impellers 31 are also secured.

The upper end of the casing 21 is closed by a head 32 from which the outer casing 33 of an annular chamber 16 extends upward, communication being established between the interior of the casing 21 and the chamber 16 by holes or passageways 34. 35 are intake passageways entirely exterior to the chamber 16, leading to the pump impeller.

Immediately below the impeller 31 is a collar 35 closely fitting and secured on the shaft 30. Below this collar the shaft is journaled in a bearing 36, which is carried by the casing 33. Below the bearing 36 the shaft is housed in a hollow cylindrical sleeve 37, which is spaced away from the shaft forming therearound a packing chamber and also forming the inner wall of the annular chamber 16. The upper end of the sleeve 37 is threaded or otherwise secured into and sealed to an annular hub 38 integral with the casing 33 and the lower end closely fits into a suitable opening in the head 32.

Adjacent the lower and upper ends of this sleeve and tightly secured to the shaft 30, are flanged collars 39, 40 respectively, these collars having each a slight clearance from the interior of the sleeve. Also disposed within the sleeve and closely fitting the same are annular collars 41, 42 each spaced from the shaft and which respectively have a close running fit with the flanged collars 39, 40 respectively. The exterior of the facing ends of the collars 41, 42 are turned down to form with the interior of the sleeve, stuffing boxes in which packing rings 43, 44 are disposed, the packing being held in place by gland rings 45, 46 which are forced against the packing by a compression ring 47. 48 is an annular ring of fibrous packing, which is disposed between annular collars 49, 50, carried respectively by the shell 37, and the head 32 and which collars form a stuffing box to hold the packing against the collar 39. The packing ring 48 is spaced from the flanged upper end of the collar 39, leaving between such collar and the shell 37 an annular space 51, which is maintained in communication, through holes 52 in the sleeve 37, with the chamber 16.

In Fig. 3, which shows the application of the seal and oil-head chamber to a motor having a stationary shaft, the corresponding parts of the device have been given the same numbers with the suffix "A". In this form of the device, the motor is enclosed in an annular shell preferably made up of parts 60, 61, and 62, suitably secured together as by bolting or welding. The motor shaft 30A does not rotate, and is suspended from a head 63, which head is carried from the upper end of the shell-section 60 by arms 64, rotation of the shaft being prevented as by a key 65.

The shaft 30A is hollow and the power cable 13A passes thereinto preferably through a suitable opening in one of the arms 64, leading thence downward to the coils of the stator 22A, which stator is mounted on the stationary shaft.

The rotor 23A is rigidly secured to the casing 21A of the motor, this casing being suitably supported and turning on bearings 66, 67. The lower end of the casing 21A carries an impeller shaft 68, this shaft being not only keyed to the casing, but securely sealed thereto so that it effects a water tight closure which seals the lower end of the casing 21A. 31A is the pump impeller, discharge from which is carried upward through the passageway 69 formed between the outside of the casing 21A and the interior of the shell 60—61—62. 16A is the oil head chamber, which is preferably an integral part of the casing 21A and extends upward therefrom, as before, above the joints between the collars 40A and 42A. Secured into, and sealed to, the upper end of the casing forming the outer part of the chamber 16A is the sleeve 37A as before, which sleeve forms the inner wall of the oil head chamber and the outer wall of the packing chamber. The various component parts of the packing within this latter chamber are substantially identical with those previously described, have been referred to by the same number, suffix "A", and are not further here mentioned.

Holes or passageways 34A connect the interior of the casing 21A and the oil-head chamber 16A, and openings 52A connect the packing-chamber with the oil-head chamber as before.

Disposed within the lower end of the casing 21A is an expansion bellows 19A functioning in identical manner with the previously described expansion bellows 19. The bellows 19A is secured into, and sealed to, the lower end of the shaft 30A, the control opening in such shaft being continued downward to its lower end. The upper end of the bellows 19A is open and from this opening, a passageway or pipe 20A leads upward through the shaft, terminating above the end thereof in the discharge pipe leading upward from the shell portion 60, thus establishing the interior of the bellows 19A in communication as before, with the fluid surrounding the motor.

It will be noted that the lower end of the motor casing is entirely closed so that entrance of fluid into the oil filled motor must be downward along the shaft 30 or 30A through the surrounding sleeve 37, or 37A, and the packing means therebetween, and that the point of entrance of such fluid into the oil filled enclosure is through the joint between the collars 40 and 42, or the corresponding collars 40A, 42A of Fig. 3. The chamber 16 or 16A is definitely extended above this joint, so that at all times the level of the oil is above the joint, and such difference in specific gravity as exists between the oil and the fluid which is to be kept out of the motor, due to such head repels the entrance of such fluid.

The pressure on the oil within the motor is that due to hydrostatic head of the surrounding fluid, acting through the bellows 19 or 19A. The pressure on the fluid to be repelled from the motor is the hydrostatic head at the ingress point. Hydrostatic heads are thus balanced at any head, and are eliminated as a cause of ingress or egress movement into, or from the motor.

As temperature rises in the motor compression of the bellows effects compensation for the expansion.

To prepare the motor for use, the interior of the motor, all passageways, the packing chamber and the oilhead chamber are filled with the desired oil, extreme care being taken that no air is entrained. After such filling, the motor is ready to be submerged and put into use.

In use, the rotor turning, and/or other means not germane to the invention, circulates the oil. Heat generated in the operation of the motor is carried away from the rotor by this oil circulation and is absorbed by the cooling surfaces of the surrounding casings. Should any water have entered, if lighter than the oil, it will follow the general direction of the arrow D through the opening 34 or 34A, into the oil-head chamber and will rise into the space E at the extreme

upper portion of such chamber where it will remain until such accumulation occurs as to require draining and refilling of the chamber.

During operation, the surrounding fluid is in contact, or substantially so, with the upper end of the packing chamber. Entrance of this fluid into the chamber is resisted by centrifugal action along the joint between the collars 40, 42, or 40A, 42A, by virture of the greater centrifugal action of the rotating collar on the heavier oil. Such fluid as passes this joint, will follow along the shaft to the similar lower collar joint and should any pass this joint, will enter the annular space 51, from which it will eventually be forced through the openings 52 into the oil-head chamber where it will also rise into the space E at the top of such chamber.

It will be understood that in this description only such parts of the motor and other parts of the device, as are necessary to the functioning of the seal are described, and that only such motor and pump parts, of previously known types, as are necessary for an understanding of the present invention are illustrated.

It will also be understood that the particular detail of the packing is largely illustrative and that other packing means may be used.

I claim:

1. A submergible electric motor including a closed casing adapted to be filled with liquid, a motor in the casing, and a partition dividing said casing into a motor compartment and a superposed chamber for liquid, said partition having openings therethrough establishing communication between said compartment and chamber, the shaft of said motor extending upward from said compartment through mechanical leakage-sealing means, said sealing means lying below the upper end of said chamber.

2. A submergible electric motor, including a closed casing adapted to be filled with a liquid, a motor in the casing, a partition dividing said casing into a motor compartment and a superposed chamber for liquid, said partition having apertures establishing communication between said compartment and said chamber, the shaft of said motor extending from said compartment through a housed mechanical leakage seal, said seal being below the upper level of said chamber, and bellows means for equalizing the internal and external pressures on said casing.

3. A submergible electric motor including a closed casing adapted to be filled with a liquid, a motor in the casing, an apertured partition dividing said casing into a motor compartment and a chamber for liquid in communication with one another, the shaft of said motor extending from said compartment, a housing extending from said compartment and disposed around said shaft, leakage-sealing means within said housing and around said shaft, said sealing means lying below the uper level of said chamber, there being means establishing communication between said housing and said chamber, and bellows means for equalizing the internal and external pressures on said casing.

4. In a submergible electric motor, adapted to be filled with a di-electric lubricating fluid, said motor including a closed casing, and a shaft, a rotor and a stator, all within said casing; a closed chamber for fluid above said casing and means establishing communication between said casing and said chamber, the shaft of said motor extending through a wall of said casing, sealing means including a housing sealed to said casing, extending therefrom and enclosing said shaft, packing means within said housing at said casing, packing means spaced therefrom, and means establishing communication between said chamber and said housing adjacent said casing, a portion of said chamber extending above all of said sealing means, and above the communicating means between said casing and chamber.

5. In a submergible electric motor adapted to be filled with a di-electric lubricating fluid, said motor including a closed casing, and a shaft, a rotor and a stator, all within said casing; a closed chamber for fluid above said casing and means establishing communication between said casing and said chamber, the shaft of said motor extending through a wall of said casing, sealing means including a housing sealed to said casing, extending therefrom and enclosing said shaft, packing means within said housing at said casing, packing means spaced from said casing at a plurality of places, and means establishing communication between said chamber and said housing adjacent said casing, a portion of said chamber extending above the highest portion of said housing, and above the communicating means between said casing and chamber.

6. A submergible electric motor, including a casing adapted to be filled with a liquid, a motor in the casing, a closed chamber for liquid, and means establishing communication between said casing and said chamber, the shaft of said motor extending from said casing, a housed mechanical leakage seal, carried by said casing and around said shaft, and means establishing communication between said chamber and the housing of said seal, said communicating means and said seal all lying below the upper level of said chamber.

7. A submergible electric motor, including a casing adapted to be filled with a liquid, a motor in the casing, the shaft of said motor extending from said casing, a housed mechanical leakage seal, carried by said casing and around said shaft, a closed chamber for liquid, and means establishing communication between said chamber and said casing, means establishing communication between said chamber and said seal housing, and bellows means for equalizing the interior and exterior pressures on said casing, said seal, and both of said communicating means being below the upper portion of said chamber.

8. A submergible electric motor, including a casing adapted to be filled with a liquid, a motor in the casing, a closed chamber for liquid, means establishing communication between said chamber and said casing, the shaft of said motor extending from said casing, a housing extending from said casing and disposed around said shaft, mechanical leakage-sealing means within said housing and around said shaft, and means establishing communication between said chamber and said housing, said sealing means and said communicating means lying below the upper level of said chamber.

9. A submergible electric motor, including a casing adapted to be filled with a liquid, a motor in the casing, a closed chamber for liquid in communication with said casing, the shaft of said motor extending upward from said casing, a housing extending upward from said casing and disposed around said shaft, mechanical leakage-sealing means within said housing and around said shaft, said sealing means lying below the upper level of said chamber, means establishing communication between said chamber and said

housing, and bellows means for equalizing the interior and exterior pressures on said casing.

10. A submergible electric motor including a stationary shaft, the stator of said motor being fixed on said shaft, the rotor of said motor surrounding said stator and being encased in and rigidly secured to a casing closed at its lower end, said casing extending above said rotor and being partitioned off to form a closed chamber surrounding said shaft, said chamber having limited communication with said casing, and a housed mechanical leakage seal about said shaft, said seal housing and chamber being in communication adjacent their lower ends, said chamber and casing being adapted to be filled with a liquid.

11. A submergible electric motor including a stationary shaft, the stator of said motor being fixed on said shaft, the rotor of said motor surrounding said stator and being encased in and rigidly secured to a casing closed at its lower end, said casing extending above said rotor and being partitioned off to form a closed chamber surrounding said shaft, said partition having openings therethrough, and a housed mechanical leakage seal about said shaft, and lying below the top of said chamber, said housing and chamber being in communication adjacent their lower ends, said chamber and casing being adapted to be filled with a liquid, and bellows means for equalizing the internal and external pressures on said casing and chamber.

12. A submergible electric motor, having in combination a closed shell, a stator within and carried by said shell; a shaft rotatably supported within said shell, said shaft extending from said shell, a rotor on said shaft within said shell, housed, mechanical leakage sealing means within said shell and about said shaft, said shell being adapted to be filled to a level above said sealing means with an insulating oil, and bellows means for equalizing the internal and external pressures on said shell.

13. In a submergible electric motor comprising a casing enclosing and sealing the working parts of said motor, and having its shaft extending through the motor casing and vertically upward therefrom, an annular member, around and spaced from said shaft, hermetically sealed to said casing and extending upward therefrom, packing means within said member, around said shaft at its exit from said motor, and packing means spaced thereabove in said annular member, a closed chamber disposed above said casing and having its upper end above the upper of said packing means, and passageways leading respectively from said motor casing, and from said annular member adjacent but above the lower of said packing means, into the base of said chamber.

14. In a submergible electric motor comprising a casing enclosing and sealing the working parts of said motor, and having its shaft extending through the motor casing and vertically upward therefrom, an annular member, around and spaced from said shaft, hermetically sealed to said casing and extending upward therefrom, packing means, within said member, around said shaft at its exit from said motor, and packing means spaced thereabove, and within said annular member, a closed chamber carried by and extending upward from said casing above the upper of said packing means, a passageway connecting said casing and said chamber, and a passageway leading from said annular member above and adjacent the lower of said packing means, into said chamber.

15. In a submergible electric motor, a closed shell having a partition dividing it into a motor casing and a chamber thereabove, an open top housing depending within said chamber and sealed to the top of said shell and to said partition, a motor housed within said casing and having its shaft extending upward through said housing, mechanical sealing means for said shaft within said housing, and below the top of said chamber, said housing having an opening above said partition into said chamber, and said partition having an opening establishing limited communication between said chamber and casing.

16. In a submergible electric motor, a closed shell having a partition dividing it into a motor casing and a chamber thereabove, an open top housing depending within said chamber and sealed to the top of said shell and to said partition, a motor housed within said casing and having its shaft extending upward through said housing, a plurality of sealing means for said shaft within said housing, the upper of said means lying below the top of said shell, and the lower thereof adjacent said partition, said housing having an opening above said lower sealing means into said chamber, and said partition having an opening establishing limited communcation between said chamber and casing.

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