

May 28, 1935.

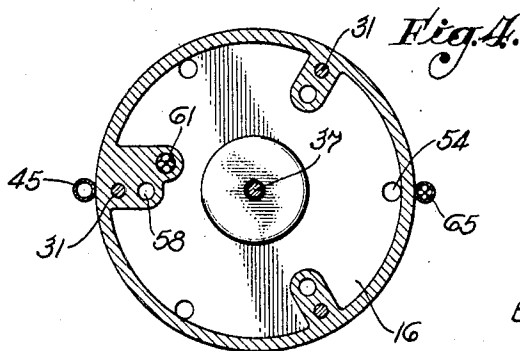
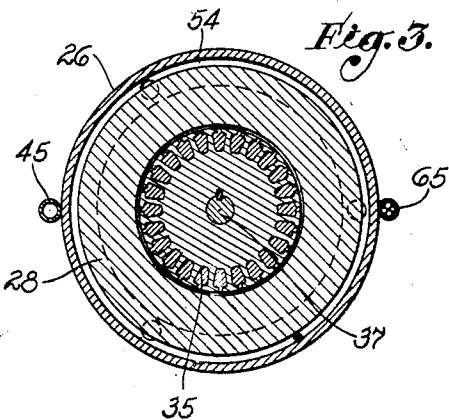
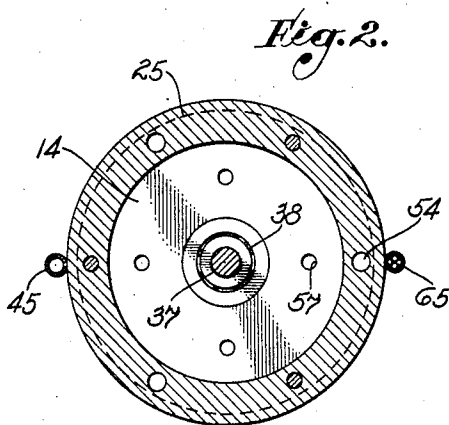
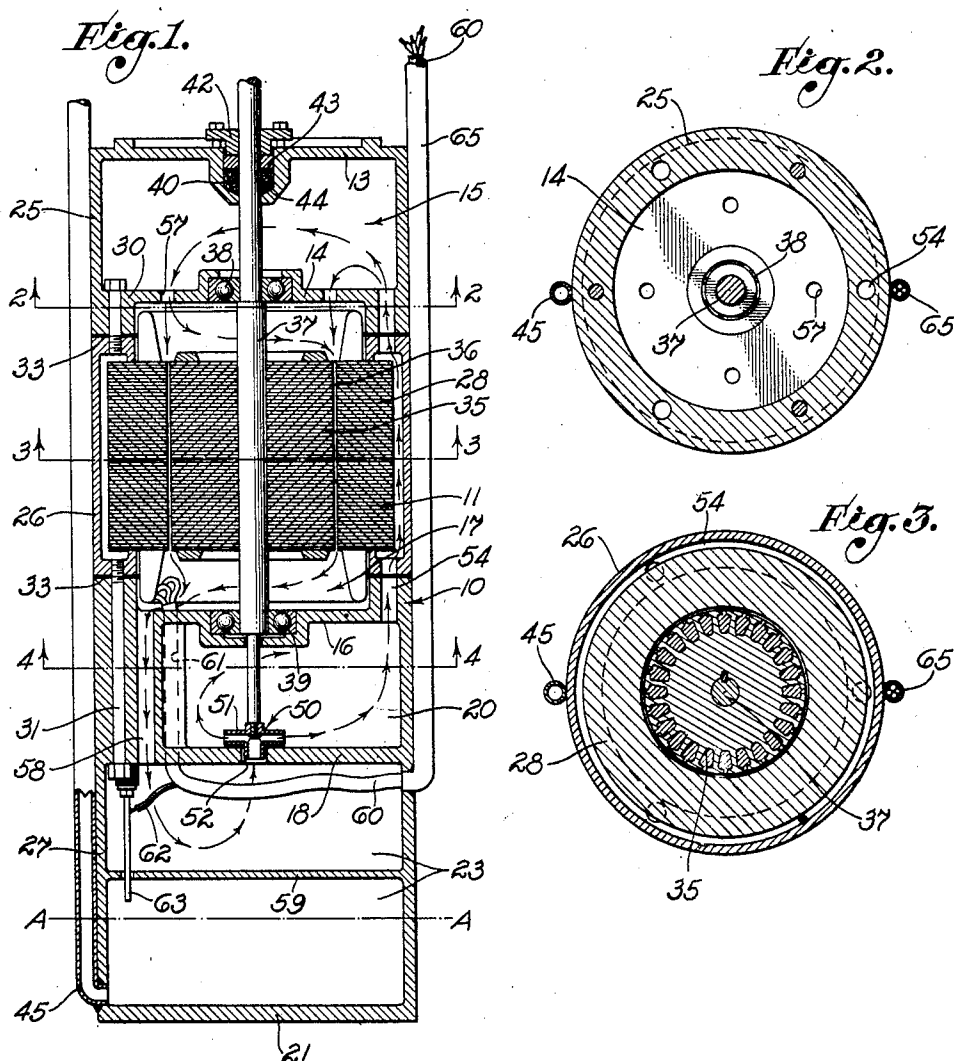
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2,002,916

SUBMERSIBLE MOTOR CONSTRUCTION

Filed April 16, 1934

2 Sheets-Sheet 1



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Fig. 5.

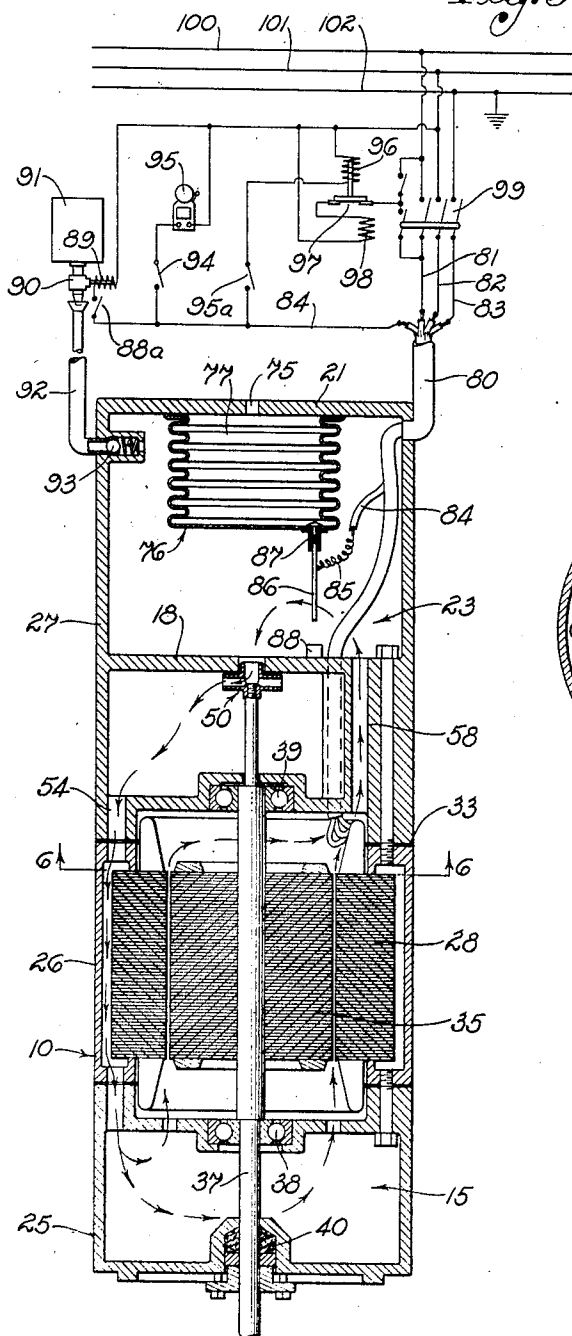
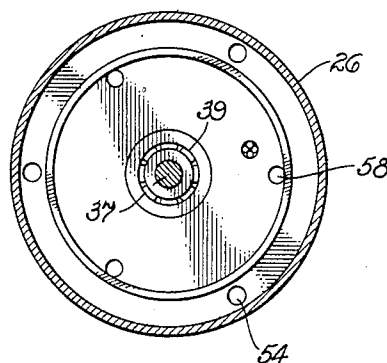


Fig. 6.



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SUBMERSIBLE MOTOR CONSTRUCTION

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Application April 16, 1934, Serial No. 720,774

16 Claims. (Cl. 172-36)

Our invention relates to submersible structures, and more particularly to a submersible electric motor. Many of the features incorporated in the present invention are particularly applicable to submersible structures in which a differential pressure is maintained on the sealing means which seals the junction of the shaft and the shell. The invention will be particularly described with reference to such an unbalanced system, though it will be clear that many of the features of the invention find utility in other systems.

It is an object of the present invention to provide a shell such as a motor shell containing an internal liquid, and to provide a pumping means in the shell for pumping this internal liquid in such a manner that the pressure on the internal portion of the seal is somewhat in excess of the pressure on the external portion of the seal so that any leakage which takes place will be outward from the shell rather than inward into the shell. In this way it becomes possible to prevent entrance of any external liquid in which the shell may be submerged, thus making it possible to submerge the motor in a liquid which would be injurious to the working parts of the motor should it come in contact therewith.

It is a further object of the present invention to provide a pump for pumping the internal liquid through a closed circulation path in cooling relationship with the motor.

A further object of the invention is to throttle the flow of the internal liquid moving through this closed circulation path in such a manner that the discharge of the pump means is effective in increasing the pressure on the internal portion of the seal.

A further object of the invention lies in the provision of a novel system which compensates for expansion of the internal liquid due to heat generated by the motor and which compensates for any change in volume effected by the pumping means.

This system for compensating for expansion may take the form of a chamber adapted to receive any excess internal liquid, and it is an object of the present invention to provide such a structure.

A further object of the invention lies in the provision of a pump means operatively connected to the motor and intaking from such an expansion-compensating chamber.

Another object of the present invention is to provide a movable diaphragm means which may compensate for expansion, and to provide a system in which the internal forces in such a movable diaphragm means may, if desired, be utilized in con-

junction with a pump for maintaining the excess internal pressure on the seal.

A further object of the invention lies in the provision of a novel control means for controlling the submersible structure, usually a submersible motor, in response to the pressure or quantity of the internal liquid.

A further object of the invention is to provide a novel control means including a switch means operated by a movable diaphragm means.

Still another object of the invention is to provide a novel system for introducing electric potentials into a shell in which different pressures are developed in different sections thereof.

Further objects and advantages of the invention will be made evident hereinafter.

Referring to the drawings,

Fig. 1 is a vertical sectional view of one form of the invention.

Figs. 2, 3, and 4 are sectional views taken on corresponding lines of Fig. 1.

Fig. 5 is a vertical sectional view of an alternative form of the invention and illustrating one form of electrical connection which may be used in conjunction therewith.

Fig. 6 is a horizontal sectional view taken on the line 6-6 of Fig. 5.

Referring particularly to Fig. 1, we have illustrated a submersible motor structure including a motor shell indicated in general by the numeral 10, and an electric motor indicated in general by the numeral 11. The upper end of the shell 10 is closed by an upper wall 13 which cooperates with an intermediate wall 14 in defining a seal chamber 15. The intermediate wall 14 cooperates with a lower wall 16 in defining a motor chamber 17 in which the motor 11 is positioned. An intermediate wall 18 extends across the motor shell 10 and cooperates with the lower wall 16 in defining an intermediate or pumping chamber 20, while the intermediate wall 18 cooperates with a lower wall 21 of the motor shell 10 in defining an expansion-compensating or pressure-transferring chamber 23.

Various constructions may be used for forming such a motor shell, but in the form shown this shell is formed in three sections 25, 26, and 27. The intermediate section 26 may be permanently associated with a stator 28 of the motor 11, especially if a motor of the "can" type is utilized, in which event the intermediate section 26 may comprise the sheath around the stator. If such a sectional shell is utilized it is desirable to secure the sections 25, 26, and 27 together in fluid-tight relationship. In the form shown this is accom-

plished by the use of a series of bolts 30 and 31 respectively associated with the sections 25 and 27 and extending into some portion of the intermediate section 26 to clamp these sections together and form fluid-tight joints therebetween. In the embodiment illustrated, these bolts are threaded into the sheath of the stator 28. If desired gaskets 33 may be positioned between the adjacent sections. So also, if desired, the upper and lower walls 13 and 21 may be detachably connected to the upper and lower sections 25 and 27 respectively to facilitate adjustment of the bolts 30 and 31.

The motor 11 also includes a rotor 35 spaced from the stator 28 in the usual manner to define a gap 36 which may serve as a circulating passage in a manner to be hereinafter described. This rotor 35 is operatively connected to a shaft 37 journalling bearings 38 and 39 respectively retained in the walls 14 and 16. In the embodiment shown the upper end of this shaft 37 extends through the seal chamber 15 and through a sealing means 40 which seals the junction of the shaft and the motor shell 10, this shaft then extending upward to any suitable driven mechanism such as a pump, not shown.

Various types of sealing means may be utilized, and if a pressure differential is maintained on this sealing means, it is not necessary that the sealing means be of such type as to absolutely prevent any passage of liquid therethrough. Instead, this sealing means may be of such a type as to permit the passage of minute amounts of liquid therethrough, the differential pressure on the sealing means being relied upon to insure that any leakage will be outward from the shell rather than inward into the shell. Such a sealing means provides an internal portion communicating with the internal liquid inside the motor shell 16 and provides an external portion communicating with whatever medium is outside the shell, this medium usually being the external liquid in which the motor is submerged. One type of such seal is illustrated in Fig. 1 as including a gland 42 compressing a packing material 43 positioned in a packing chamber 44 surrounding the shaft.

In the embodiment shown, the internal liquid substantially fills the upper part of the motor shell 10 to a level A—A. The lower portion of the chamber 23 below the level A—A may be filled with water or other liquid of greater density than the liquid in the upper end of the motor shell 10. Two bodies of dissimilar liquids are thus maintained in pressure-transferring relationship in the chamber 23. This system is particularly applicable to structures which are to be submerged in water, for in this case the liquid below the level A—A can be the water in which the motor is submerged. In this instance it is desirable to provide an open communication between the lower end of the chamber 23 and the external liquid, this being provided in the embodiment shown by a pipe 45 extending upward along the motor shell and terminating at a position near the upper end of this shell so as to be in open communication with the external liquid at this point. Such a construction permits the motor shell to be preliminarily filled with the internal liquid when the motor is being lowered into its submerged position without danger of escape of internal liquid. If desired, both the internal and external liquids may be preliminarily positioned in the motor shell before submergence. As the motor is lowered beneath the surface of the external liquid, the pressure in the chamber

23 will, of course, increase due to the open communication between this chamber and the external liquid. A corresponding pressure is built up on the internal liquid in the upper part of the motor shell so that prior to the time that the motor is energized, the pressures inside and outside the motor shell are substantially equal. Exact equalization is sometimes undesirable, and in reality is never obtained with the system shown in Fig. 1, for the liquids are in pressure-equalizing contact at the level A—A, but the internal liquid being of lower density than the external liquid has a buoyant effect which maintains the pressure on the internal portion of the seal 40 slightly greater than the pressure on the external portion thereof even when the motor is not energized.

Greatest tendency toward intermixture of the internal and external liquids occurs in the seal when the shaft 37 is rotating. There is little tendency toward such intermixture when the shaft is stationary, but movement of this shaft tends to effect considerable intermixture at the sealing surfaces. It is thus desirable that the differential pressure be built up on the seal when the motor is energized. This may be accomplished by the use of a pumping means indicated by the numeral 50 and operatively connected to the shaft 37. In the form shown this pumping means takes the form of an impeller 51 positioned on the lower end of the shaft 37, the eye of the impeller extending into an opening 52 of the intermediate wall 18 so that the impeller withdraws internal liquid from the upper part of the chamber 23 and delivers this liquid under pressure to the intermediate chamber 20. A passage 54 is provided to transmit this pressure to the seal chamber 15, this passage being formed through the sections 25, 26, and 27, as shown.

We prefer to utilize the pumping means 50 for another purpose; namely, circulating the internal liquid in cooling relationship with the motor 11. The passage 54 extends in cooling relationship with the motor and conducts the internal liquid from one end of the motor to the other. It is preferable to provide a return passage for returning this internal liquid to the intake of the pumping means 50. Such a return passage may be in the form of any passage communicating between the seal chamber 15 and the intake of the pump means 50, such a passage preferably extending in cooling relationship with the motor. In the embodiment shown this return passage may include the gap 36, the liquid being conducted to the upper end of this gap through a plurality of openings 57 in the upper wall 14. The internal liquid is conducted from the vicinity of the lower end of the gap 36 through openings 58 formed through the lower section 27, these openings communicating with the upper end of the chamber 23. The return passage means may thus be considered as including the openings 57, the gap 36 and the openings 58. Rotation of the impeller 51 thus sets up a closed circulation of internal liquid flowing through a closed circulation path indicated by the arrows. A portion of this path lies in the zone immediately inside the motor shell 10 so that if the motor shell is submerged in a cool external liquid, the heat developed by the motor is first conducted to the internal liquid flowing in the closed circulation path, and is then conducted through the walls of the motor shell to the external liquid. This type of cooling has been found to be very advantageous. It is sometimes desirable to interpose a baffle 59 in the chamber 23 above the sur-

face of contact A—A, this baffle providing one or more pressure-transferring openings but isolating the circulating internal liquid from the surface of contact A—A, thus allowing quiescent contact between the bodies of internal and external liquids. However, this baffle can be dispensed with in some instances.

If such a closed circulation of the internal liquid is utilized, it is preferable to interpose a throttle means in the closed circulation path in such position that a back pressure is built up which maintains the excess pressure on the internal portion of the seal 40. Such a throttle means can be any restricted passage interposed in the closed circulation path, preferably in the return passage. In the form illustrated the gap 36 may be utilized in this capacity, if the cross-sectional area of this gap is made small. Thus, the passages 54 may be made relatively large so that the pressure drop therein is small, the pressure in the seal chamber 15 being substantially the same as the discharge pressure of the impeller 51. The internal liquid flowing through the closed circulation path is throttled by the gap 36 so that the pressure in the passage 58 is substantially the same as the intake pressure of the impeller 51. It will be clear, however, that a throttle means other than the gap 36 may be utilized, it being often possible to decrease the size of the openings 57 or 58 to function in this regard.

Current is supplied to the motor 11 through an armored cable or pipe 60 carrying conductors which are electrically connected to the motor. As shown these conductors extend into the chamber 23 and upward through an opening 61 into the motor chamber 17. One of the conductors, usually not connected to the motor 11, is indicated by the numeral 62 and is electrically connected to an electrode 63 insulated from the motor shell and extending downward in the chamber 23 through an opening in the baffle 59 if this baffle is used. Should the internal liquid contract to a sufficient degree, or should sufficient internal liquid escape through the seal 40, the level A—A will rise so that the external liquid in the chamber 23 will contact the live electrode 63, thus completing a control or indicating circuit such as will be described with reference to the form of the invention shown in Fig. 5. Additional internal liquid can be supplied to the motor shell 10 at this time to again lower the level A—A. In the embodiment shown this additional internal liquid can be supplied to the motor shell through a pipe 65 in which the conductors extend upward, this pipe extending to a point above the external liquid in which the motor shell is submerged.

Referring particularly to Fig. 5, the structure therein shown is quite similar to the structure shown in Fig. 1, the motor shell being reversed in position so that the shaft extends downward so as to be operatively connected to a driven means such as a pump positioned below the motor structure. The seal chamber 15 is thus at the lower end of the motor structure, while the pressure-transferring or expansion - compensating chamber 23 is positioned at the upper end thereof. No pipe 45 is used in this form of the invention. Instead, an opening 75 is formed in the wall 21.

In this form of the invention expansion of the internal liquid and pressure transfer between the internal and external liquids is effected by the use of a movable diaphragm means 76 which in effect closes one portion of the motor shell. Preferably this movable diaphragm means is in the

form of a collapsible bellows defining a chamber 77 which is in communication with the external liquid through the opening 75. If such a collapsible bellows is utilized, it is desirable to position it in the chamber 23. Thus, in this form of the invention the internal and external liquids are separated by the movable diaphragm means 76, and expansion and contraction of the internal liquid is compensated for by movement of this diaphragm means 76, it being understood that this diaphragm means will move in response to pressure changes of the internal liquid and in response to the quantity of internal liquid in the motor shell. Thus, as the internal liquid gradually leaks through the seal 40, the diaphragm means will expand inward.

If desired, this diaphragm means may be so constructed that the internal stresses therein assist in maintaining a pressure differential on the seal. Thus, if this diaphragm means is formed so that its normal position would be more expanded than shown in Fig. 5, the contraction of this diaphragm means to the position shown in Fig. 5 would set up internal stresses which would assist the action of the pumping means 50 in establishing the desired pressure differential on the seal 40. So also, this form of the invention utilizing the internal stresses in the diaphragm means 76 can be made to maintain a slight pressure differential on the seal 40 even when the motor is not energized. The action of the internal stresses in the diaphragm means 76 can, of course, be augmented by externally applied resilient forces such as that which might be exerted by a compression spring between the wall 21 and the movable end of the diaphragm means 76, or by a suitable weight applied to this movable end. Regardless of the presence of assisting internal forces, it will be clear that the diaphragm means 76 serves in the additional capacity of transmitting to the internal liquid pressure variations in the external liquid so that the desired small differential pressure can be maintained by the pumping means 50.

In this form of the invention current is supplied to the motor through an upward extending cable 80 shown as enclosing four conductors, three of which are respectively indicated by the numerals 81, 82, and 83, these conductors being electrically connected to the motor. The fourth conductor indicated by the numeral 84 is electrically connected through a flexible lead 85 to a contact 86, this contact being insulated from the diaphragm means 76, but operatively connected thereto by an insulating block 87. A corresponding contact 88 is mounted on the wall 18 in a position to be engaged by the contact 86 when the diaphragm means 76 reaches a predetermined lower position, the contacts 86 and 88 forming a switch means.

The conductor 84 forms a part of a control circuit electrically connected to a suitable control or indicating means capable of indicating or directly controlling the submersible electric motor. There are various ways in which this control may be effected. Usually the switch means formed by the contacts 86 and 88 closes the control circuit only when there is a deficiency of internal liquid, and it is often desirable to provide a control means automatically supplying additional internal liquid to the motor shell upon closing of the control circuit. Thus, the conductor 84 is shown as being connected through a switch 89a to a solenoid winding 89 of a solenoid

valve 90 controlling the flow of internal liquid from a tank 91 to the chamber 23 through a pipe 92. Preferably a check valve 93 is provided so that no return flow can take place in the pipe 92, though this check valve is not always essential and can often be dispensed with.

Also connected to the conductor 84 through a switch 94 is a bell or other indicating means 95 which, when actuated, indicates to the operator that the control circuit is closed and that the submersible motor is in need of attention. The conductor 84 is also connected by a switch 95a to a solenoid 96 which, when energized, opens the contacts of a switch 97 connected in series with a holding coil 98 of a main switch 99 controlling the energization of the motor. Thus, energization of the solenoid 96 will break the holding circuit of the switch 99 and thus allow this switch to quickly open to de-energize the motor, this switch connecting the conductors 81, 82, and 83 to conductors 100, 101, and 102 of a supply line. The conductor 102 is grounded so that when the contact 86 engages the contact 88 the circuit is completed from the conductor 102 through ground and through the external liquid to the motor shell 10 and thence to the contact 88, the current then flowing through the contact 86, to the conductors 85 and 84, the current returning to the conductor 101 through the solenoids 89 or 96 or the indicating means 95. The control circuit will remain closed only while the contacts 86 and 88 are in engagement. As additional internal liquid is delivered to the pipe 92, this circuit is thus broken. Due to the time lag between the opening of the valve 90 and the delivery of internal liquid to the motor shell, separation of the contacts 86 and 88 will immediately close the valve 90 but flow of the internal liquid already delivered to the pipe 92 to the chamber 23 will not be prevented until equilibrium conditions are reached. Thus, if the pipe 92 is open to the atmosphere at its upper end, the level of the internal liquid therein under equilibrium conditions will be somewhat above the surface of the external liquid in which the motor is submerged. The pipe 92 is usually relatively long, and of small diameter, so that an appreciable time elapses between the instant that the valve 90 is opened and the instant when the additionally supplied liquid reaches the surface of the internal liquid in the pipe 92. This action is very desirable for the diaphragm means 76 continues to be deformed in a direction to separate the contacts 86 and 88 even after the valve 90 is closed and until pressure equilibrium conditions between the pipe 92 and the chamber 23 exist. A reserve supply of internal liquid is thus delivered to the motor shell with each closing of the control circuit.

It may often be desired to render inoperative one or the other of the control means shown associated with this control circuit. Thus, if the operator desires that the disconnect means formed by the solenoid means 96 be rendered inoperative, he can open the switch 88a, allowing the switches 94, 95a to remain closed. Similarly, if it is desired to disconnect the indicating means from the circuit, the switch 94 may be opened. So also, if the disconnect means is not to be used, the switch 95a can be opened to accomplish this result.

In both forms of the invention illustrated the conductors extend through the shell and into a low-pressure zone, the intake of the corresponding pumping means 50 communicating with this

zone to reduce the pressure therein. This is often desirable inasmuch as a lower pressure differential is maintained at the junction of the cable-enclosed or pipe-enclosed conductors and the shell than would be the case if the conductors extended into a higher-pressure zone of the structure.

While many of the features have been shown associated with the motor structure in which a differential pressure is maintained on opposite sides of the seal, this combination is not essential to the novelty of many of these features. Thus, the idea of providing a pumping means for circulating internal liquid from one end of the motor to the other in a closed path may be used regardless of the function of this pumping means in setting up a differential pressure in the seal. So also the sectional shell construction finds utility regardless of its association with an unbalanced system. The provision of means for compensating for expansion may also be used in other systems, though this means cooperates with the pumping means in a particularly desirable way if an unbalanced system is utilized. In other instances, however, this expansion-compensating means can be used independently of a pumping means to compensate for the inevitable expansion of the internal liquid which takes place when the motor is energized in a manner to heat this liquid. In the absence of such expansion-compensating means the expanding liquid would set up detrimentally high-pressure differentials on the seal and, when contraction took place, would allow external liquid to enter the interior of the motor shell.

So also, the control means illustrated finds utility regardless of whether or not it is combined with an unbalanced system.

Various changes and modifications may be made without departing from the spirit of the invention and it will be understood that the embodiments herein set forth in detail have been selected for illustrative purposes only and not as limiting our inventive concept to the details of the particular embodiments herein disclosed.

Our copending application Serial No. 634,909, filed September 26, 1932, discloses and claims various systems for maintaining a pressure differential on opposite sides of a seal, the present application being directed to an improvement over the structures shown in this copending application. So also, our copending application Serial No. 524,494, filed March 23, 1931, contains claims on a control system for an electric motor.

We claim as our invention:

1. In combination in a submersible electric motor: a motor shell containing an internal liquid and adapted to be submerged in an external liquid; an electric motor in said motor shell and providing a shaft extending through said shell; a seal at the junction of said shaft and said shell and providing an internal portion contacted by said internal liquid and an external portion communicating with said external liquid; pumping means in that end of said shell opposite said seal and intaking internal liquid from one section of said shell and discharging said internal liquid at higher pressure into another section of said shell; and means transferring the discharge pressure of said pump to said internal liquid contacting said internal portion of said seal to maintain on said internal portion of said seal a pressure in excess of the pressure on said external portion of said seal.

2. In combination in a submersible electric

motor: a motor shell containing an internal liquid and adapted to be submerged in an external liquid; an electric motor in said motor shell and providing a shaft extending through said shell; a seal at the junction of said shaft and said shell and providing an internal portion communicating with said internal liquid, and an external portion communicating with said external liquid; pumping means intaking internal liquid from one section of said shell and discharging said internal liquid at higher pressure into another section of said shell to establish a closed circulation of said internal liquid in said shell and moving through a closed circulation path, a portion of said path communicating with said internal portion of said seal, there being a return flow of said circulated internal liquid to said one section of said shell from said other section of said shell; and throttle means for throttling said return flow taking place from the vicinity of said seal and communicating with said internal portion of said seal to build up a back pressure on said closed circulation and which back pressure is transmitted to said internal portion of said seal to build up thereon a pressure, said throttle means being spaced from said pumping means.

3. In combination in a submersible electric motor: a motor shell containing an internal liquid and adapted to be submerged in an external liquid; an electric motor in said motor shell and providing a shaft extending through said shell; walls defining a seal chamber communicating with the junction of said shaft and said shell; walls defining an intake passage and a smaller discharge passage communicating with said seal chamber; pump means associated with said shaft and intaking internal liquid from a portion of said shell spaced from said seal chamber, the discharge of said pump means communicating with said intake passage and the intake of said pump means communicating with said discharge passage whereby said pump means circulates neutral liquid into and from said seal chamber, said discharge passage throttling said flow to build up a pressure in said seal chamber; and a seal for sealing said junction of said shaft and said shell and providing an inner portion communicating with said seal chamber.

4. In combination in a submersible electric motor: a motor shell containing an internal liquid and adapted to be submerged in an external liquid; an electric motor in said motor shell and providing a shaft extending through said shell; a seal at the junction of said shaft and said shell and providing an internal portion communicating with said internal liquid and an external portion communicating with said external liquid; pumping means intaking internal liquid from one section of said shell and discharging said internal liquid at higher pressure into another section of said shell; means transferring the discharge pressure of said pump to said internal portion of said seal to maintain on said internal portion of said seal a pressure in excess of the pressure on said external portion of said seal; and means for transferring pressure between the intake of said pump means and said external liquid.

5. In combination in a submersible electric motor: a motor shell containing an internal liquid and adapted to be submerged in an external liquid; an electric motor in said motor shell and providing a shaft extending through said shell; a seal at the junction of said shaft and said shell and providing an internal portion communicating with said internal liquid and

an external portion communicating with said external liquid; pumping means intaking internal liquid from one section of said shell and discharging said internal liquid at higher pressure into another section of said shell to establish a closed circulation of said internal liquid in said shell and moving through a closed circulation path a portion of said path communicating with said internal portion of said seal; throttle means in said closed circulation path and communicating with said internal portion of said seal to build up a back pressure on said closed circulation and which back pressure is transmitted to said internal portion of said seal to build up thereon a pressure; and means for transferring pressure between the intake of said pump means and said external liquid.

6. In combination in a submersible electric motor: a motor shell containing an internal liquid and adapted to be submerged in an external liquid; an electric motor in said motor shell and providing a shaft extending through said shell; walls defining a seal chamber communicating with the junction of said shaft and said shell; walls defining an intake passage and a smaller discharge passage communicating with said seal chamber; pump means associated with said shaft and intaking internal liquid from a portion of said shell spaced from said seal chamber, the discharge of said pump means communicating with said intake passage and the intake of said pump means communicating with said discharge passage whereby said pump means circulates neutral liquid into and from said seal chamber, said discharge passage throttling said flow to build up a pressure in said seal chamber; a seal for sealing said junction of said shaft and said shell and providing an inner portion communicating with said seal chamber; and means for transferring pressure between the intake of said pump means and said external liquid.

7. A combination as defined in claim 2 in which said closed circulation path includes passage means in cooling relationship with said motor and includes zones immediately inside said shell and into which zones said pump directly discharges whereby said internal liquid flows through said closed circulation path in cooling relation with said motor and in heating relation with said shell to transfer heat from said motor to said external liquid through said shell.

8. In combination in a submersible motor structure: a shell containing an internal liquid and submerged in an external liquid; a motor in said shell and providing a shaft extending therefrom; pressure-transfer means for transferring pressure between said internal liquid and said external liquid; a pumping means in said shell at one end of said motor, the intake of said pumping means communicating with said pressure-transfer means; walls forming cooling passages extending through said motor and respectively communicating at one end with the discharge and intake of said pumping means, the other ends of said passages being in communication with each other whereby said pumping means sets up a closed circulation of internal liquid through a closed circulation path transversing said motor and including said cooling passages; and a seal at the junction of said shaft and said shell and providing an internal portion communicating with said internal liquid flowing through said closed circulation path whereby the pressure on said internal portion is controlled by said pumping means.

9. In combination in a submersible electric motor: a shell defining a chamber substantially filled with an internal liquid said shell being submerged in an external liquid; a motor in said chamber; a shaft associated with said motor and extending from said shell; sealing means at the junction of said shaft and said shell and including an internal portion communicating with said internal liquid and an external portion communicating with said external liquid; pump means in said shell and pumping said internal liquid, the discharge of said pump means communicating with said internal portion of said seal to build up thereon a pressure greater than the pressure on said external portion of said seal; walls defining passage means extending from one end of said motor to the other in cooling relationship with said motor, said pump circulating said internal liquid through said passage means in a closed circulation path; and means for compensating for the expansion of said internal liquid when heated by the operation of said motor, said means including walls defining a chamber communicating with said internal liquid and receiving the excess of said internal liquid caused by the expansion thereof.

10. In combination: a submersible motor structure including a motor shell and a motor therein; movable diaphragm means associated with said shell and movable in response to changes in pressure in said shell; switch means operatively associated with said movable diaphragm means to close when said movable diaphragm means reaches a predetermined position; control means for said submersible motor structure; and a circuit connecting said control means and said switch means whereby said control means is actuated in response to the position of said movable diaphragm means.

11. A combination as defined in claim 10 in which said motor shell includes an internal liquid and in which said movable diaphragm means separates said internal liquid from the medium around said motor shell in a manner to transfer pressure therebetween.

12. In combination in a submersible motor structure: a motor shell containing an internal liquid and submerged in an external liquid; walls defining a seal chamber at one end of said motor shell and containing internal liquid; a seal for sealing said external liquid from said internal liquid in said sealing chamber; walls defining a motor chamber in said shell; a motor in said motor chamber and heating said internal liquid to cause expansion thereof; means for compensating for said expansion; walls forming an intermediate chamber in said shell; walls forming cooling passages extending from one end of said motor to the other end thereof in cooling relationship therewith, at least one of said passages communicating between said seal chamber and said intermediate chamber, at least one of said passages communicating between said seal chamber and said means for compensating for said expansion of said internal liquid; and pump means

circulating said internal liquid through said passages in a closed circulation path; said pump means being operatively associated with said motor.

13. In combination in a submersible motor structure: a motor shell defining a motor chamber, an intermediate chamber and an expansion-compensating chamber; a motor in said motor chamber; a shaft associated with said motor; pump means operatively connected to said shaft and intaking from said expansion-compensating chamber and discharging into said intermediate chamber; and passage means extending in cooling relationship with said motor and connecting said intermediate chamber and said expansion-compensating chamber, said pump means circulating a cooling medium from said expansion-compensating chamber into said intermediate chamber and through said passage means in a closed circulation path.

14. In combination in a submersible electric motor: a shell containing an internal liquid and submerged in an external liquid; a motor in said shell; a shaft associated with said motor and extending from said shell; a seal at the junction of said shaft and said shell and providing an internal portion communicating with said internal liquid and an external portion communicating with said external liquid; means substantially equalizing the pressures on said internal and external portions of said seal when said motor is not operating; and means for building up the pressure on said internal portion of said seal to a value above the pressure on the external portion of said seal when said motor is set into operation and when said shaft moves relative to said seal.

15. A combination as defined in claim 14 in which said last named means includes a pump operatively connected to said shaft, the discharge pressure of said pump raising the pressure on said internal portion of said seal when said pump is operating.

16. In a submersible electric motor, the combination of: a motor shell submerged in an external liquid and containing an internal liquid; a motor in said shell; means for building up the pressure in one zone of said shell to a pressure above that in another zone of said shell and above the pressure of said external liquid at the depth of submergence of said motor shell; and means for conducting an electric current into said shell and to said electric motor, said means extending through the walls of said shell into the lower-pressure zone thereof whereby any pressure differential at the junction of said shell and said means due to a pressure difference between said internal and external liquids at said junction will be lower than the pressure differential which would exist if said means extended through said shell into the higher-pressure zone thereof.

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