Sept. 27, 1932. E. MENDENHALL ET AL 1,879,625

SUBMERSIBLE ELECTRIC MOTOR

Filed June 8, 1926

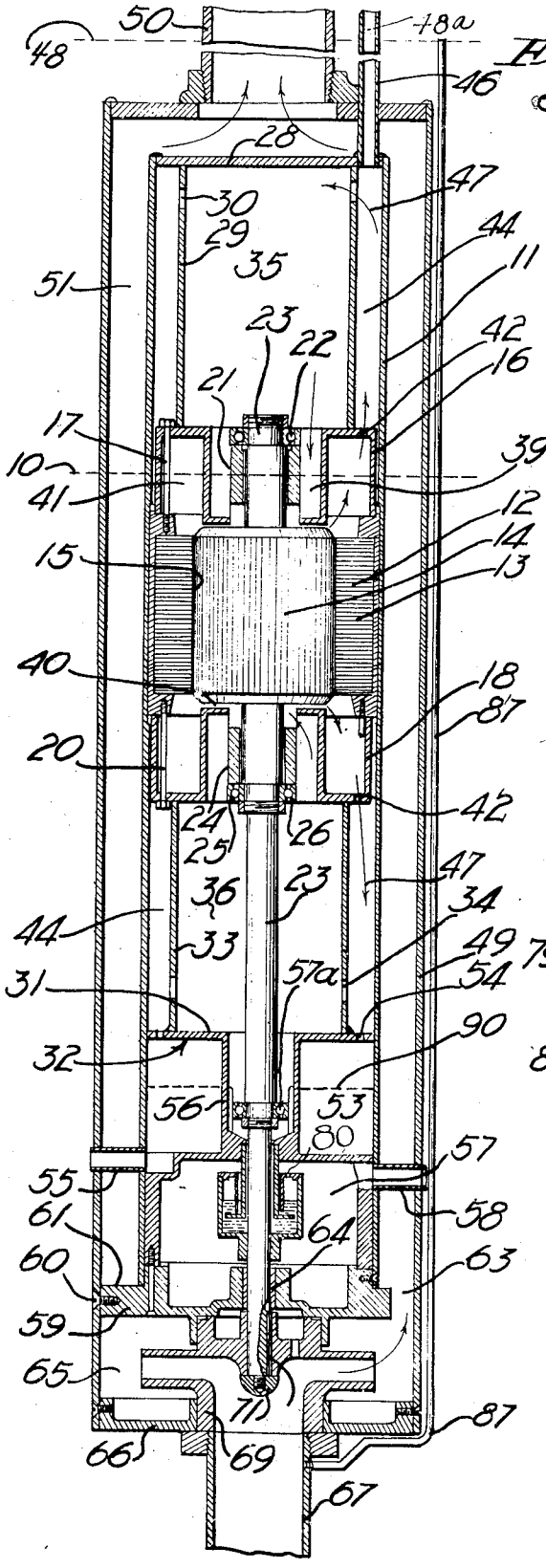


Fig. 1.

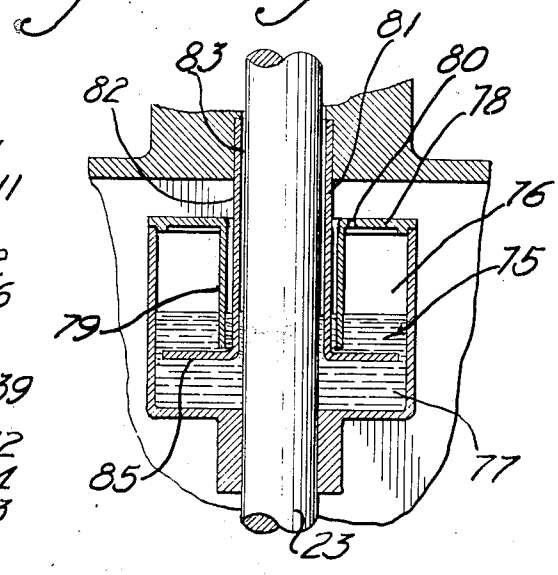


Fig. 2.

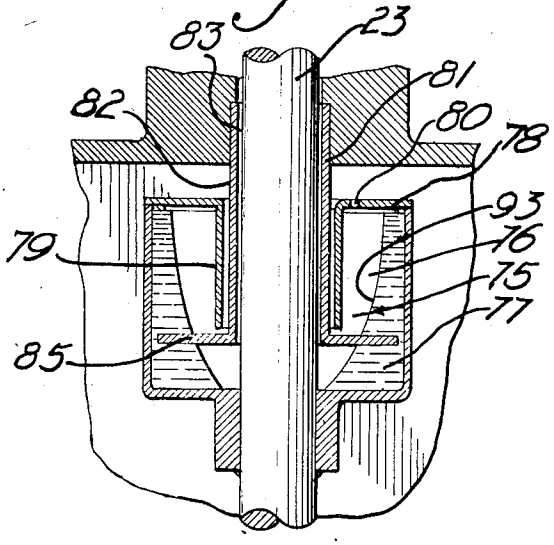


Fig. 3.

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UNITED STATES PATENT OFFICE

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SUBMERSIBLE ELECTRIC MOTOR

Application filed June 8, 1926. Serial No. 114,414.

This invention relates to oil and water well pumps, and it particularly relates to a pump in which the driving motor is located in the well directly adjacent to the pump unit.

The ordinary form of oil well pump consists of a reciprocating pump which is situated near the lower end of the well, the plunger of this pump being reciprocated by a string of sucker rods which extends upward to the surface of the ground where it is connected to a driving means. The cost of providing sucker rods, pump shafts and bearings for the respective oil and water well pumps is considerable, and the attention which these parts demand is also considerable.

It is an object of this invention to provide a pump structure in which the driving motor is situated in the well directly adjacent to the pump unit. This construction eliminates the sucker rods or the pump shaft and bearings such as are required in the ordinary well pump.

Since the motor of the pump is adjacent to the pump unit it is below the liquid level in the well. It is somewhat of a problem to keep the motor properly cooled and lubricated and at the same time maintain a pressure inside the pump structure which is substantially equivalent to the pressure outside the pump structure, so that the lubricating medium or other neutral liquid employed in the motor shell will not be displaced and so that the parts will be relieved of unnecessary strain.

It is an object of this invention to provide a pump structure of the character mentioned in which the motor will run in a lubricating medium or other neutral liquid which is circulated around the motor and in which the pressures inside and outside the pump structure are substantially in balance.

There is a tendency for the liquid being pumped to pass around the motor shaft by which the pump unit is operated into the spaces in which the neutral liquid is situated. This liquid passing thereinto destroys the lubricating and cooling qualities of the liquid and the motor will soon get out of order.

It is an object of this invention to provide a pump structure of the character mentioned in which liquid being pumped cannot pass around the motor shaft into the space in which the neutral liquid is located.

A still further object of the invention lies in the provision of a novel submersible motor structure whether or not this structure is used in combination with a turbine pump.

Other objects lie in the provision of a novel submersible shell so sealed that none of the external liquid may enter therein even though a rotatable shaft extends therefrom.

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

Referring to the drawing in which we illustrate our invention,

Fig. 1 is a vertical section through the pump of our invention.

Fig. 2 is an enlarged fragmentary section showing the novel sealing means of our invention when the pump is idle.

Fig. 3 is a view similar to Fig. 2 showing the sealing means when the pump is in operation.

In clearly setting forth the details of our invention we have chosen to describe it in a deep well installation and adapted to pump water from the pump to the surface of the ground. It should be clear that we are not limited to this use. Neither are we limited to the use of an oil or other lubricating medium as a neutral fluid, the terms used in the written description being for illustrative purposes only.

Referring to the drawing in detail, the numeral 11 represents a shell which encloses a motor 12. The motor 12 is placed near the middle of the shell 11 in a motor chamber thereof and consists of a stator 13 and a rotor 14 which revolves in a cylindrical opening 15 of the stator 13. An upper frame 16 is secured by bolts 17 above the stator and rotor 13 and 14, and a lower frame 18 is secured below the stator and rotor by bolts 20. The upper frame 16 has a central collar 21 which supports a thrust bearing 22, the thrust bearing 22 being secured at the upper end of a motor shaft 23 on which the rotor 14 is secured. The lower frame 18 has a collar 24

below which a cavity 25 is formed, in which cavity a radial bearing 26 is placed. The radial bearing 26 is secured on the motor shaft 23 below the rotor 14. Extending from the upper frame 16 to a top plate 28 of the shell 11 is a cylindrical baffle 29 having openings 30 formed near the upper end thereof. Extending from the lower frame 18 to an upper wall 31 of a balance chamber member 32 is a cylindrical baffle 33 having openings 34 formed near the lower end thereof. An upper oil circulating chamber 35 is formed in the shell 11 and in which is positioned the upper baffle 29, while a lower circulating chamber 36 is formed in the shell 11 and retains the lower baffle 33. The upper and lower frames 16 and 18 provide passages 39 which connect between either of the chambers 35 and 36 and the ends of the rotor 14. The frames are so spaced that radial passages 40 are provided between the frames 16 and 18 and the ends of the rotor through which lubricating medium in the form of oil or other neutral liquid is thrown by centrifugal force provided by the skin friction of the ends of the rotor 14. The upper and lower frames 16 and 18 provide cavities 41 into which the oil passes from the passages 40. Openings 42 are provided in the frames 16 and 18 which connect the cavities 41 to spaces 44 which are formed outside the baffles 29 and 33 in the outer portions of the oil circulating chambers 35 and 36.

When the motor is in operation the lubricating medium or other neutral liquid, which is supplied through an oil tube 46 which attaches to the upper end of the shell 11, is circulated as represented by arrows 47 in Fig. 1. The lubricating medium is drawn through the passages 39 into the radial passages 40 whereas it is thrown outward by centrifugal force. The lubricating medium then passes into the cavity 41 and through the spaces 44. The oil then passes through the openings 30 and 34 in baffles 29 and 33 and into the chambers 35 and 36 respectively. This provides an efficient circulation which keeps the motor thoroughly lubricated and cooled. The tube 46 extends upward to a point above the surface level of the external or pumped liquid, this surface level being indicated by the numeral 48, and preferably extends to the surface of the ground in the event that the pump of our invention is installed in a well. The tube 46 provides an auxiliary chamber 48*a* into which the neutral liquid rises in a manner to be hereinafter explained.

Surrounding the shell 11 is a jacket 49 to which a discharge column 50 is connected. The jacket 49 provides an outlet passage 51 for the pump, through which fluid being pumped passes in order to reach the discharge casing 50 by means of which it is conducted to the surface of the ground. The liquid being pumped is brought into contact with the shell 11 and the lubricating medium is kept cool by the liquid being pumped as it passes around the shell 11. The shell 11 and the jacket 49 thus provide a double-walled shell separating the motor chamber from the external liquid, the pressures on the opposite sides of this shell being substantially equalized by means which will now be described.

The balance chamber member 32 provides a balance chamber 53 which is connected to the space 44 surrounding the lower circulating chamber 36 by small openings 54. The balance chamber 53 is also connected at its lower end to the exterior of the jacket by means of a tube 55. The member 32 has an impervious central cylindrical wall 56 which provides a pocket in which a lower radial bearing 57*a* is placed. The lower radial bearing 57*a* is secured to the pump shaft 23 which extends downward entirely through the balance chamber member 32 to the lower end of the pump structure. Formed below the balance chamber 53 is a liquid chamber 57 which is connected to the exterior of the pump by a tube 58. This liquid chamber is formed at the lower end of the shell 11 and is closed by a casting 59 which is secured to the jacket 49 by suitable screws 60 which extend through a flange 61 thereof. The flange 61 has openings 63 formed therein to permit liquid to pass upward through the outlet space 51.

The casting 59 provides a bearing 64 which journals the lower end of the motor shaft 23.

The lower end of the motor shaft 23 extends into an impeller chamber 65 which is formed in the lower end of the jacket 49 below the casting 59 and above a lower head 66, to which head 66 a water casing 67 providing a suction passage is secured. An impeller 69 of common construction is placed in the impeller chamber 65 and is secured by a key and nut 70 and 71 to the lower end of the motor shaft 23.

Referring particularly to Fig. 2, secured to the motor shaft 23 is a packing means in the form of a fluid-packed seal 75 which is located inside the liquid chamber 57. The fluid-packed seal 75 provides a cup 76 in which a sealing medium, preferably in the form of mercury as indicated at 77, is placed. The cup 76 is provided with a cover plate 78 from which a tube 79 extends downward, the lower end of the tube 79 projecting below the level of the mercury 77. Openings 80 are formed in the cover plate 78 which connect the cup 76 with the liquid chamber 57. A stationary baffle 81 is supported by the balance chamber member 32 as illustrated in the drawing. This baffle member 81 has a sleeve portion 82, the upper end of which extends into an opening 83 through which the motor shaft 23 extends, this sleeve portion 82 surrounding the motor shaft 23. The sleeve portion 82 forms an impervious member extending into the cup 76 inside the tube 79. A

radial flange 85 projects outward from the lower end of the sleeve portion 82, as shown.

Connected to the suction side of the pump unit of the invention preferably to the upper end of the water-casing 67 is a small pipe 87. This pipe 87 extends upward alongside the jacket 49 to a point a short distance thereabove, terminating at a level which is to be the lowest liquid level in the well.

The pump, just described, is installed inside a well casing (not shown) below the liquid level thereof. After the pump is lowered into the well sufficient lubricating oil may be poured into the tube 46 to entirely fill this tube and the interior of the shell 11. It will be seen that the oil, which should be lighter than the fluid to be pumped, in passing downwardly into the chambers 44, 35, 36, 44, and 53 displaces the water therein which flows outwardly into the well through the tube 55. Sufficient oil should be poured in to entirely displace the water which will be evidenced by the appearance of oil on the surface of the water in the well or the amount of oil needed can be readily calculated by calculating the volume to be filled.

It is preferable to start filling the motor with oil as it is lowered in place, keeping the oil level in the pipe 46 above the level of the water in the well during the time the pump is being lowered in place. This is not difficult due to the peculiar relationship between the balance chamber 53 and the pipe 46. It will be observed from an inspection of the drawing that the cylindrical balance chamber 53 is something over twenty times the diameter of the pipe 46, or that it has an area of something over 400 times that of the pipe 46, since the areas are as the squares of the diameters. Water is free at all times to enter or leave the chamber 53 through the pipe 55. If the pump, initially filled with oil, is lowered into the well without adding oil, water will flow into the chamber 53 through the pipe 55 in sufficient amounts to maintain a static balance, that is, to keep the level of the oil in the pipe 46 at about the level of the water in the well. But the area of the chamber 53 being so much greater than the area of the pipe 46, it is evident that even after the pump is lowered a considerable distance very little water will enter the chamber 53. In fact the pump would have to be lowered 400 feet to allow enough water to enter the chamber 53 to push the oil up one foot. That is, one foot of water in the chamber 53 is necessary to fill 400 feet of the tube 46 with oil. This being the case, it is obviously not difficult to keep the pump full of oil during the operation of submergence.

Regardless of the method used to initially place the pump in the well, it is desirable after it is in place to supply sufficient additional oil to insure the chamber 53 being entirely filled so that some oil initially runs out of the tube 55. This oil should have some lubricating value, have a moderately high dielectric strength, and be moderately nonhygroscopic. Most light lubricating oils have these properties.

The liquid chamber 57 is filled with water which enters through the tube 58, and a part of the cup 76 is likewise filled with water which passes thereinto through the openings 80 in the cover plate 78. The space inside the sleeve portion 82 of the baffle member 81, however, is filled with oil which may creep down through the opening 83, this oil being separated from the water in the liquid chamber 57 by the sealing medium 77. Electricity is supplied to the motor 12 through conductor wires, not shown, which extend to the pump from the surface of the ground. These conductor wires, if desired, may be passed through the oil tube 46. The motor is energized and the pump is set into operation.

The impeller 69 draws water through the water casing 67 and throws it into the lower end of the jacket 49. The water passes upward around the shell 11 and into the discharge casing 50 by means of which it is conducted to the surface of the ground. The lubricating medium in the circulating chambers 35 and 36 is circulated, as previously described, being brought into contact with the shell 11 and cooled by the water contacting the outer surface of the shell 11.

It is an object of the invention to maintain substantially equal pressures in the chambers 57 and 53 so that there will be no differential pressure on the seal provided by the mercury in the cup 75. This equality of pressure is insured by the pipes 55 and 58 which connect both chambers with the fluid in the well at all times and thus provide equalizing channels through which the pressures in the chambers are maintained substantially the same.

It is quite probable that when the pump is set into operation the level of the water in the well will be drawn down. When this occurs, the level of the oil in the oil tube 46 will also drop and the level of the water in the balance chamber 53 will drop proportionately. If the chamber 53 is entirely full of oil the lowering of the water in the well will lower the level of the oil in the tube 46 and this will cause oil to flow downwardly and displace oil from the chamber 53 so that oil will flow into the well through the tube 55. If owing to prior changes in level or other reasons the oil in the chamber 53 only fills the chamber down to a surface indicated at 90, the lowering of the level of the water in the well will only slightly affect the position of this surface. In fact with the dimensions shown in the drawing the level of the water would have to fall 400 feet to lower the surface 90 one foot. If, however, the water rises in the well, the oil level in the oil tube 46 must also

rise, which means that water must flow through the tube 55 into the balance chamber 53. It is very obvious that the water level 90 therein will rise also. It should be particularly noted that the area of the balance chamber 53 is many times the area of the oil tube 46 so that even though the water level should rise a considerable distance, the oil level in the tube 46 rising therewith, the level 90 of the water in the balance chamber 53 will move but a short distance. The water in the balance chamber 53 thus forces oil into, or allows oil to flow from, the tube 46, in a manner to keep the pressure inside the shell always substantially equal to the pressure of the water, or other liquid surrounding the jacket 49. The difference in densities of the oil and water prevents the levels of these two liquids being exactly the same, the oil level in the tube 46 being slightly higher than the level of the water in the well. The balance chamber 53 is made sufficiently large so that it will normally take care of any changes in level of the water in the well.

One feature of the invention is that the water and oil in the balance chamber 53 are not in contact with any moving parts. This prevents an agitation of the water and oil and an emulsification thereof.

When the pump is operating, the mercury 77 occupies the position shown in Fig. 3, the mercury being thrown into this position by centrifugal force. The mercury provides a central cone 93 but the outer edges of the flange 85 still project into the body of mercury, thus maintaining a seal between the upper part of the cone 93 and the lower part thereof. This part of the invention is very important. The water occupies that part of the cone which is outside the baffle member 81 and above the radial flange 85, whereas the lubricating medium may occupy the space inside the sleeve portion 82 and that part of the cone 93 which is below the flange 85. Were it not for this sealing means of the invention, there would be a marked tendency for water being pumped to flow upward around the bearing 64 and through the opening 83 through which the motor shaft 23 extends. By the present arrangement, however, the water flowing by the bearing 64 passes into the liquid chamber 57, and may flow outward through the tube 58. This will be likely to happen since the fluid being pumped would be under a higher pressure than the pressure of the fluid in the well outside the pump. The tube 79, since it is supported by the cup 76, rotates therewith and revolves the water in the upper part of the cone 93 at substantially the same rate of speed as the mercury 77 is rotated. When the mercury is in the position shown in Fig. 3, it is under a very high pressure and any foreign matter which may be occluded thereby at other times will be forced therefrom, thus keeping the mercury substantially clean.

If the water level 48 of the well were pumped down to the lower end of the pump, it will be seen that all of the oil in the shell 11 would flow therefrom. When the water level would rise again, the shell would fill with water which, of course, would be disastrous to the motor. For this reason it is necessary to provide a means for preventing the water from being pumped below a certain level. This means is provided in the form of the pipe 87. The upper end of the pipe 87 terminates at the lowest level to which the water can be safely drawn. When the water level is drawn below this level, the upper end of the pipe 87 is exposed and air is drawn therethrough into the water casing 67 which supplies air to the impeller 69 and prevents it from properly functioning. When this occurs, the pump will not pump water and it may be shut down until the water level in the well rises again. It is better to do this than to take a chance of getting water into the shell 11.

Certain of the elements shown herein are also disclosed and claimed in a copending application filed by Charles Robert Sessions on June 8, 1921, Serial 476,092, which discloses a different type of balancing system. Certain of the elements herein shown are also disclosed and claimed in our copending application, Serial 217,688, filed September 6, 1927, directed to a different type of pressure-equalizing means and a system wherein a body of the neutral liquid is entrapped in the motor chamber rather than having free access to an oil tube as disclosed in the present application. Our copending application, Serial 255,544, filed February 20, 1928, discloses and claims a different combination of certain of the elements from that disclosed in the present application and is directed to a system wherein the internal and external pressures are not necessarily equalized by a pressure-equalizing means. Further, our copending application, Serial 225,182, filed October 10, 1927, contains claims directed to the mercury seal herein disclosed.

We claim as our invention:

1. In a submersible electric motor structure, the combination of: a motor; a shell surrounding the motor and surrounded by a liquid which may be injurious to the motor; walls forming a balance chamber, said balance chamber being in communication at opposite ends with the interior of said shell and with said liquid surrounding said shell; an oil tube communicating with said shell and extending upward to a point above the surface of said liquid; a neutral liquid which is not injurious to said motor, said neutral liquid filling said shell around said motor and at least partially filling said balance chamber; a motor shaft extending longitudinally through said shell; and a fluid-packed

seal around said shaft, said fluid-packed seal preventing any emulsification between said liquids around said shaft.

2. In combination: a shell surrounded by a primary liquid, the pressure of which at a section opposite said shell may be a variable quantity, said shell containing a secondary liquid; walls forming an auxiliary chamber communicating with the interior of said shell; and walls forming a balance chamber in said shell in which said primary and secondary liquids are in pressure-equalizing relationship for forcing said secondary liquid upward in said auxiliary chamber until the pressure on said secondary liquid in said shell is substantially equal to the pressure of said primary liquid at said section opposite said shell.

3. In a submersible motor structure, the combination of: a shell surrounded by an external liquid, the pressure head of which at a section opposite said shell may be a variable quantity; a motor in said shell; a tube in open communication with the interior of said shell, there being a neutral liquid in said shell and extending upward in said tube; pressure-transferring means associated with said shell and causing the level of said neutral liquid in said tube to vary in response to variations in the pressure head of said external liquid; and conductor means extending through said tube and into the interior of said shell whereby current is supplied to said motor, said conductor means being smaller than said tube to allow the space in said tube around said conductor means to freely conduct said neutral liquid.

4. In a submersible motor structure, the combination of: a shell surrounded by an external liquid; a motor mounted in said shell, there being a pair of circulating chambers formed in said shell on opposite ends of said motor, there being a neutral liquid around said motor and in said circulating chambers; and means for circulating said neutral liquid in the said circulating chambers in cooling relationship with said motor and along the inner surface of said shell in such a manner that said external liquid cools said neutral liquid.

5. In a submersible motor structure, the combination of: walls forming a motor chamber, a balance chamber, and a liquid chamber, said motor chamber and said balance chamber being in communication and at least partially filled with a neutral liquid, said liquid chamber and said balance chamber being at least partially filled with the external liquid in which said motor is submerged, the pressures on said liquids being substantially equalized in said balance chamber; a motor in said motor chamber; a shaft on said motor and extending into said liquid chamber; and means for sealing said shaft in fluid-tight relationship with said walls.

6. In a submersible motor structure, the combination of: a motor; a shell surrounded by an external liquid and providing a motor chamber in which said motor is positioned, said motor chamber being substantially filled around said motor with a neutral liquid which is non-injurious to said motor, said neutral liquid being relatively immiscible in said external liquid; walls forming a balance chamber communicating at one end with said motor chamber and at the other end with said external liquid, whereby said balance chamber contains bodies of said neutral and external liquids; and an oil tube in open communication with said motor chamber and extending upward to a point above the surface of said external liquid.

7. In an electric motor structure adapted to operate substantially filled with a neutral liquid, the combination of: a motor including a rotor and a stator; a shell surrounding said motor; means extending adjacent an end of said rotor for defining a passage in which the rotation of said motor circulates said neutral liquid outward when said motor is in operation; and a baffle in said shell extending away from said means for guiding the neutral liquid thus circulated adjacent the inner surface of said shell.

8. In a submersible electric motor structure, the combination of: a motor; a shell providing a motor chamber in which said motor is positioned, said motor chamber being substantially completely filled around said motor with a neutral liquid which is non-injurious to said motor, said shell being surrounded by an external liquid which may be injurious to said motor; a fluid-packed seal containing a body of sealing liquid in pressure-transferring relationship with said neutral liquid and with said external liquid and preventing intermixing of said neutral and external liquids; and walls forming a balance chamber communicating with said neutral and external liquids and containing bodies of these liquids.

9. In a submersible electric motor structure, the combination of: walls defining a motor chamber adapted to be submerged in an external liquid; a motor in said motor chamber; an oil tube communicating with one end of said motor chamber and adapted to supply a neutral liquid thereto which is not injurious to said motor; and walls defining a balance chamber communicating with said motor chamber at a point on the opposite side of said motor from the point of entrance of said neutral liquid from said oil tube, said balance chamber communicating with said external liquid so as to contain pressure equalized bodies of said neutral and external liquids.

10. In combination: a shell surrounded by a primary liquid, the pressure of which at a section opposite said shell may be a variable

quantity, said shell containing a secondary liquid; a tube in open communication with the interior of said shell and extending to a point above the surface level of the primary liquid, the upper end of said tube being open; and walls defining a balance chamber in open communication with said primary liquid around said shell and with said secondary liquid in said shell in a manner to contain pressure-equalized bodies of said liquids, the cross-sectional area of said tube being much smaller than the cross-sectional area of said balance chamber whereby a small change in the relative amounts of primary and secondary liquids in said balance chamber causes a relatively large change in level of the secondary liquid in said tube.

11. In a submersible electric motor structure, the combination of: a cylindrical shell containing a body of neutral liquid; a motor mounted in said shell, said motor providing means for circulating said neutral liquid through circulating chambers in opposite ends of said shell; and a pair of cylindrical baffles in said circulating chambers for guiding said neutral liquid through and around said cylindrical baffle in heat-transferring relationship with said shell.

12. In combination in a structure adapted to be submerged in an external liquid: a shell substantially filled with neutral liquid; a rotatable shaft extending through a wall of said shell; means adjacent the junction of said shaft and said shell and rotating with said shaft, said means retaining a body of mercury; stationary means secured in fluid-tight relationship with a portion of said shell and extending downward below the surface of said body of mercury whereby said mercury communicates with said neutral liquid and said external liquid in a manner to be displaced by any difference in pressure existing therebetween; means defining a balance chamber in said shell, one end of said balance chamber being in open communication with said neutral liquid in said shell and the other end being in open communication with said external liquid whereby contacting bodies of said liquid are maintained therein in pressure-equalizing relationship; and an oil tube in open communication with said neutral liquid in said shell and extending upward above the surface level of said external liquid, the upper end of said oil tube being open to the atmosphere, said oil tube having a cross-sectional area much smaller than the cross-sectional area of said balance chamber whereby a small change in level in said balance chamber effects a large change in level of said neutral liquid in said oil tube, said balance chamber forcing said neutral liquid upward in said oil tube until a static balance between said neutral and external liquids is effected.

13. In combination in a structure adapted to be submerged in an external liquid: a shell containing a neutral liquid; a rotatable shaft extending from said shell; a fluid-packed seal sealing the junction of said shaft and said shell and displaceable by any difference in pressures between said neutral liquid and said external liquid; means for substantially equalizing the pressures exerted on said fluid seal by said neutral and external liquids; and an oil tube in open communication with said neutral liquid in said shell and extending upward above the surface level of said external liquid, said neutral liquid extending upward in said oil tube until the pressure head built up substantially equals the pressure of said external liquid acting on said pressure equalizing means.

14. In a submersible structure the combination of: a shell surrounded by an external liquid the pressure of which at a section opposite said shell may be a variable quantity, said shell containing a neutral liquid; a tube in open communication with the interior of said shell and extending to a point above the surface level of said external liquid, the upper end of said tube being open; and a pressure-equalizing means communicating with said neutral and said external liquids for maintaining the pressures on said liquids substantially equal, said pressure-equalizing means thereby maintaining in said oil tube a head of said neutral liquid substantially equivalent to the pressure head of said external liquid at a section opposite said shell.

15. In a submersible structure the combination of: a shell surrounded by an external liquid; a rotatable shaft in said shell; and walls forming an annular balance chamber around said shaft but separated therefrom by an impervious wall, said balance chamber being in communication with a neutral fluid in said shell and with said external liquid in a manner to contain pressure-equalized bodies of said neutral fluid and said external liquid.

16. In combination in a structure adapted to be submerged in an external liquid: a shell; a rotatable shaft extending through the walls of said shell; means rotating with said shaft for retaining a body of sealing liquid around said shaft; an impervious member extendng into said sealing liquid, one side of said impervious member communicating with the interior of said shell and the other side thereof communicating with said external liquid, said body of sealing liquid being displaceable by any pressure difference existing between said external liquid and the interior of said shell; and means for maintaining the pressure inside said shell substantially equal to the pressure of said external liquid with which said other side of said impervious member communicates.

17. In a submersible motor structure in combination with a pump operating in an external liquid in a well and adapted to change

the surface level thereof: a shell adjacent said pump and submerged in said external liquid, said shell providing a motor chamber; a motor in said motor chamber and providing a shaft operatively connected to said pump, said motor chamber being filled around said motor with a neutral liquid; walls defining a balance chamber in open communication with said external liquid and with said neutral liquid; and means preventing pumping by said pump when said surface level of said external liquid falls to a predetermined level.

18. In a submersible motor structure in combination with a pump operating in an external liquid in a well and adapted to change the surface level thereof: a shell adjacent said pump and submerged in said external liquid, said shell providing a motor chamber; a motor in said motor chamber and providing a shaft operatively connected to said pump, said motor chamber being filled around said motor with a neutral liquid; walls defining a balance chamber in open communication with said external liquid and with said neutral liquid; and means communicating between the intake of said pump and said external liquid at a point above said motor chamber whereby air is drawn into said pump before said surface level is lowered by said pump to such a level that said neutral liquid would drain from said motor chamber.

19. In a submersible structure the combination of: a shell surrounded by an external liquid and defining a chamber containing a neutral liquid the density of which is less than the density of said external liquid; a rotatable shaft in said chamber and adapted when rotated to agitate said neutral liquid; walls forming a balance chamber immediately below said chamber, said walls including an upper wall bounding one or more ports through which said chamber communicates with the upper end of said balance chamber whereby any agitation in said chamber is not transferred to said balance chamber; and walls defining a passage in open communication between the lower end of said balance chamber and said external liquid.

20. In a submersible motor structure, the combination of: a motor; a motor shell providing a motor chamber in which said motor is positioned; a jacket around said motor shell and spaced therefrom to form an annular passage through which may flow a stream of the external fluid in which said motor structure is submerged; walls forming a balance chamber in said motor shell, one end of said balance chamber communicating with said motor chamber; and walls defining a passage communicating with the other end of said balance chamber and extending across said annular passage and opening on said external fluid around said jacket whereby said other end of said balance chamber is in open communication with said external fluid.

In testimony whereof, we have hereunto set our hands at Los Angeles, California, this 3rd day of June, 1926.

EARL MENDENHALL.
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