

Aug. 18, 1942.

T. G. MYERS

2,293,616

SUBMERSIBLE STRUCTURE

Filed Feb. 28, 1938

4 Sheets-Sheet 1

Fig. 1

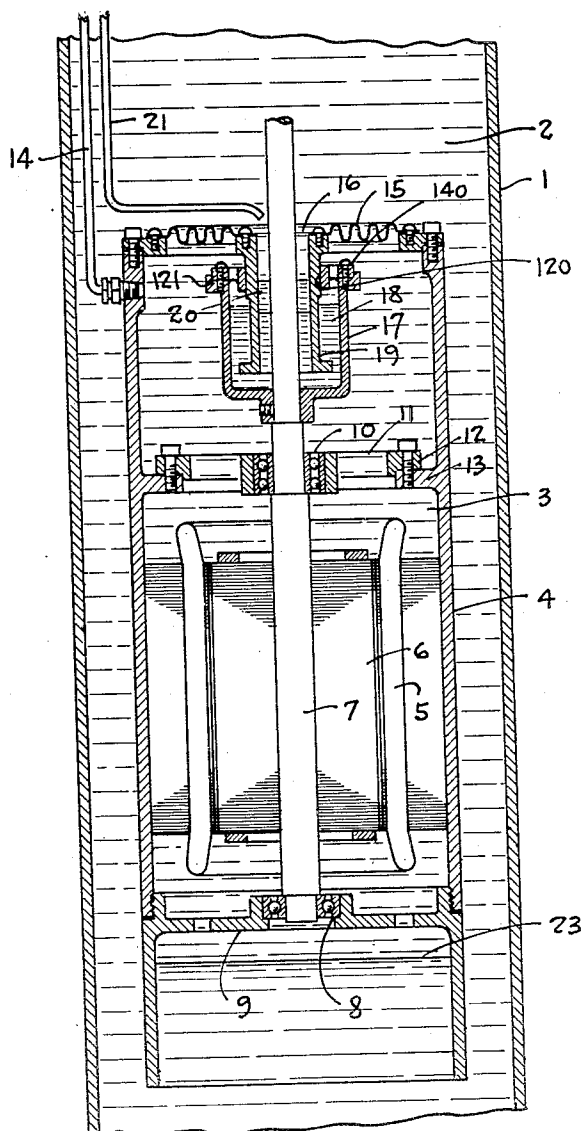


Fig. 2

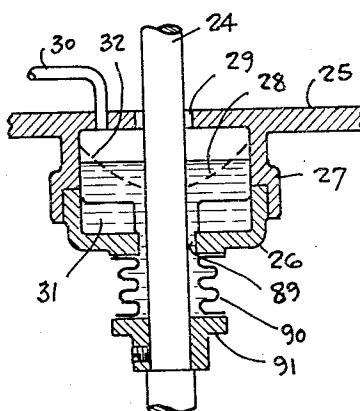
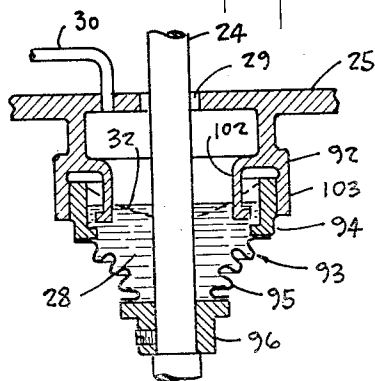


Fig. 3



INVENTOR
Thomas G. Myers
BY *John Flann*
ATTORNEY

Aug. 18, 1942.

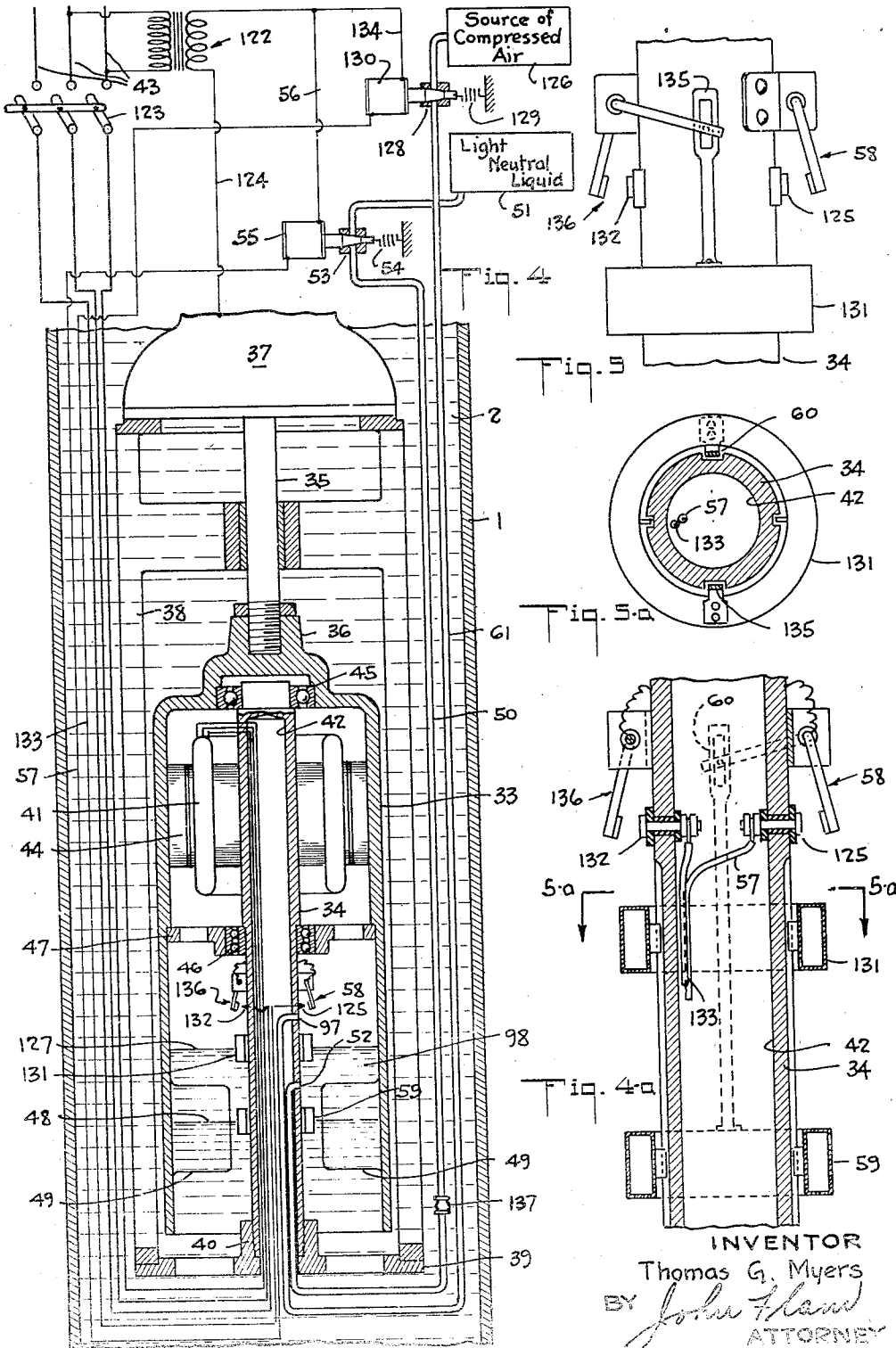
T. G. MYERS

2,293,616

SUBMERSIBLE STRUCTURE

Filed Feb. 28, 1938

4 Sheets-Sheet 2



INVENTOR
Thomas G. Myers
BY *John F. Lane*
ATTORNEY

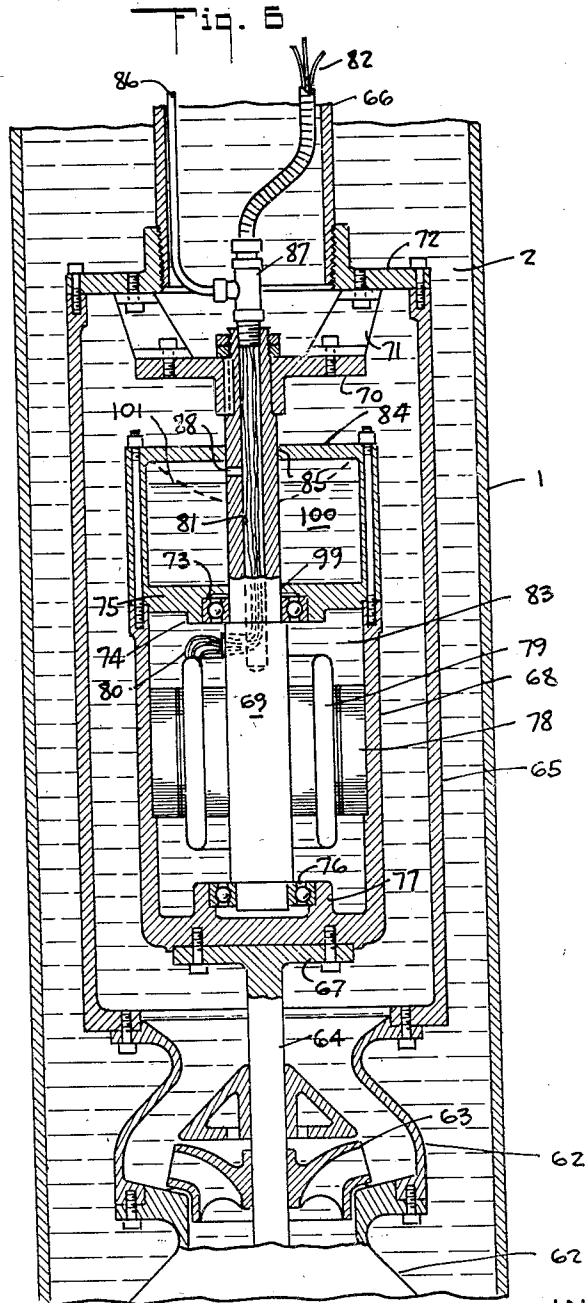
Aug. 18, 1942.

T. G. MYERS
SUBMERSIBLE STRUCTURE

2,293,616

Filed Feb. 28, 1938

4 Sheets-Sheet 3



INVENTOR
Thomas G. Myers
BY *John Flann*
ATTORNEY

Aug. 18, 1942.

T. G. MYERS

2,293,616

SUBMERSIBLE STRUCTURE

Filed Feb. 28, 1938

4 Sheets-Sheet 4

Fig. 7

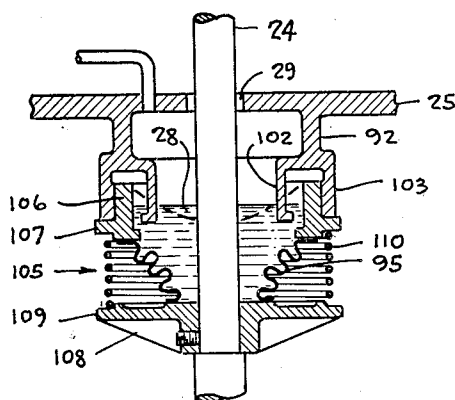
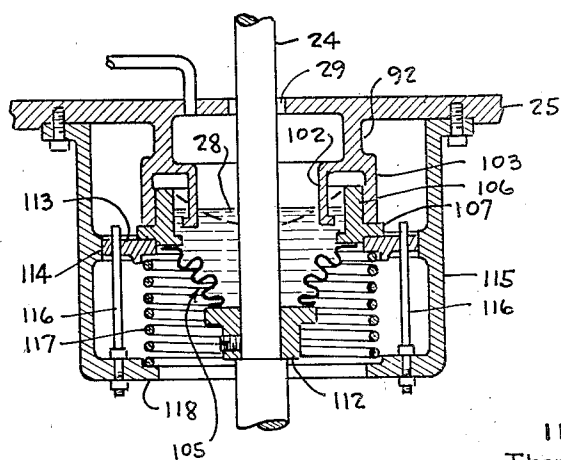


Fig. 8



INVENTOR
Thomas G. Myers
BY *John Flamm*
ATTORNEY

UNITED STATES PATENT OFFICE

2,293,616

SUBMERSIBLE STRUCTURE

Thomas G. Myers, Los Angeles, Calif., assignor to
U. S. Electrical Motors, Inc., Los Angeles, Calif.,
a corporation of California

Application February 28, 1938, Serial No. 193,121

10 Claims. (Cl. 172—36)

This invention relates to submersible structures; for example, to submersible electric motors adapted to be directly connected to pumps lowered into a well liquid. Installations of this general character have been proposed and used. They involve the problem of excluding the harmful well liquid from the windings, as well as from the bearing structures.

Various sealing devices for accomplishing these functions have been heretofore devised. In some of these, the motor casing is intended to be at least partially filled with an inert, neutral liquid that may also serve as a lubricant. In many instances, oil is a suitable liquid for this purpose. Problems however, arise in connection with such fillings and seals, which it is the aim of this invention to solve. These problems may now be discussed.

Whenever two unlike liquids are in contact, such as mercury and water, and when there is some agitation, an emulsion of the two liquids results. Where mercury is used as a sealing medium and in contact with the neutral liquid and the well liquid, this emulsification harms the seal. In cases where the neutral filling liquid, such as oil, is in contact with well liquid, such emulsification or mixture would in time seriously reduce the insulation quality of the liquid in the casing, with resultant serious effects upon the motor.

It is one of the objects of this invention to prevent harmful emulsification or mixing of the liquids that are involved in systems of this character.

The manner in which this result is obtained may take several forms. Mechanical separation of the liquids in a novel way, forms another object of the invention.

It is still another object of the invention to make it possible to reduce the relative motion of liquids in contact, thereby retarding or preventing harmful emulsification.

This invention possesses many other advantages, and has other objects which may be made more easily apparent from a consideration of several embodiments of the invention. For this purpose there are shown a few forms in the drawings accompanying and forming part of the present specification. These forms will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a view, mainly in longitudinal section, illustrating a form of the invention in use in a well;

Figs. 2 and 3 are fragmentary views, mainly in section and on an enlarged scale, of modified forms of the invention;

Fig. 4 is a view similar to Fig. 1 of a further modified form of the invention;

Fig. 4a is an enlarged detail fragmentary sectional view of a part of the apparatus illustrated in Fig. 4;

Fig. 5 is an elevation of part of the mechanism illustrated in Fig. 4a;

Fig. 5a is a section as seen on plane 5a—5a of Fig. 4a;

Fig. 6 is a view similar to Fig. 1 of a further modification; and

Figs. 7 and 8 are fragmentary views, mainly in section, of further modified forms of the invention.

In Fig. 1 the well is shown as defined by a well casing 1 in which there is the well liquid 2. This well liquid may be water or the like which it is desired to pump out of the well.

For this purpose, use is made of a submersible electric motor, having the motor elements accommodated in a space 3 formed within a submersible casing 4. Within this space 3 there are accommodated the primary or stator windings 5; and the rotor 6 mounted on a rotary shaft 7. The motor, comprising the parts 5 and 6, may be of the conventional induction motor squirrel cage type, appropriately connected through waterproof cables to a source of electrical energy at the top of the well.

The shaft 7, shown in this instance as extending upwardly out of the casing, is intended to be directly connected to a pump (not shown). Provisions are made for insuring against the entry of well liquid within at least that part of the casing 3 in which the motor windings and the shaft are located. The manner in which this is done will now be described.

The rotary shaft 7 is shown in this instance as being supported for rotation by a lower ball bearing structure 8, the outer race of which is supported on a transverse perforated wall 9 extending across the bottom of casing 4. Adjacent its upper end the shaft 7 is similarly rotatably supported by the ball bearing structure 10. The outer race of this ball bearing structure is shown in this instance as supported on a spider 11, having the flange 12 secured to an integrally formed flange 13 extending inwardly from the wall of casing 4. In the present instance, the casing 4

may be filled with a neutral liquid or gas, such as oil, carbon tetrachloride, or air. When the casing is filled with gas or air, it is desirable to have a layer of oil on top of the water to prevent absorption of the gas in the water.

The top or cover 15 of casing 4 is a flexible, corrugated diaphragm securely fastened in fluid tight manner to the casing, and has an aperture 16 through which the shaft 7 extends. In order to provide a fluid tight seal around the shaft 7, use is made of a heavy sealing liquid. For this purpose a rotary cup 17 is shown as carried by the shaft 7 for the accommodation of a heavy sealing liquid 18, such as mercury. Depending into the body of sealing liquid 18 is the non-rotary sleeve-like annular member 19. This member is supported by the cover 15. The lower edge of this member 19 extends considerably below the surface of the body of liquid 18. In this manner the area of the top surface of the liquid 18 is divided so that a part of it is in contact with the filling in the casing 4. The inner annular part would normally be exposed to well liquid 2. In order for well liquid to pass into the casing it would have to pass through the inner annular portion of the liquid 18, around the lower edge of the non-rotary sleeve 19, and again upwardly through the outer annular portion of liquid 18. There is thus a liquid sealing effect provided by the elements just described.

In order to prevent any whip or vibration of the shaft 7 due to wear of the supporting bearings or other causes, from being imparted to the liquid filling in cup 17, along with the rotary movement of the shaft, means are provided to prevent relative lateral motion between cup 17 and the sleeve 19. This means may include a journal surface 120 formed on a split flange 140 fastened to the upper end of the sleeve 19, and engaged by a cooperating bore 121 formed in the upper end of cup 17. Together these form a centering fit which maintains the members coaxial. With this arrangement, sleeve 19 must be supported so that it is free to follow lateral motion of the cup, otherwise whip and vibration which are bound to be present in the shaft would destroy the centering fit. Thus, by mounting the sleeve 19 on a yielding support, such as diaphragm 15, it is free to adjust itself to the variations in movement of the shaft, and the sealing surface of the liquid remains undisturbed.

As previously mentioned, the rotation of cup 17 sets up a rotation of the mercury 18, and where this mercury 18 is in contact with another liquid, an emulsion or mixture is apt to form; and especially is this true where there is relative motion between the liquids at the surfaces of contact.

In order to avoid an area of contact between the body of liquid 18 and the well liquid 2, there is superimposed upon the inner surface of liquid 18 a supplemental heavy liquid 20, which is carbon tetrachloride or the like. This carbon tetrachloride layer does not form an emulsion as easily as the mercury 18. Accordingly the emulsion or mixture between the mercury 18 and the well liquid is prevented.

Surfaces in contact with the mercury 18, such as of cup 17 and sleeve 19, may be appropriately treated to insure against undesirable chemical action. Furthermore, a filler pipe may be provided, both for the carbon tetrachloride 20 and the mercury 18, indicated generally by 21.

Provision may be made to maintain the fluid pressure within casing 4 at about the same value

as the liquid measure exterior of the casing 4; or slightly above this exterior pressure. For this purpose various arrangements have been proposed and used. In the present instance, pressure balance is secured by leaving the bottom of casing 4 open, permitting the well liquid to rise normally to about the level indicated by the level 23. The flexible diaphragm 15 would serve to maintain the pressures within and without the casing equal, even though the bottom was tightly closed. In that case, however, some means, such as an outwardly opening check valve, or a pipe leading from the bottom of the casing to the top of the well, would have to be provided to permit replacement of the liquid filling of the casing when desired.

At the level 23 there is a pressure transfer between the fluid filling the casing 4 and the exterior well liquid. As long as there is sufficient air, fluid or liquid within the casing 4, this surface 23 is prevented from rising to any of the rotary parts of the apparatus or to the windings.

The prevention of emulsification illustrated in Fig. 1 may be secured in somewhat different ways. In Fig. 2 the rotary shaft 24 extends out of the top 25 of the casing, which in this form may be a rigid member. The shaft carries a rotary cup 26 in telescopic relation with the non-rotary depending sleeve-like member 27. The cup 26 has a central aperture 39 sufficiently large to provide substantial clearance around shaft 24 which passes through it and is connected to the shaft by a flexible member 90, such as a Siphon, which is attached to a collar 91 secured to the shaft. Thus any vibration or misalignment of the shaft is not transferred to the cup. Within the space formed in the cup 26 and the member 27, there is disposed a sealing liquid 28, which may be carbon tetrachloride or mercury. The top surface of this liquid seal 28 is in contact with well liquid through the clearance aperture 29 in the top 25. A filler pipe 30, as before, may be provided for the seal.

Whatever emulsion or mixing may occur, due to the contacting well liquid and liquid 28, is reduced by centrifugal separation. For this purpose the cup 26 is provided with radial ribs or vanes 31. During rotation of the cup 26, these vanes cause the heavier part of the mixture to be thrown radially outwardly and against the overlapping sealing surfaces between the members 26 and 27. The dotted line 32 indicates the surface of the heavy liquid 28 under the influence of centrifugal force when the shaft 24 and cup 26 are rotated. The centrifugal separator action continues during periods of operation of the motor. It causes the heavier constituents of the mixture to be separated and to be urged by centrifugal action into proper sealing relationship.

In Fig. 3 is shown a further variation of the arrangement in which there is an annular sleeve dividing the surface of the liquid seal into two portions, as well as means for guiding the cup. Thus, the shaft 24 extends through an opening 29 in the rigid top member 25, which carries an annular depending member 92 surrounding the shaft. The lower end of this member is divided to form a skirt 102 and a cylindrical guide 103. The rotating cup 93 includes the upper ring 94, which rotatively engages the cylindrical guide 103, and is supported on the flexible member 95, which in turn is attached to collar 96 secured to the shaft. The cup 93 is sufficiently deep, so that the liquid sealing material which it contains will not reach the top of the cup when the latter

s rotated at its usual speed. The centrifugal separator action is the same as in the form shown in Fig. 2, and in addition, a seal such as disclosed in connection with Fig. 1 is provided. The sealing liquid 28 is urged to better sealing relation with the rotary and non-rotary elements, by the resultant centrifugal force.

In the form of the invention illustrated in Figs. 4, 4a, 5 and 5a, the well liquid 2 is shown as disposed in the well casing 1, as before. In this instance the electric motor is provided with a rotary casing 33, guided for rotation about a central stationary shaft-like member 34.

The rotary casing 33 is shown as provided with a pump operating shaft 35, appropriately fastened to the central boss 36, extending upwardly from the casing 33. This shaft 35 is shown as extending upwardly to the pump 37. The pump, it will be understood, is suspended from above in the usual manner and supports a stationary frame 38, extending downwardly so as to support a stationary spider 39. Upon this spider there is a boss 40 into which the central stationary member 34 is secured.

At the upper end of the stationary member 34 there is supported the stationary stator windings 41. The connections for this winding, as shown, extend downwardly through the bore 42 formed centrally of the stationary member 34, and outwardly through the bottom of the spider 39. These connections may then proceed, as by way of a water-proof cable, to the top of the well for connection to an appropriate source of power, such as the mains 43, a switch 123 being interposed to control the motor.

The rotor windings are provided on the rotor laminations 44 fastened to the inside of the casing 33. This rotor winding may be of the conventional squirrel cage type. For rotatably supporting the casing 33 upon the central non-rotary member 34, use is made of a ball bearing structure 45, the inner race of which is mounted upon the top of the member 34. Another ball bearing structure 46 is supported on a transverse apertured wall 47 formed within the casing 33.

In the present instance the upper portion of the casing 33 is intended to be filled with some neutral fluid lighter than the well liquid. For example, oil or air may be used. Where the casing is filled with air, there is preferably a layer of oil on the water to prevent the air being absorbed in the water. Pressure balance between the inner and outer liquids is secured by leaving the bottom of the casing 33 open, the normal level of the contacting surfaces of the liquids being indicated at the surface 48.

Since casing 33 is rotary, rotation is imparted by its operation to the liquid filling the casing 33. There would normally be a considerable relative motion between the two liquids at the surface 48, enhancing deleterious mixing or emulsification. In order to reduce this effect, means are provided to reduce the relative motion between the liquids at the surface of contact 48. For this purpose fins or vanes 49 are disposed radially within the casing 33 and carried by the wall thereof. These vanes have a considerable depth, intersecting or passing through the plane 48. They have the effect of rotating both bodies of liquids immediately adjacent the surface of contact 48. In this way relative motion is made so insignificant as effectively to prevent material emulsification or mixing.

In this form of the invention it is necessary

to insure that the contact level 48 will be maintained between the upper and lower limits of the vanes 49. For this purpose the liquid filling of oil in the casing 33 should be replenished upon undue rise of the level 48. The manner in which this is accomplished will now be described.

A filler pipe 50 is provided, extending to the top of the well and to a source 51, such as a reservoir, of the neutral liquid, which is maintained under suitable pressure. The lower end of this pipe 50 extends into the hollow member 34, and thence the liquid may enter by way of aperture 52 into the casing 33. This filler pipe 50, however, is controlled by a valve 53, normally closed as by a spring 54, and may also be provided with a check valve 137 to prevent reverse flow of the oil. Valve 53 is adapted to be opened by a solenoid 55 whenever the circuit for this solenoid is energized. This circuit may include a step down transformer 122, having its high tension side connected to two of the power mains 43 so as to not be affected by the switch 123. The low tension side of the transformer is grounded, as by being connected to the pump housing, or a continuation thereof, by lead 124. The remaining terminal of the transformer is connected to solenoid 55 by a conductor 56. The other terminal of solenoid 55 connects to conductor 57. This conductor 57 is connected to one terminal, as 125, of a float operated switch 58, located immediately below the bearing structure 46 within the casing 33. This float operated switch 58 is intended to close only upon an undue rise of the surface level 48. For this purpose any appropriate float mechanism may be provided. For example, the ring float 59 may be disposed around the stationary member 34 and connected through a lost motion connection 60 to operate the switch 58 upon sufficient upward movement of the float 59. The float 59 is made hollow and of such material as to be maintained substantially at the level 48 between the two liquids.

The principle of providing a rotary casing is advantageous when using an upwardly directed shaft 35, since the shaft need not pass through the top of the casing, and thus no sealing means is required to maintain the casing fluidtight at this point.

It may be desirable to provide a gaseous atmosphere for the motor to operate in, thereby reducing friction losses. Thus, air or gas under suitable pressure may be introduced into casing 33 by a pipe 61, leading from a source 126 at the top of the well. This pipe enters bore 42 of stationary shaft 34, and communicates with the interior of the casing through opening 97. In order to prevent rapid absorption of this air or gas by contacting the well fluid, a layer 98 of neutral liquid or oil is provided. This has the surface of contact 48 with the well liquid as before, blades 49 serving to prevent emulsification at this surface. To insure the presence of the proper amount of air in the casing to maintain the upper surface 127 of this oil within the desired limits, a valve 128 is provided to control conduit 61. This valve is normally maintained closed by a spring 129, and is opened by energization of a solenoid 130 in response to the closing of a float operated switch 136. Switch 136 is similar to switch 58 and is actuated through a lost motion connection 135 by a float 131, arranged to float adjacent the surface 127 of the light liquid 98.

One contact of this switch is grounded, the other contact 132 being connected by lead 133 to solenoid 130; lead 134 from the solenoid to transformer 122 completes this circuit.

It will be apparent that a rise in the level of surface 48 will close switch 58, causing valve 53 to open and admit additional oil to casing 33. The pressure of the air or gas above the upper surface 127 of this oil will be effective to maintain this surface substantially against movement, hence the added oil will depress surface 48 until the lowering of float 59 opens the switch, stopping the flow of oil. If the upper surface 127 advances into the casing to a predetermined height within the casing 33 due to an insufficient volume of air, float 131 will close switch 136, causing valve 128 to open, admitting air to the casing. This depresses the liquid surface, permitting the float to fall, open the switch and check the flow of air.

It is not necessary for the purposes of the invention to maintain the liquid surfaces 48 and 127 within close limits, but only that the former be at a point where it will be engaged by paddles 43 and the latter at a reasonable distance below the motor. Furthermore, for additional assurance, the normal depth of the oil, between levels 48 and 132 may be sufficient to ensure that even when all the air is inadvertently permitted to escape, the water level will never reach even as far as switches 58 and 136.

The showing of switches 58 and 136 is merely diagrammatic, as it would be desirable to provide switches capable of making and breaking the circuits abruptly. Such switches are well known and many types are on the market.

It is possible for the pump structure to be located below the rotary casing. In this connection, a slightly different form of seal construction may be advisable. This is illustrated in the form of the invention shown in Fig. 6.

In this form, as before, there is a well casing 1 in which there is the well liquid 2. The pump is shown in more or less diagrammatic form by the bowls 62 and by one of the pump runners 63 fastened to the rotary shaft 64. The stationary parts of the pump are shown as supported at the bottom of a hollow column 65 leading to the relatively smaller pump discharge column 66.

The pump operating shaft 64 is shown in this instance as fastened by the aid of the flange 67 to the bottom of a rotary casing 68 enclosed within the hollow column 65. This rotary casing 68 is shown as supported upon a central stationary member 69. This stationary member is supported by the aid of the flange 70 and the standard 71 to the top flange 72 of the column 65.

The rotary supports for the casing 68 are shown as including the ball thrust bearing structure 73. The inner race of this structure 73 is supported within the central boss 74 formed upon the transverse wall 75. Similarly, at the lower closed end of the casing 68, a ball bearing structure 76 is provided, having its outer race supported upon the upwardly extending central boss 77.

The rotor squirrel cage winding may be accommodated upon the laminations 78 supported in the casing 68. The stator windings 79 are shown as supported upon the stationary member 69. The connections 80 for the stator winding 79 are shown as extending into the recess 81 in the member 69, and thence upwardly through the cable connections 82 to the top of the well.

In the present instance, a filling 83 of relatively heavy neutral liquid is provided for the casing 68. This may be carbon tetrachloride or the like. The top 84 of the casing 68 has an aperture 85 through which the stationary shaft 69 passes. This aperture is a close fit about the shaft, but is not sealed against entry of the well liquid. The wall 75 has a similar opening 99 for the shaft. The heavy filling may be replenished, if desired, through a filler pipe 86 extending to the T fitting 87, which accommodates the cable 82 and which is screwed into the top of the stationary member 69. In this way the heavy liquid filling can pass through the pipe 86 into the recess 81, and thence through the radial aperture 88 into the interior of the casing 68. Since the casing is substantially filled with liquid which is heavier than the well liquid, any of the latter entering the casing through opening 85, or any emulsion formed, will remain in the chamber 100 formed between the top 84 of the casing and wall 75.

This heavy liquid is given a motion of rotation by operation of the casing 68, which tends to throw the heavy liquid outwardly, separating it from any mixture between the heavy liquid and the contacting well liquid 2. The heavy liquid naturally settles toward the bottom of the casing and the separated well liquid rises to the top. This level of contact 101 is intended to be normally considerably above the ball bearing structure 73.

In Fig. 7 is shown another variation of the arrangement in which an annular sleeve divides the surface of the liquid seal into two portions, and in which means are provided for guiding the cup, as well as maintaining it against axial movement. Shaft 24 passes through opening 29 in the rigid top member 25, which carries the annular depending member 92 with skirt 102 and cylindrical guide 103, as before. The rotating cup 105 in this case includes an upper ring 106 engaging the cylindrical surface of guide 103, the ring also having an annular lip 107 engaging the lower edge or shoulder of guide 103. This ring is supported on the flexible member 95 which is attached to a collar 108 secured to the shaft. The flange 109 of collar 108 is approximately the same outside diameter as lip 107, and a compression spring 110, confined between the lip and the collar, maintains the lip in contact with the guide. A sealing liquid 28 is provided as before. The arrangement described effectively prevents vibration of the shaft being imparted to the surface of the sealing liquid adjacent the sealing surfaces, and aids in maintaining the effectiveness of the seal.

The modification shown in Fig. 8 differs from that of Fig. 7 in that the spring is stationary. Thus the collar 112 supporting the spring does not have an extended flange. A ring 113 engages the under side of lip 107. This ring is guided concentrically with guide 103 by a cylindrical surface 114 formed in cage 115 which is supported by top 25. Ring 113 is maintained against rotation by stationary anchor pins 116 secured to the cage, but is free to move axially in response to spring 117, confined between it and an inwardly extending flange 118 on the cage. This spring is effective to urge lip 107 into engagement with the lower edge of the guide 103, the operation and advantages of the seal being the same as in the previously described form.

What is claimed is:

1. In a submersible structure adapted to be

submerged in well liquid, a casing, a body of liquid serving to exclude the well liquid from the casing, and having a surface open to the interior of a part of the casing, and means simultaneously engaging both of said liquids and interposing a resistance to relative rotation between the liquids.

2. In a submersible structure adapted to be submerged in well liquid, a rotary casing, a stationary support for said casing, and a neutral liquid in the casing, and in contact with the well liquid, said casing including means retarding admixture of the liquids.

3. In a submersible structure adapted to be submerged in well liquid, a casing, a neutral liquid in the casing, and in contact with the well liquid, said neutral liquid being in contact with rotating surfaces of the structure, tending to impart rotation thereto, and means simultaneously engaging both of said liquids, whereby relative rotation between the liquids is retarded adjacent the contacting surface.

4. In a submersible structure adapted to be submerged in well liquid, a casing, a neutral liquid in the casing, and in contact with the well liquid, said neutral liquid being in contact with rotating surfaces of the structure, tending to impart rotation thereto, and means whereby relative rotation between the liquids is retarded adjacent the contacting surface, comprising paddle members extending across said surface.

5. In a submersible structure adapted to be submerged in well liquid, a rotary casing, a stationary support for said casing, a neutral liquid in the casing and in contact with the well liquid, and paddles carried by the casing and extending across the surface of contact between the liquids.

6. In a submersible structure adapted to be submerged in well liquid, a rotary casing having an opening at the bottom, a neutral liquid lighter than well liquid in the casing and in contact at its lower surface with the well liquid, and means carried by the casing for retarding relative motion between the two liquids at the surface of contact.

7. In a submersible structure adapted to be submerged in well liquid, a rotary casing having an opening at the bottom, a neutral liquid

lighter than well liquid in the casing and in contact at its lower surface with the well liquid, and paddles carried by the casing and extending across the surface of contact between the liquids.

8. In a submersible structure adapted to be submerged in well liquid, a rotary casing, a neutral liquid in the casing and in contact with the well liquid, the surface of contact being within the casing, and means for replenishing the neutral liquid in the casing, comprising a float switch adapted to be actuated when the surface of contact approaches a definite position, a circuit controlled by the switch, and a source of neutral liquid supply controlled by said circuit.

9. In a submersible structure adapted to be submerged in well liquid, a casing, a neutral fluid in the casing, and a layer of neutral liquid in the casing to separate the fluid from the well liquid, said layer of neutral liquid having a surface of contact with the well liquid as well as a surface of contact with said fluid, means for replenishing the neutral liquid in the casing comprising, a float switch adapted to be actuated when the surface of contact with the well liquid approaches a definite position, a circuit controlled by the switch, and a source of neutral liquid supply controlled by said circuit, and means for maintaining the surface of contact with the fluid below a definite point comprising, a second float switch adapted to be actuated when said surface approaches said point, a circuit controlled by said second switch, and a source of fluid controlled by said last mentioned circuit.

10. In a submersible structure adapted to be submerged in well liquid, a casing, a body of fluid in the casing, and a layer of neutral liquid in the casing to separate said fluid from the well liquid, said layer of neutral liquid having a surface of contact with said well liquid, means for replenishing the neutral liquid in the casing, comprising a float switch adapted to be actuated when said surface of contact approaches a definite position, a circuit controlled by the switch, and a source of neutral liquid supply controlled by said circuit.

THOMAS G. MYERS.