March 3, 1964 G. E. GROSS 3,123,652

SUBMERSIBLE DEVICE

Filed Nov. 15, 1960

Fig. 1.

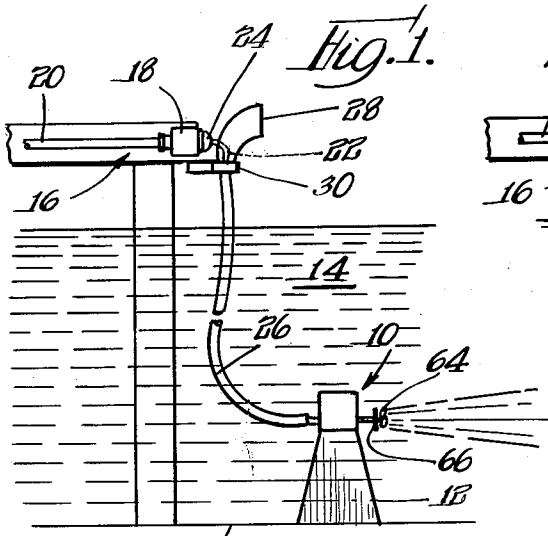


Fig. 2.

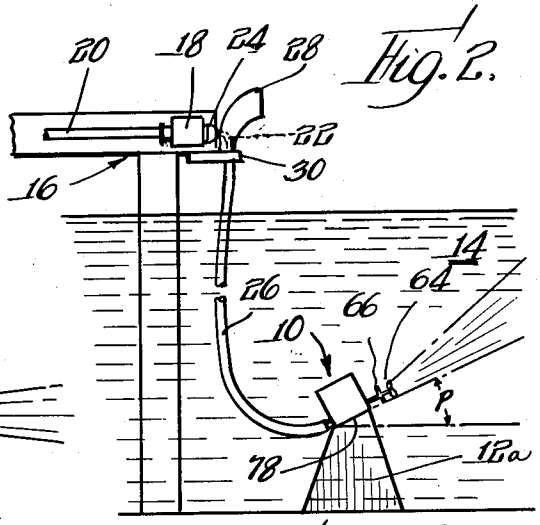


Fig. 3.

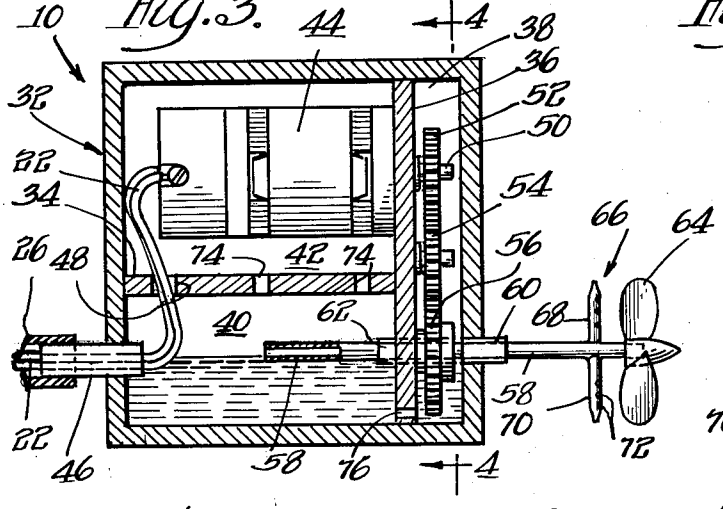


Fig. 4.

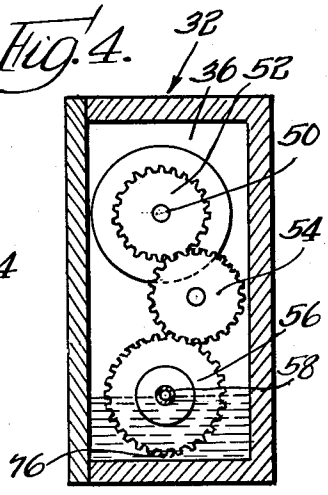
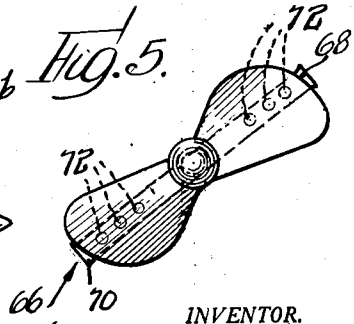


Fig. 5.



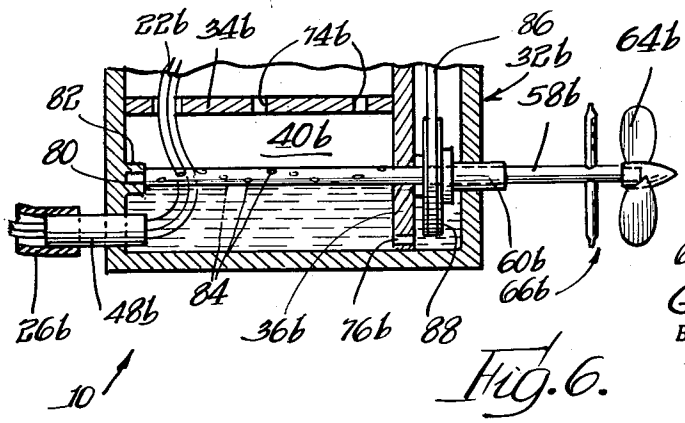


Fig. 6.

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SUBMERSIBLE DEVICE

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4 Claims. (Cl. 261—28)

This invention relates generally to submersible devices and especially to submersible devices incorporating a motor.

Submersible devices incorporating motors have been known and used for many years, a common example being submersible water well pumps. However, the submersible capability of the prior art devices has been generally achieved by sealing the motor in a special housing employing leakproof journals for passing the output shaft and employing leakproof fittings for admitting the energy source. As a result of this construction, prior art submersible devices are notoriously expensive.

Therefore, an important object of the present invention is to provide a highly effective and low cost, submersible device incorporating a motor.

A more general object of the invention is to provide a new and improved submersible device.

Another object of the invention is to provide a submersible device which incorporates a motor and which does not require leakproof shaft seals.

Yet another object of the invention is to provide a submersible device which employs liquid from the surroundings as a lubricant.

A further object of the invention is to provide a submersible device incorporating a motor which is air-cooled in operation.

A still further object of the invention is to provide a submersible device which is useful for mixing a gas in the liquid surroundings.

And a still further object of the invention is to provide a submersible device which is useful for controlling ice formation on bodies of water in the wintertime.

A yet further object of the invention is to provide a submersible device incorporating an electric motor.

Additional objects and features of the invention pertain to the particular structure and arrangements whereby the above objects are attained.

One form of a submersible device constructed in accordance with the invention includes a housing arranged for substantial exclusion of the liquid surroundings in which the device is adapted to be operated, a motor mounted in the housing, a bushing extending through an exterior wall of the housing gravitationally inferior to the motor, a hollow shaft passing rotatably through the bushing and arranged to be driven by the motor, the hollow interior of the shaft being open to the interior of the housing, a propeller screw on the shaft exterior of the housing for incurring a flow of liquid away from the device, radial arm means on the shaft between the housing and the screw including means communicating the hollow interior of the shaft with the surroundings, and a conduit connecting the interior of the housing with a source of gaseous fluid, so constructed and arranged that liquid leaking into the housing is drawn into the shaft with the gaseous fluid to be discharged at the arm means.

The invention, both to its structure and mode of operation, will be better understood by reference to the following disclosure and drawing forming a part thereof, wherein:

FIG. 1 is a schematic, side elevational view of a submersible device constructed in accordance with the invention, shown submersed in a body of water for aerating or controlling ice formation on the same;

FIG. 2 is a view of the submersible device of FIG. 1 disposed for controlling ice formation on the body of water during the wintertime;

FIG. 3 is an enlarged, side elevational view in cross-section of the submersible device of FIG. 1;

FIG. 4 is a view taken through the section 4—4 of FIG. 3;

FIG. 5 is an enlarged, front elevational view of the propeller screw and radial arm means of the device of FIG. 1; and

FIG. 6 is a fragmentary view similar to the showing of FIG. 3 but illustrating a modified embodiment of the invention.

Referring now in detail to the drawing, specifically to FIG. 1, a submersible device indicated generally by the numeral 10 will be seen mounted on a pedestal 12 beneath the surface of a body of water 14. Jutting out from the shore of the body of water 14 is a pier structure 16, and an electric outlet box 18 is secured to the pier structure 16 generally above the water line to be connected to a conventional source of A.C. electric power by means of a conduit 20. Power is supplied to the device 10 from outlet box 18; and as will be recognized, the submersible device of the invention may also be arranged in the form of a completely self-contained unit, as for example by employing a D.C. motor energized from a battery.

As will be described more fully hereinafter, the submersible device 10 incorporates an electric motor; and electric power is conducted to this motor by means of wires 22. The wires 22 are coupled to the outlet box 18 employing a plug 24 and are carried to the submersible device 10 within a hollow, flexible conduit 26. Conduit 26 is advantageously arranged to be of sufficiently greater size than the wires 22 to allow free passage of air from the atmosphere to the submersible device 10. Furthermore, a shielded, air-inlet member 28 is desirably secured to the surface end of conduit 26; and the member 28 can be fastened to the pier structure 16 by means of a clamp 30 or it may be arranged with a buoyant element to be floated on the surface of the body of water 14.

Turning now to FIG. 3, the submersible device 10 will be seen to include a housing indicated generally by the numeral 32. Housing 32 may take a number of suitable constructions. For example, housing 32 may be fabricated from either metal or plastic panels bolted together with gaskets interposed in the joints. The panels may also be cemented together or molded integrally. In any event, the housing 32 is arranged for substantial exclusion of the liquid surroundings in which the device 10 is adapted to be operated.

A pair of partitions, partitions 34 and 36, divide the housing 32 into a transmission chamber 38, an exhaust chamber 40 and a motor chamber 42. In use, motor chamber 42 is disposed gravitationally superior to the exhaust chamber 40. An electric motor 44 is securely mounted in chamber 42, and the electrically conductive lead wires 22 are passed through a fitting 46 secured in an exterior wall of housing 32 and through a hole 48 drilled in partition 34 to make connections with motor 44. As shown, fitting 46 comprises a tubular member opening into the exhaust chamber 40. The motor 44 is advantageously selected to be of a type suitable for service in highly humid atmospheres. Moreover, the electric motor 44 can be replaced by other types of motors, such as air motors, gasoline motors, spring motors, etc., if desired.

The output shaft 50 of motor 44 extends rotatably through partition 36 into the transmission chamber 38, and a gear 52 is affixed to shaft 50 within the confines of chamber 38. Gear 52 meshes with an idler gear 54 which, in turn, meshes with another gear 56, idler 54 being laterally offset in order to minimize radial thrust on the shaft bearing of gear 56. This arrangement is well illustrated in FIG. 4.

A hollow shaft 58 is secured to gear 56 and extends from exhaust chamber 40 to a point exterior of the housing 32, shaft 58 being journalled in aligned sleeves or bushings 60 and 62 mounted respectively in an exterior wall of housing 32 and in partition 36. A propeller screw 64 is fastened to shaft 58 exterior of the housing 32 in order to incur a flow of the liquid surroundings away from the device 10 when the shaft 58 is rotated by motor 44.

A radial arm device, indicated generally by the numeral 66, is specifically shown to include two hollow, diametrically arranged arms 68 and 70. However, other numbers of arms may be employed. The hollow portions of arms 68 and 70 are arranged to open into the hollow interior of shaft 58; and the arms 68 and 70 are provided with a plurality of apertures 72 opening in a generally downstream direction relative to the flow of water incurred by propeller screw 64. The apertures 72 communicate chamber 40 with the liquid surroundings of the device 10, the flowpath being from the chamber 40, through the open, cantilevered end of shaft 58, through the hollow interior of the shaft 58, into the hollow portion of arms 68 and 70 and through the apertures 72. The radial arm device 66 is advantageously disposed in approximate arcuate registry relative to the propeller screw 66 as is well shown in FIG. 5.

It will be recognized that, when the device 10 is immersed in a body of liquid such as the body of water 14, the liquid can find entrance to the housing 32 through the bushing 60 around shaft 58. Furthermore, liquid can enter through the holes 72 and pass into the exhaust chamber 40. Since the device 10 is arranged to prevent any substantial accumulation of this liquid within the housing 32, means are provided for interconnecting the several chambers. These means advantageously include apertures 74 in partition 34 and aperture 76 in partition 36.

Having thus described one embodiment of the invention, it is important now to state how the illustrated embodiment operates. When the device 10 is submersed in the body of water 14 and before motor 44 is energized, water from the body 14 will tend to seep into the housing 32 as has been hereinabove described. However, when motor 44 is energized as by connecting the lead wires 22 to a source of electrical current by means of plug 24, motor 44 will drive the shaft 58 through the gear train comprising gears 52, 54 and 56. The rotation of shaft 58 thus incurred will, of course, rotate the propeller screw 64 and the radial arm device 66.

As the individual arms 68 and 70 of device 66 pass through the water, a region of reduced pressure will be developed in the vicinity of the holes 72 due to an aspirator effect. The region of reduced pressure thus created will tend to draw fluid through the hollow interior of shaft 58; and when sufficient liquid has leaked into the housing 32 to reach or perhaps cover the open, cantilevered end of shaft 58, the fluid thus drawn through the shaft 58 will comprise appreciable quantities of this liquid. Accordingly, the liquid leaking into housing 32 will be pumped therefrom; and the apertures 74 in partition 34 will allow those small quantities of liquid accumulating in the chamber 42, from leakage or from condensation, to pass readily into chamber 40 from whence they will be exhausted.

The liquid from within the housing 32 will continue to be exhausted in this manner until an equilibrium state is achieved and the liquid level in chambers 38 and 40 rests at approximately the level of the hollow interior of shaft 58, as is well shown in FIG. 3. The aperture 76 in partition 36 permits approximate equalization of the level in chambers 38 and 40; and it is to be noted that the liquid thus standing in chamber 38 will afford lubrication for the gears and shaft bearings.

Moreover, the region of reduced pressure which is associated with the arm device 66 and which incurs the flow of fluid through the shaft 58 tends to draw air into the

housing 32 from the earth's atmosphere through the conduit 26. This flow of air tends to cool motor 44 and is, in addition, discharged through the holes 72 as minute bubbles. The propeller screw 64 urges fluid in a direction generally away from the arm device 66; and when the fluid discharged through the holes 72 comprises appreciable quantities of air in the form of minute bubbles, the propeller screw 64 distributes these bubbles of air in the body of water 14. If particularly efficient aeration is required, ozone may be introduced into the inlet member 28 to be distributed by the propeller screw in a manner similar to that which has been described for air. Likewise, other gases may be introduced into the body of water 14 if desired.

It is to be further pointed out that rotation of the arms 68 and 70 incurs a centrifuge effect on the fluid, either gaseous or liquid, contained within the arms, this centrifuge effect assisting the exit of the fluid from the arms.

In addition, when the device 10 is arranged as a self-contained unit, i.e. with no connections to the surface, it is advantageous to include within housing 32 a container of compressed gas operated as by a float valve. Such an arrangement of the invention is not specifically claimed herein, the same being reserved for a copending application subsequently to be filed.

The device of the invention has been found to possess utility in the field of aquariums, particularly with respect to maintaining an aquarium properly aerated. As will be recognized, the present invention requires only the exit of a tube or conduit from the aquarium tank, it being manifestly easier to provide an effective seal for such a tube than for a rotary member.

While the embodiment of FIGS. 1 and 3–5 has been described as being employed for aeration, the device has other utility. For example and referring to FIG. 2, the device 10 can be angulated in an upward direction at an angle P; and the angle P has been found to be permissive of various values, for example 30°. The angulation of device 10 is advantageously achieved by providing a modified form of the pedestal, indicated as pedestal 12*a* in FIG. 2. The pedestal 12*a* is provided with an appropriately angulated surface 78 to which the device 10 is mounted. Otherwise than has been noted, the submersible device illustrated in FIG. 2 is similar to the submersible device of FIGS. 1 and 3–5. Accordingly, like numerals have been used to designate like elements in the several figures.

It is to be pointed out that the angulation of device 10 described with respect to FIG. 2 is particularly useful when it is desired to direct the warmer, lower strata of water in the body 14 to the surface for purposes of ice control in the wintertime. When so arranged, ice control effects can be achieved in conjunction with aeration, the aeration of the warmer water reducing its density and tending to buoy it up to the surface.

The invention, of course, is not limited to the embodiments thus far shown and described. For example, a modified embodiment of the invention is illustrated in FIG. 6. There, a submersible device is indicated generally by the numeral 10*b*; and other parts similar to the parts illustrated with respect to the embodiment of FIGS. 1 and 3–5 are indicated by like numerals in FIG. 6, the suffix letter "*b*" being applied to distinguish those parts associated with the latter embodiment.

The submersible device 10*b* is arranged to eliminate the sleeve 62 from the arrangement of FIGS. 1 and 3–5. In its stead, a shaft 58*b* terminates within chamber 40*b* in a solid stub shaft 80. A tubular boss 82 extends from an exterior wall of housing 32*b* in alignment with shaft 58*b* to provide a journal for the stub shaft 80.

Since the otherwise free end of shaft 58*b* is closed by the stub shaft 80 in the embodiment of FIG. 6, it has proved advantageous to fashion shaft 58*b* with a number of radial ports 84 communicating with the hollow interior of the shaft.

Furthermore, the means for transmitting power from the motor to the shaft **58***b* are shown in FIG. 6 to comprise a flexible drive belt **86** and a system of pulleys including the pulley **88** which is securely fastened to the shaft **58***b*.

In other respects, the embodiment of FIG. 6 is constructed similarly to and operates in an analogous manner to the embodiment of FIGS. 1 and 3–5.

The specific examples herein shown and described should be considered as illustrative only. Various changes in structure, other than those set forth, will, no doubt, occur to those skilled in the art; and such changes are to be understood as forming a part of this invention insofar as they fall within the spirit and scope of the appended claims.

The invention is claimed as follows:

1. In combination with a body of liquid, a submersible device for introducing gas into said liquid comprising a closed housing, means for supporting said housing completely submerged in said liquid, said housing including an upper portion and a lower portion, said upper portion having a top and wall means depending therefrom providing an air bell in said upper portion, said lower portion having opening means therein below said air bell, an electric motor mounted in the upper portion of said housing entirely within said air bell, a hollow shaft extending through said opening means and having one end inside the lower portion of said housing below said air bell and the other end outside of said housing, the inner end of said hollow shaft opening into the interior of the lower portion of said housing, said shaft being spaced below said motor, drive means within said housing drivingly interconnecting said electric motor and said hollow shaft for rotationally driving said shaft from said motor, means imperfectly sealing said shaft to said housing at said opening means whereby liquid can leak into said housing through said opening means, hollow radially extending means on said shaft outside said housing opening into the hollow shaft and having small apertures therein for aspirating fluid from inside said housing through said hollow shaft upon rotation of said shaft and said radially extending means in said liquid, and conduit means extending through said opening means and communicating with a source of gaseous fluid for supplying such gaseous fluid to the interior of said housing for aspiration through said shaft and said radially extending means along with liquid leaking into said housing.

2. A device as set forth in claim 1, and further including a substantially horizontal partition in said housing substantially between said upper and lower housing portions and defining a motor chamber in which said motor is mounted and an exhaust chamber below said motor chamber into which said conduit and said hollow shaft open, said partition having opening means therein providing communication between said motor chamber and said exhaust chamber.

3. A device as set forth in claim 1, and further including a substantially vertical partition in said housing defining a transmission chamber and further chamber means in which said motor is mounted and into which said conduit means and said hollow shaft open, said transmission chamber extending vertically from adjacent said motor to adjacent said hollow shaft, said drive means being mounted within said transmission chamber, said hollow shaft extending through said partition, and said partition having opening means therein near the bottom thereof providing communication between said chamber means and said transmission chamber.

4. A device as set forth in claim 3, and further including a substantially horizontal partition in said housing substantially between the upper portion and the lower portion of said housing and abutting said substantially vertical partition, said substantially horizontal partition dividing said chamber means into a motor chamber in which said electric motor is mounted and an underlying exhaust chamber into which said hollow shaft and said conduit means open, said horizontal partition having openings therein providing communication between said motor chamber and said exhaust chamber.

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