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3,155,308

FLUID PUMP

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FIG. 1.

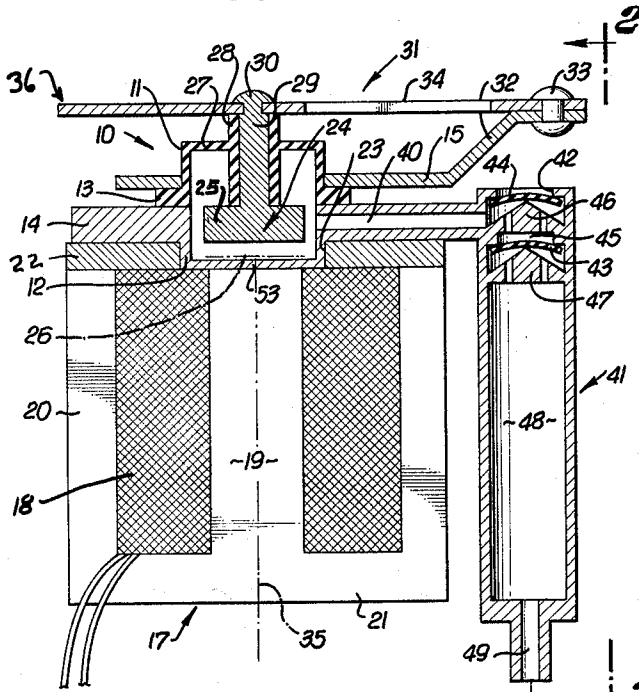


FIG. 2.

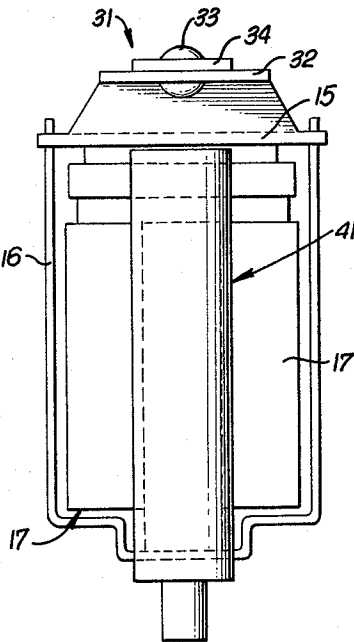


FIG. 4.

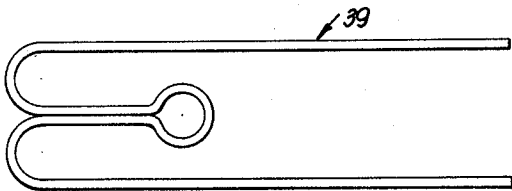
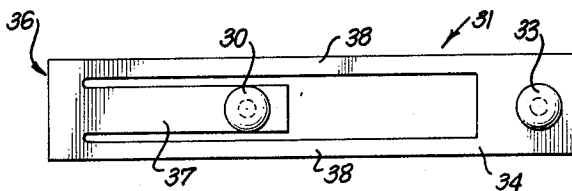


FIG. 3.



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FLUID PUMP

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This invention relates generally to pumping devices, particularly of the type that includes a power unit and armature operable to effect creation of fluid pressure pulsations. The invention is principally concerned with pumping devices for supplying air to aquariums, it being understood however that it has application to various other purposes requiring pumping displacement of fluids, particularly air or other gases.

The invention concerns itself with solution to problems arising by virtue of the construction of prior pumping devices wherein they tend to chatter and wear out too rapidly, and also require too many parts. Chattering is typically the result of overloading of the pump causing the armature to strike against the electromagnet, such overloading often being inadvertently caused by restrictions in the discharge line leading to the aquarium tank. In addition, the diaphragms of prior pumps tend to fail when the armatures attached thereto do not travel or reciprocate linearly, a result which is caused by difficulties encountered in yieldably supporting the armature for reciprocation. Also, loss of power occurs when the connecting link attaching the diaphragm to the armature describes an arc distorting the diaphragm by moving it to one side of center.

The present invention has for its major object to overcome these and other problems associated with prior pumping devices, through the simplification and novel combination and construction of pump unit elements. As broadly considered, the invention incorporates means for creating pressure pulsations including a pump chamber in which the pulsations are created, a power unit, as for example an electromagnet, for creating a magnetic field which moves in the pump chamber, and an armature movable in the chamber in response to field movement therein for effecting pulsation creation. Typically, the pressure pulsations are created in the chamber in response to mechanical pulsing thereof, the armature being reciprocable in the chamber and coupled thereto to create the mechanical pulsing of the chamber. Desired simplification is thus achieved in an unusual manner since direct coupling of the armature to the pump chamber eliminates the usual connection or connections required between the armature and a flexible pumping diaphragm. Also, the arrangement is such as to cause the armature to be carried away from the electromagnet in response to back-pressure build-up in the pump chamber, thereby solving the problem of unwanted chatter.

As mentioned, another significant advantage achieved by the invention concerns the provision for essentially linear armature reciprocation. To this end a novel arrangement of cantilever springs is provided to support the armature, one spring supporting another so that the free ends thereof describe arcs which cancel one another so that the armature reciprocates essentially linearly and the pump chamber flexible wall is not subjected to wear rate increasing transverse motion in addition to axial flexing.

These and other objects and advantages of the invention, as well as the details of an illustrative embodiment will be more fully understood from the following detailed description of the drawings, in which:

FIG. 1 is an elevation taken in section through the typical embodiment of the pumping device;

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FIG. 2 is an end elevation taken on lines 2-2 of FIG. 1;

FIG. 3 is a plan view showing the spring support for the armature; and

FIG. 4 is a plan view of a modified armature spring support.

In FIGS. 1 and 2 the means for creating pressure pulsations includes a pump chamber generally designated at 10 in which the pulsations are created. Typically, the pump chamber includes first and second coaxial cup-shaped bodies 11 and 12, the former being formed of yieldable material such as rubber or other type elastomer. It has a thickened flange 13 which is held clamped against the flange 14 of the second body 12, the latter typically being formed of a suitable plastic material. Such clamping action may be secured in the manner illustrated, as by a cap 15 fitting downwardly over the body 11 and against the flange 13, and a bracket or bail 16 attached to the cap and extending downwardly along the sides of a power unit at 17, the bail extending therebeneath to clamp the underside thereof as better shown in FIG. 2.

The power unit 17 typically comprises an electromagnet for creating a magnetic field moving generally axially within the chamber 10, and also with respect to the electromagnet coil 18. The coil 18 is ring-shaped, and extends about an inner pole 19 and within an outer E-shaped pole 20, it being understood that the poles 19 and 20 comprise portions of the electromagnet ferrous core which also has a base 21. The core may also be understood as including the ferrous plate 22 or washer which is located at the end face of the outer pole 20 and extends radially inwardly in overlapping relation to the end of the coil 18, this plate element functioning to extend the flux path passing through the poles 19 and 20. The use of this plate thereby strengthens the field produced in the chamber 10 and permits use of heavier wire in the coil 18, the latter permitting manufacture of the coil for less cost than would otherwise be required in the absence of the plate. As is seen in FIG. 1, the plate 22 has an opening 23 receiving the cup-shaped body 12 to extend proximate the end face of the inner pole 19. This feature is important in view of the requirement that the armature actuated by the electromagnet be located proximate the end face thereof.

Such an armature is generally indicated at 24 in FIG. 1 and is supported for reciprocation within the chamber 10 in response to movement therein of the electromagnet field produced by the power unit. The armature illustrated has an enlarged head 25 which travels as close to the inner wall of the body 12 as indicated by the broken lines 26, contact with such inner wall being undesirable from the standpoint of unwanted chatter. In accordance with the invention, armature movement within the chamber effects the desired pulsation creation therein, and typically the armature is coupled to the chamber to create mechanical pulsing thereof which in turn creates fluid pressure pulsation creation within the chamber interior. One advantageous and unusual way to couple the armature to the chamber 10 for purposes of creating the desired mechanical pulsations thereof is to couple to the flexible wall 27 of the cup-shaped body 11 to cause the latter to reciprocate with the armature toward and away from the cup-shaped body 12. Such coupling may be brought about in the manner illustrated, wherein the body 11 is provided with a tubular portion 28 through which the armature elongated section 29 extends from within the chamber to the exterior thereof and away from the body 12.

The projecting extent of the armature section 29 is suitably fastened as for example by means of the rivet 30 to cantilever spring means generally indicated at 31 in FIGS. 1 and 3 which supports the armature for

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reciprocation. Such spring means is shown as carried by the cap 15, the latter having an extension 32 which is fastened as by rivet 33 to a first cantilever flat spring 34 extending generally transversely of the axis 35 of the armature, and at the opposite side of the chamber 11 from the power unit 17. The first cantilever spring 34 extends leftward beyond the axis 35 to a location generally indicated at 36 at which the first spring is joined with and carries a second cantilever spring 37. The latter extends back toward the axis 35 and between the bifurcations 38 of the first spring, in order to support the armature as by means of the rivet 30, the head of which is turned over the second flat spring terminal extent. One advantage of so supporting the armature is to derive a generally linear armature movement in spite of the fact that the cantilever springs, considered individually, describe arcs during such reciprocation of the armature. Thus in FIG. 1 the terminal 36 of the spring 34 will describe an arc which is convex to the left, whereas the rivet head terminal of the spring 37 will describe an arc which is convex to the right. The springs as combined, however, will cause the armature to reciprocate linearly. Another form of spring is shown in FIG. 4 as comprising a one-piece length of wire 39 which has the general shape of the spring combination 31, and functions in a manner similar thereto.

Referring back to FIG. 1, the pump chamber 10 is ported to pass fluid pressure pulsations created in the chamber, one form of such porting being shown at 40. Typically, a valve unit 41 which is shown as outside the chamber 10, is in pressure pulsation communication with the chamber through the porting 40. The valve unit illustrated has air inlet and outlet openings 42 and 45 and flexible covers 44 and 43 cooperating with such openings to control in-flow and out-flow of air to and from the valve unit in response to pressure pulsations transmitted to the covers or gates. Thus, upon a pressure reduction transmitted through the porting 40, the cover 44 flexes downwardly as aided and defined by the cover support 46 to admit air into the valve unit 41, and upon transmission of an increased pressure pulse through porting 40, the cover 44 closes the opening 42 and the air drawn into the valve unit is discharged through the opening 45 below the support 46. In this regard the cover 43 during such discharge flexes downwardly to a configuration as determined by the top surface of the support 47 therefor. The supports 46 and 47 are apertured to pass air therethrough. A plenum chamber is shown at 48 within the valve unit 41 to accumulate and dampen pressure pulsations, thereby to provide a steady stream of air discharging at the outlet 49. The latter is shown in communication with a fish tank 50 through a line 51 and a suitable valve 52 therein.

Should the line 51 or valve 52 at any time undesirably restrict the flow of air to the tank, a back-pressure build-up may develop within the valve unit and be communicated to the chamber 10. In this event the stroke of the armature toward the power unit will be shortened, so that when the armature next moves away from the electromagnet the flexible wall 27 of the body 11 will deflect upwardly to greater extent thereby to insure against chattering of the armature head 25 against the cup-shaped body 12, and in particular the wall 53 thereof.

I claim:

1. In a pumping device, means for creating fluid pressure pulsations including a pump chamber in which said pulsations are created, a power unit for creating a magnetic field moving in the chamber, and an armature movable in said chamber in response to field movement therein for effecting said pulsation creation, the armature being carried to move away from the power unit as fluid enters the pump chamber, the pump chamber having a wall member characterized as flexible in reciprocation in response to said armature movement during which the

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armature at all times remains essentially rigid in said chamber.

2. In a pumping device, means for creating fluid pressure pulsations including a pump chamber having porting to pass fluid pressure pulsations created in the chamber, an electro-magnetic power unit for creating a magnetic field moving in the chamber, and an armature movable in said chamber in response to said field movement therein for effecting said pulsation creation, the armature being carried to move away from the power unit as fluid enters the pump chamber, the pump chamber having a wall member characterized as flexible in reciprocation in response to said armature movement during which the armature at all times remains essentially rigid in said chamber.

3. In a pumping device, means for creating fluid pressure pulsations including a pump chamber having porting to pass fluid pressure pulsations created in the chamber, an electromagnetic power unit for creating a magnetic field moving in the chamber, and an armature movable in said chamber in response to said field movement therein for effecting said pulsation creation, the armature being carried to move away from the power unit as fluid enters the pump chamber, the pump chamber having a wall member characterized as flexible in reciprocation in response to said armature movement during which the armature at all times remains essentially rigid in said chamber, and a valve unit outside said chamber and in pressure pulsation communication therewith through said porting.

4. In a pumping device, means for creating fluid pressure pulsations including a pump chamber ported to pass fluid pressure pulsations created in the chamber, a power unit for creating a magnetic field moving in the chamber, and an armature movable in said chamber in response to said field movement therein for effecting said pulsation creation, the armature being carried to move away from the power unit as fluid enters the pump chamber, the pump chamber having a wall member characterized as flexible in reciprocation in response to said armature movement during which the armature at all times remains essentially rigid in said chamber, the chamber being subject to back pressure build-up and the armature being carried to move away from the power unit in response to said build-up.

5. In a pumping device, means for creating fluid pressure pulsations including a pump chamber in which said pulsations are created, a power unit for creating a magnetic field moving in the chamber, and an armature movable in said chamber in response to said field movement for effecting said pulsation creation, the armature being carried to move away from the power unit as fluid enters the pump chamber, the pump chamber having a wall member characterized as flexible in reciprocation in response to said armature movement during which the armature at all times remains essentially rigid in said chamber, and multiple cantilever springs supporting the armature to reciprocate essentially linearly.

6. In a pumping device, means for creating fluid pressure pulsations, including a pump chamber in which fluid pressure pulsations are created in response to mechanical pulsing of the chamber, the chamber being ported to transmit said fluid pulsations, an electromagnetic power unit for creating a magnetic field which moves in the chamber, and an armature reciprocable in the chamber in response to said field movement therein and coupled to the chamber to create said mechanical pulsing thereof, the armature being carried to move away from the power unit as fluid enters the pump chamber, the pump chamber having a wall member characterized as flexible in reciprocation in response to said armature movement during which the armature at all times remains essentially rigid in said chamber.

7. The invention as defined in claim 6 in which said power unit is at one side of the chamber, and including yieldable means supporting the armature to reciprocate

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along an axis extending toward and away from said power unit.

8. The invention as defined in claim 7 in which said yieldable means includes first and second cantilever springs extending generally transversely of said axis and at the opposite side of said chamber, the first spring carrying the second spring and the second spring supporting said armature.

9. The invention as defined in claim 6 including a valve unit outside said chamber and in pressure pulsation communication therewith through said porting, the valve unit having air inlet and outlet openings and flexible covers co-operating therewith to control in-flow and out-flow of air in response to pressure pulsations transmitted to said covers.

10. The invention as defined in claim 7 in which said chamber includes first and second coaxial cup-shaped bodies and including structure holding said bodies and power unit in stacked relation and supporting said yieldable means at the opposite side of the chamber.

11. The invention as defined in claim 7 including a valve unit in such pressure pulsation communication with

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the chamber as to regulate in-flow and out-flow of air to and from the valve unit so that back pressure build-up in the valve unit and communicated to said chamber will deflect said flexible wall to carry the armature relatively away from said power unit.

12. The invention as defined in claim 10 in which said power unit has a core that includes outer and inner poles and an annular coil between said poles and including a flux path extending ferrous plate at the end face of said outer pole and extending inwardly in overlapping relation to said coil, the plate having an opening receiving one of said cup-shaped bodies to extend proximate the end face of said inner pole.

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