

Nov. 10, 1970

MOTOAKI MATSUURA

3,539,276

AIR SUPPLY DEVICE

Filed Feb. 28, 1969

3 Sheets-Sheet 1

FIG. 1

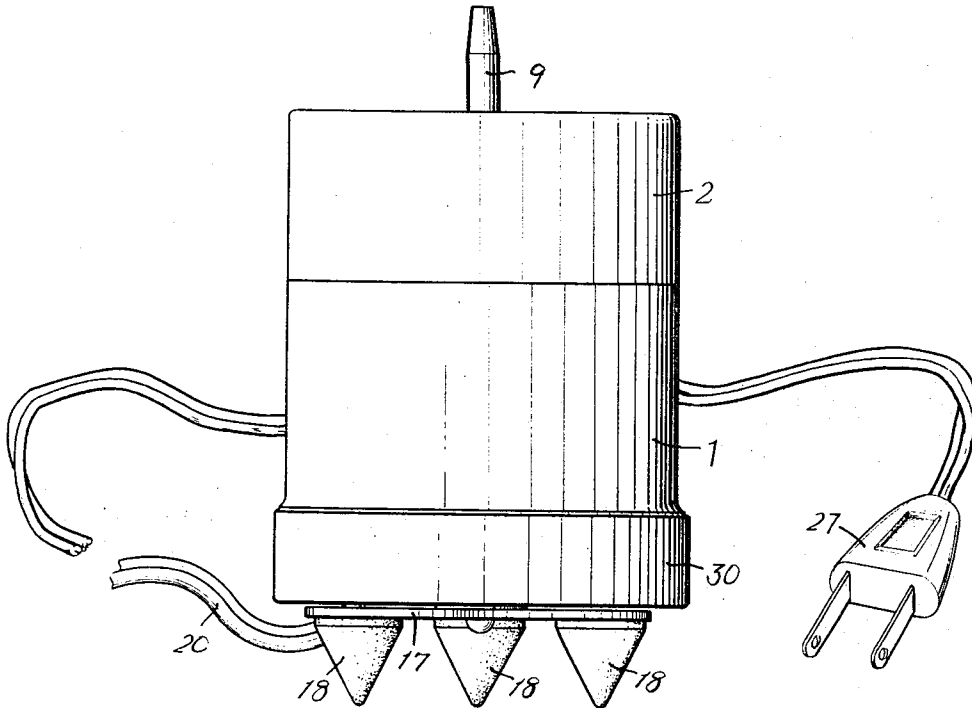


FIG. 4

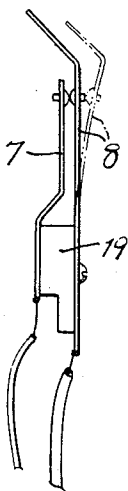
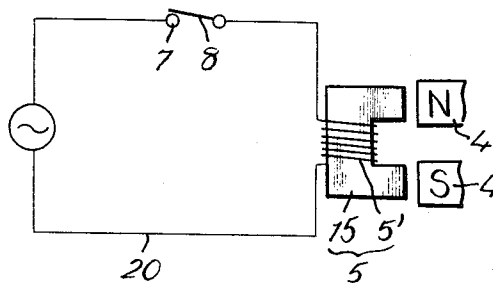


FIG. 5



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FIG. 2

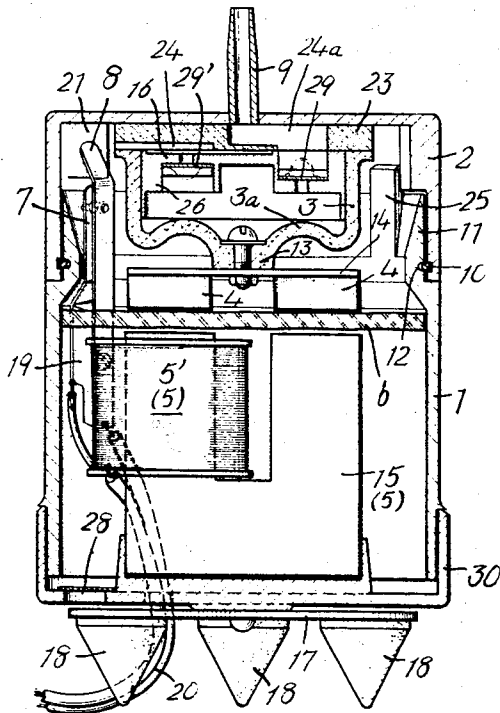


FIG. 6

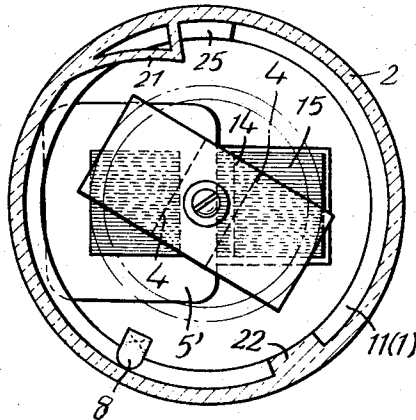


FIG. 7

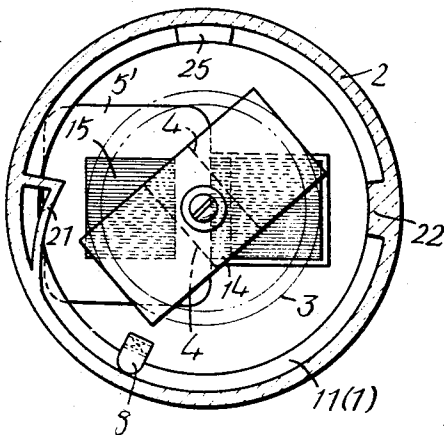
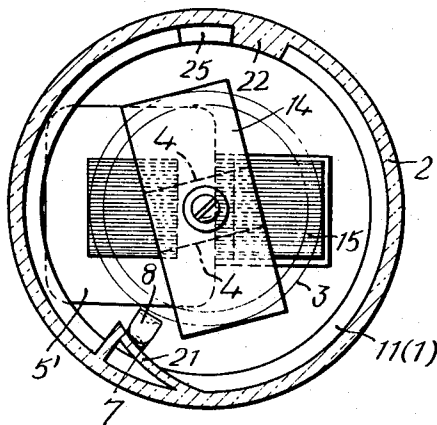


FIG. 8



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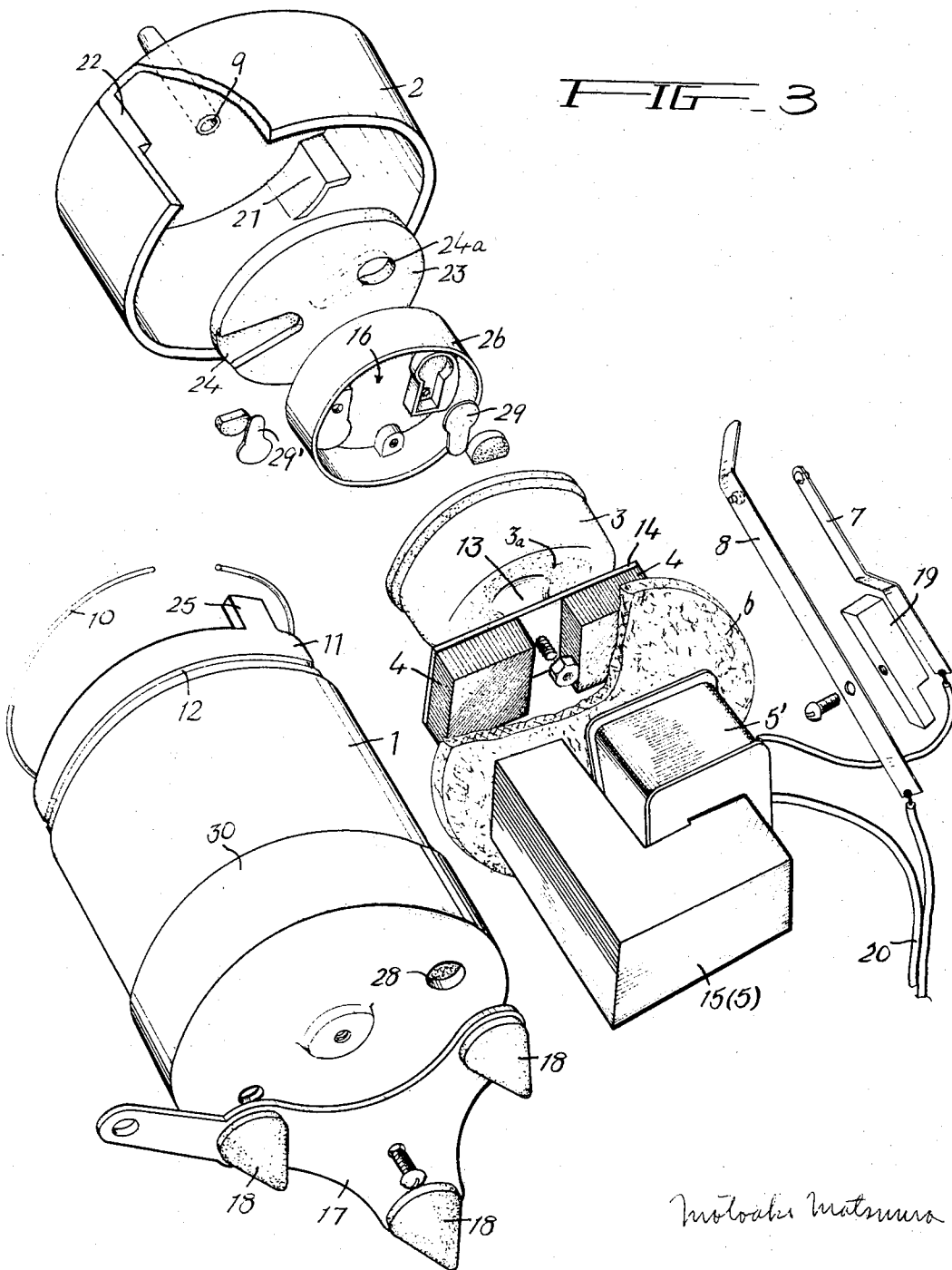
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3 Sheets-Sheet 3



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3,539,276

AIR SUPPLY DEVICE

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Int. Cl. F04b 35/04

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3 Claims

ABSTRACT OF THE DISCLOSURE

An air supply device for supplying air bubbles to an aquarium, comprising an electro-magnet disposed in a cylinder bottom portion with poles facing towards the cylinder top portion; a filter disk disposed over said electro-magnet poles; a diaphragm assembly disposed over said filter disk including a bowl shaped diaphragm, a magnet assembly mounted on the underside of said diaphragm facing said electro-magnet poles, a diaphragm support plate with a ring-shaped wall, said support plate being affixed to the cylinder cover; inlet and outlet one-way valves in the diaphragm assembly to permit air from said air inlet to pass to said air outlet tube; and, a cam piece within the cover and extending switch contact arms, extending from the electro-magnet to the cover, whereby, the turning of the cover on the cylinder variously positions the permanent magnet with respect to the electro-magnet varying the magnetic coupling and oscillation intensity therebetween, the cam piece and switch contact arms defining a circuit make and break area for the electro-magnet circuit.

BACKGROUND OF THE INVENTION

The present invention relates to an air supply device for blowing in air bubbles to an aquarium, and more particularly to a device which supplies air to an aquarium fish tank or tub so as to produce air bubbles for the fish oxygen supply.

It is indispensable to send air into an aquarium to produce bubbles for the oxygen supply of the fish. For this purpose, many devices of this kind have heretofore been proposed. The most typical device is provided with an electro-magnet located opposite to a permanent magnet mounted onto an elastic plate. The center part of the elastic plate is connected to a diaphragm of the air supply device. Using the repeated oscillation produced between the electro-magnet and the permanent magnet by alternating current, this oscillation is transmitted to the diaphragm through the elastic plate, and at this time the oscillation exhausts air inside the diaphragm to the fish tank. However, this conventional device is not always satisfactory in supplying air efficiently. Indeed, the elastic steel plate on which a permanent magnet is mounted has elastic property, but it is self-evident that it also has certain roughness. The oscillation of the permanent magnet transmitted to this elastic plate effects the diaphragm in the center part thereof, so as to carry out the air exhausting action. It is well known that this action also gives oscillation to the case through the mounted base parts of the elastic steel plate case. This produces considerable noise even though buffered. Also in the conventional device, the oscillation which is transmitted to diaphragm through the elastic steel plate is greatly reduced, resulting therefore in reducing the air supply efficiency. Further, the conventional device has a hole in the air pipe connected to the diaphragm in order to control the air rate, and this control exhausts part of air and allows it to leak outside. Some conventional devices change the mounting position of the electro-mag-

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net and the permanent magnet by means of screw bar controller. This changes the magnet power of the electro-magnet to that of the permanent magnet so as to control oscillation of the permanent magnet. All these air supply controls are difficult to operate. That is, in the first mentioned one it is difficult to control air rate with a plug-like control valve to a little air pipe, while in the second mentioned device, it is not always easy to set a desirable clearance between the electro-magnet and permanent magnet in a container or case which precludes observance from the outside. It therefore happens sometimes, that owing to erroneous operations, the electro-magnet comes in touch with the permanent magnet, producing abnormal noise, which is one of the disadvantages of the conventional device. Moreover, when used for a long time, the screwed steel control bar is heated to too high a degree to be accurately controlled by hand. Moreover the conventional device takes air through a small hole formed on a part of the case and sends this air into the diaphragm, and uses a filter in this hole for taking in the air. Since air flows concentratively through the small hole, the flow speed of the air increases and dust contained in the air penetrates deeply and is caught within the filter layer. It is inevitable then that this dust eventually fills up the interspaces of the filter. An electric source switch is specifically provided on the electric source cord, and this means that the conventional air supply device requires a special switch and it is necessary to operate each separate unit of the power source and air rate control.

The present invention overcomes the defects of the aforementioned conventional devices, i.e., the fundamental object of this invention is to provide an air bubble supply device of high air supply efficiency. For this purpose, in the present invention, the oscillation obtained from a permanent magnet is transmitted directly to the diaphragm without transmission through an elastic steel plate, as conventionally, so as to greatly decrease noise which is produced at the time of use, and at the same time the oscillation energy obtained in the permanent magnet immediately provides air supplying action to the diaphragm, thereby improving the air supply efficiency.

Another object of the present invention is to control air rate by utilizing a cover as one of the constituting member of the air supply device, hence there is no necessity to adopt a special control member, thereby eliminating difficulties in the operation of fine control members as is found in conventional devices, and, a large cover can serve as a control operation member to achieve accurate fine volume control.

Another feature of this invention is to avoid the adherence and accumulation of dust in the filter so as to feed accurately pure air for a long time. As hereinbefore mentioned, the conventional device has a filter using a small air inlet, causing filling up of the interspaces. In the present invention, in order to avoid this deficiency, the filter is in the interior part of the case, especially in between the electro-magnet and permanent magnet so that filtering action takes place and slows air flowing within a wide case. Accordingly dust is collected in the side of the filter, and at the same time dust thus collected receives continuous shocks caused by the oscillation of the permanent magnet and is exhausted automatically so as to always have a good cleansing action, and to insure exact purification for a long time.

Still another feature of this invention is that since the air rate control and the make and break of power source are performed by the same member, there is no necessity of installing a special switch member. For this purpose, the present invention contemplates having a switch operation member on the cover, and there is a movable contact

piece of a power source switch provided on the case. The cover can be utilized not only for air rate control but also as the switch operation member, thus it is possible to obtain the make and break switching of the power source as well as air rate control by means of the same member.

The invention as well as other objects and advantages thereof will become more apparent from the following detailed description when taken together with the accompanying drawing, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows an outside perspective view of an air supply device for bubble formation;

FIG. 2 shows a longitudinal cross section of the device of FIG. 1;

FIG. 3 presents a perspective exploded view of disassembled parts of the interior structure;

FIG. 4 illustrates in a perspective view the contact piece part of the device;

FIG. 5 is an electric circuit diaphragm of the device;

FIG. 6 presents a cross-sectional plan view showing the electro-magnet opposite the permanent magnet;

FIG. 7 shows the same cross-sectional plan view as in FIG. 6 illustrating the controlled state; and,

FIG. 8 is a view of the make and break operation of the power source switch, in the same cross-sectional plan view as in FIG. 6.

DETAILED DESCRIPTION

A detailed explanation will be given with reference to the drawing. The device of this invention uses a container which is composed of a case 1, the top part of which opens and which protrudes. There is engaging extension 11 to this top part, and a cover 2 having a pipe line 9 which is mounted onto said engaging extension 11. The engaging extension 11 in the case 1 forms an engaging groove 12 and an engaging-ring 10 fitted in this engaging groove 12 so that the cover does not slide on the case in the axial direction. Also, it is inserted rotatably to the circumferential direction. On the bottom of the cover 2 there is provided a bowl shaped diaphragm assembly 3, made of such material as rubber and having an appropriate flexibility and stability through a bed plate 23 arranged with a check valve 29 which communicates to an inlet 24. The diaphragm assembly 3 has permanent magnets 4 through a mounting plate 14 on the lower surface of a boss 13 in the center of the diaphragm. The bed plate 23 is a protruding disk with a reinforcing ring wall 26, and it has a polymerized valve seat 16 which defines the locations of check valves 29, 29' to an inlet 24 of the bed plate 23 and an outlet 24a communicating to an air pipe 9. The above mentioned reinforcing ring wall 26 is inserted into the base part of the diaphragm 3 to reinforce the diaphragm assembly 3 and consequently it stably attaches the diaphragm assembly 3 onto the cover 2, in spite of being made of a flexible material, and owing to the flexibility of the diaphragm assembly 3 it can absorb oscillations transmitted from the permanent magnet 4 to the cover 2 or the case 1 and the diaphragm provides a suitable means of air exhaustion. On the other hand, the case 1 has an electro-magnet 5 with core 15 and wound with coil 5' and is appropriately spaced from the permanent magnets 4, so that the filter 6 for filtering air is disposed between the electro-magnet 5 and the permanent magnets 4. The inner surface of the side wall of the cover 2 has a cam part 21 for a mobile contact point and a rotary limiting step 22 as illustrated in FIG. 1 or FIG. 6. The case 1 has a corresponding extension 25 to said rotary limiting step 22 and there is an elastic mobile contact piece 8 which is opposite to a fixed contact piece 7 and always in contact therewith. The end of this mobile contact piece 8 faces the cam part 21.

The circuit of the power cord 20 is as shown in FIG. 5. There is the fixed contact piece 7 and the mobile contact

piece 8 in this power circuit corresponding to coil 5'. The case 1 is used with a suitable bedplate, such as a plurality of oscillation absorbant rubber feet 18 which are attached to or detachably fitted on the bottom of the case 1 through a plate 17. To absorb the oscillation transmitted to the bedplate 19 an insulator is inserted between the fixed contact piece 7 and the mobile contact piece 8 to secure them to the case 1.

The device described is so constructed that when the electro-magnet 5 is excited by alternating current flow of a predetermined frequency, absorption and retorsion are repeated between permanent magnets 4 resulting in oscillation thereof so as to produce compression and expansion, and consequently air can be exhausted from air pipe 9. When a pipe is connected to said air pipe 9 and inserted, for instance, into a fish tank, bubbles can be sent forth therein. It is evidence then that this air rate is very efficient since oscillation by the permanent magnets 4 is transmitted as it is to the diaphragm assembly 3. Furthermore this control of air rate to be sent can be obtained by the rotation of the cover 2 around the case body 1. That is, when the cover 2 is rotated, the permanent magnets 4, 4 also rotate in the direction illustrated in FIGS. 6 and 7 so that the relative position to iron core 15 being changed, the magnet flux produced by the electro-magnet 5 stays constant and even if the height and position are unchanged, the horizontal distance with regard to the permanent magnets 4 changes, and the magnetic flux density to said permanent magnets 4 is changed so as to produce strong or weak variations in the oscillation volume created in the permanent magnets 4, thereby enabling changing or controlling the supply of air provided by the diaphragm.

Then the cover 2 further rotates and pushes the mobile contact piece 8 by means of the cam part 21, contact to the fixed contact piece 7 is interrupted and releases the power source from the electro magnet. On the bottom of the case an air inlet 28 is provided but this air inlet 28 is not especially necessary if the case 1 has a base part 30 at a position lower than the filter 6. Thus the bottom of the case can be divided into two sections with some clearance between members for the passage of air to the filter.

It is to be observed that the present invention provides for an air supply device for supplying air bubbles to an aquarium. The device generally comprises a cylindrical elongated hollow case 1 with a top portion and a bottom portion, and an engaging rotatable cover 2 which can be fitted over the top portion. The case 1 and cover 2 serve to house the components of the device. Shock absorbing legs 18 on the bottom portion of the device serve to insulate the device from its support. The device has an air inlet 28 in said bottom portion and an air outlet tube 9 extending from the cover 2. Disposed in the bottom portion is an electro-magnet 5 with poles facing towards the top portion.

A filter disk 6 is disposed over the electro-magnet poles, and, a diaphragm assembly 31 is disposed over the filter disk 6. The diaphragm assembly includes a bowl shaped diaphragm, a magnet assembly 4 mounted on the underside of this diaphragm facing the electro-magnet poles, and a diaphragm support plate 23 with a ring-shaped wall. This support plate is affixed to the cover 2. In the diaphragm there are inlet and outlet one-way valves 29, 29' to permit air from the air inlet to pass to the air outlet tube 9.

Within the cover 2 is a cam piece 21 and extending switch contact arms 7, 8 extend from the electro-magnet to the cover 2. In this manner, the turning of the cover 2 on the case 1 variously positions the permanent magnet 4 with respect to the electro-magnet 5 varying the magnetic coupling and oscillation intensity therebetween. The cam piece 21 and switch contact arms 7, define a circuit make and break area for the electro magnet circuit.

I claim:

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1. An air supply device for supplying air bubbles to an aquarium, comprising in combination:

- (a) a cylindrical elongated hollow case (1) with a top portion and a bottom portion, an engaging rotatable cover (2) which can be fitted over said top portion, said case (1) and cover (2) serving to house the components of the device, shock absorbing legs (18) on the bottom portion to insulate the device from its support, an air inlet (28) in said bottom portion and an air outlet tube (9) extending from said cover (2);
 - (b) an electro-magnet (5) disposed in said bottom portion with poles facing towards said top portion;
 - (c) a filter disk (6) disposed over said electro-magnet poles;
 - (d) a diaphragm assembly (3) disposed over said filter disk (6) including a bowl shaped diaphragm, a magnet assembly (4) mounted on the underside of said diaphragm facing said electro-magnet poles, a diaphragm support plate (23) with a ring-shaped wall, said support plate being affixed to said cover (2), inlet and outlet one-way valves (29, 29') in said diaphragm assembly to permit air from said air inlet to pass to said air outlet tube (9); and,
 - (e) a cam piece (21) within said cover and extending switch contact arms (7, 8), extending from said electro-magnet to said cover (2), whereby the turning of said cover (2) on said case (1) variously positions said permanent magnet (4) with respect to said electro-magnet (5) varying the magnetic coupling and oscillation intensity therebetween, said cam piece (21) and switch contact arms (7, 8) defining a circuit make and break area for the electro-magnet circuit.
2. An air supply device for supplying air bubbles to an aquarium, comprising in combination:
- (a) a cylindrical elongated hollow case (1) and an engaging rotatable cover (2) top and a bottom case portions, said case (1) and cover (2) serving to house the components of the device, an air inlet aperture (28) in said bottom portion and an air outlet aperture (9) extending from said cover (2);
 - (b) an electro-magnet (5) disposed in said bottom portion with poles facing towards said top portion;
 - (c) a filter disk (6) disposed over said electro-magnet poles;
 - (d) a diaphragm assembly (3) affixed to said cover (2) disposed over said filter disk (6) including a diaphragm chamber, a magnet assembly (4) mounted on the underside of said diaphragm chamber facing said electro-magnet poles, inlet and outlet one-way valves (29, 29') in said diaphragm chamber to permit air from said air inlet aperture to pass to said air outlet aperture (9); and

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- (e) make and break means within said cover and extending switch contact arms (7, 8) extending from said electro-magnet to said cover (2), whereby, the turning of said cover (2) on said case (1) variously positions said permanent magnet (4) with respect to said electro-magnet (5) varying the magnetic coupling and oscillation intensity therebetween, said switch contact arms (7, 8) defining a circuit make and break area for the electro-magnet circuit.

3. An air supply device for supplying air bubbles to an aquarium, comprising in combination:

- (a) a cylindrical elongated hollow case (1) with a top portion and a bottom portion, an engaging rotatable cover (2) which can be fitted over said top portion, said case (1) and cover (2) serving to house the components of the device, an air inlet (28) in said bottom portion and an air outlet tube (9) extending from said cover (2);
- (b) an electro-magnet (5) disposed in said bottom portion with poles facing towards said top portion;
- (c) a filter disk (6) disposed over said electro-magnet poles;
- (d) a diaphragm assembly (3) disposed over said filter disk (6) including a diaphragm chamber, a magnet assembly (4) mounted on the underside of said diaphragm chamber facing said electro-magnet poles, a diaphragm support plate (23), affixed to said cover (2), inlet and outlet one-way valves (29, 29') in said diaphragm assembly to permit air from said air inlet to pass to said air outlet tube (9); and
- (e) switch contact arms (7, 8), extending from said electro-magnet to said cover (2), with a defined make and break area therein (21) whereby, the turning of said cover (2) on said case (1) variously positions said permanent magnet (4) with respect to said electro-magnet (5) varying the magnetic coupling and oscillation intensity therebetween, said switch contact arms (7, 8) defining a circuit make and break area for the electro-magnet circuit.

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TIM R. MILES, Primary Examiner

U.S. Cl. X.R.

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