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T. H. HANSEN
THERMAL PUMP FOR GASES

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2 Sheets-Sheet 1

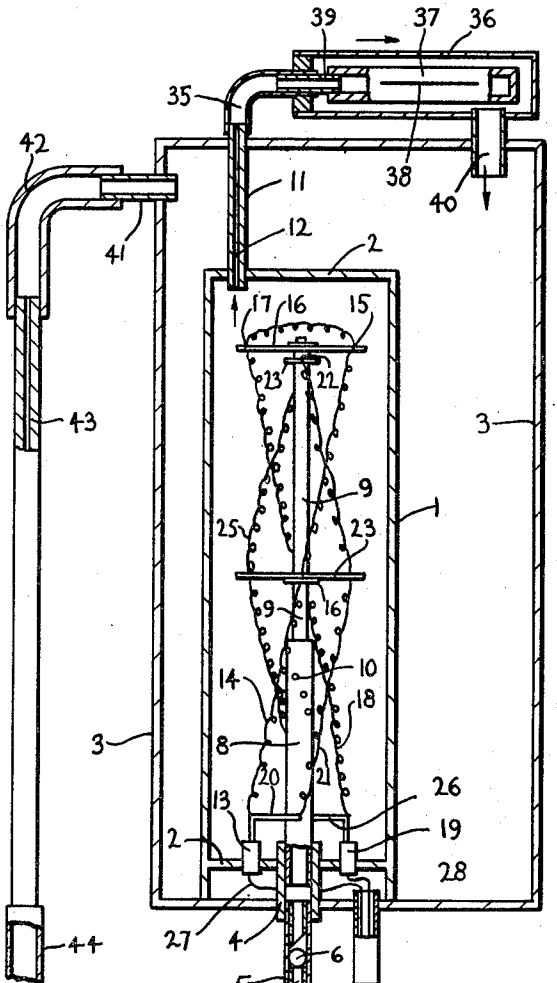


FIG. 1

FIG. 2

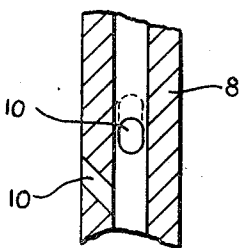
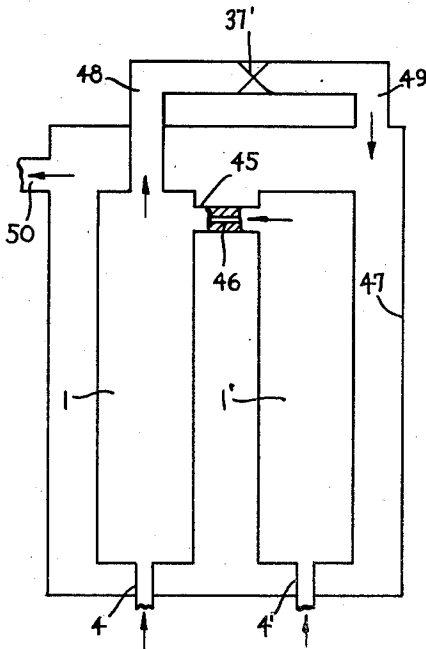


FIG. 5

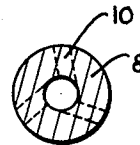


FIG. 3

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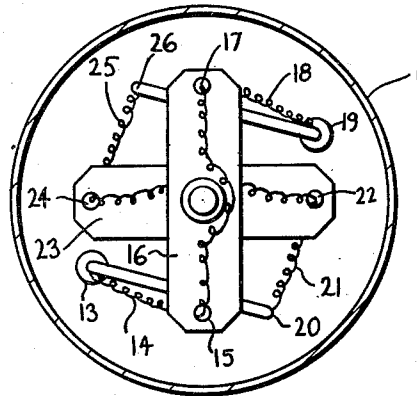


FIG. 4

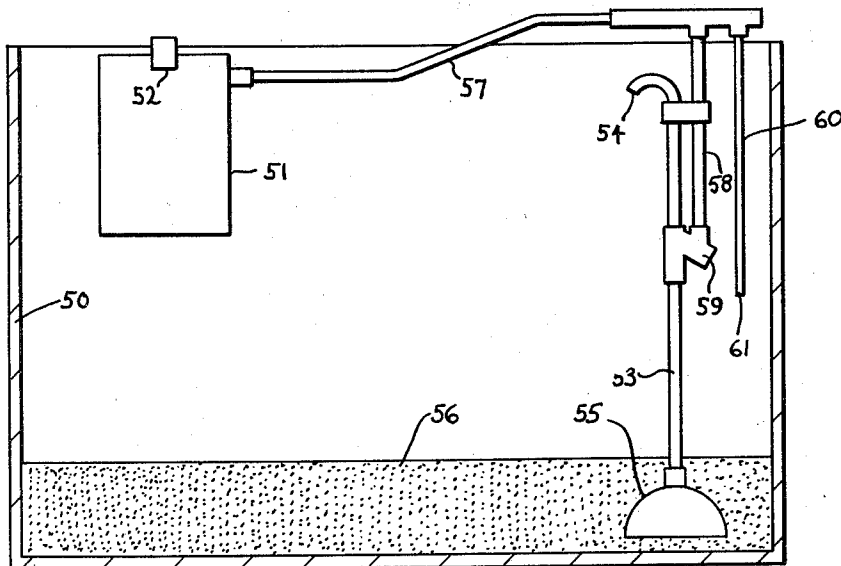


FIG. 6

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1

2,789,754

THERMAL PUMP FOR GASES

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10 Claims. (Cl. 230—1)

The present invention is directed to thermal pumps for gases and more particularly to a pump of small size and adapted for various uses, including use in connection with aquaria.

In general, pumps for gases based upon the heating thereof have previously been known. Among such pumps was one made of a test tube containing a heating element therein and an inlet and an outlet for the gas being pumped. In operation the heating element is energized intermittently a relatively small number of times per minute so that with each heating step, gas is expanded and forced out of the apparatus, with fresh gas entering the test tube in the cooling period with check valves to prevent backflow. A check valve at the end of the air hose which was immersed in water, prevented water from being sucked back into the pump. It acts as an aerator but is not practical for use with a filter. One of these valves was within the test tube and subjected to the heat therein. This rapidly deteriorated the valve so that the pump soon ceased to function. Another and important disadvantage was that the flow of gas being pumped was intermittent and the volume was quite low. As a result, this type of pump did not go into extended commercial use.

The present invention is intended and adapted to overcome the difficulties and disadvantages inherent in prior devices of the type described, it being among the objects of the present invention to provide a device which is capable of pumping large volumes of gas, such as air, with the expenditure of a relatively small amount of electrical energy and to provide a smooth uninterrupted and continuous flow of said gas.

It is also among the objects of the present invention to provide a device wherein a plurality of aquaria or the like may be supplied with air from a single source, which may consist of a multiple cylinder pump or a plurality of pumps coupled together.

It is further among the objects of the present invention to provide effective heating and cooling of the coils with a relatively large number of cycles per minute and to obtain a positive flow of air or other gas.

It is still further among the objects of the present invention to provide a structure wherein the check valves in the system are protected against deterioration by the heat in the pump and which is at all times cool enough to the touch to be easily handled.

In practicing the present invention there is provided a vertical cylinder with a tube extending into the cylinder from the bottom and provided with an exterior check valve to prevent back-flow of gas. Electric heating elements are mounted usually on a post associated with the tube and within the cylinder, in such a manner that the heat therefrom is distributed substantially completely around the tube. The cylinder is set within an outer tank and gas flowing from the cylinder and through a check valve enters said tank, which equalizes pulsations of pressure. The heating element is energized by the well-known winker button arrangement which makes and

2

breaks a circuit a number of times per minute. In the present case from 28 to 35 cycles have been found quite satisfactory.

In the accompanying drawing constituting a part hereof and in which like reference characters indicate like parts,

Fig. 1 is a vertical cross-sectional view of a thermal pump made in accordance with the present invention;

Fig. 2 is an enlarged fragmentary view of the tube showing openings for the entrance of air or other gas;

Fig. 3 is a transverse cross-sectional view of the part shown in Fig. 2;

Fig. 4 is a top plan view looking down into the top of the cylinder, showing the mica retaining spreader;

Fig. 5 is a diagrammatic view showing a modified form of the invention; and

Fig. 6 is a side elevational view showing the pump in combination with a safety air release.

Cylinder 1 is closed at top and near the bottom thereof is an insulating plate 2. The cylinder is cemented to the bottom of gas tank 3. A sleeve 4 extending into the bottom of cylinder 1 has at the outer end thereof a casing 5 for a ball or rubber check valve 6 with an inlet 7 for air or the like. Extending from casing 5 is tube 8, the upper end of which is closed and supports a solid post or stem 9 of insulating material and wound with insulating tape. A series of diagonal openings 10 in tube 8 are directed diagonally upward and outwardly. They are located near the upper part of tube 8 at the bottom of the zone of high temperature, directing the air upwardly. Thereby air or the like moves in a helical path and sweeps over the heating elements.

Exit duct 11 from the top of cylinder 1 is connected to sleeve 12 outside of tank 3. In the bottom of cylinder 1 is an insulating member 13 on which is mounted one end of electric heating coil 14, which passes through hole 15 in insulating member 16, then over the top thereof and through hole 17, the end 18 thereof being secured to insulating member 19. Arm 20 extending from terminal 13 has secured thereto one end 21 of a second heating coil. It passes through hole 22 of mica insulating member 23 across the same and down through hole 24, the lower end 25 thereof being secured to arm 26 connected with terminal 19. Slits are provided from the edges of said members to the holes to allow the wire of the coils to be slipped into said holes therethrough.

Lead wires 27 and 28 from terminals 13 and 19 pass into winker 29. A capacitor 30 is connected by wire 31 to wire 27 and by wire 32 to wire 28 to prevent electrical interference. Prongs 33 are adapted to be inserted into a source of power.

Elbow 35 extending from sleeve 12 enters cylinder 36 which contains an elastic sleeve 37 having a longitudinal slit 38 therein. Connecting sleeve 39 causes gas from elbow 35 to pass into sleeve 37. Return pipe 40 connects 36 with tank 3. Outlet 41 at the top of tank 3 is connected by elbow 42 to a tube 43 having a restricted air passage, the free end of which is attached to a pipe 44 which in turn is connected to a filter and aeration equipment, such as an aquarium to be filtered and aerated.

In the operation of the device, it is connected to a source of current, causing a cycle of heating of the electric elements, expanding the gas in cylinder 1, causing the same to flow out through duct 11, sleeves 12 and 37, slit 38, pipe 40 and out through outlet 41 into the equipment. In the next cycle with the current off, there is cooling in the cylinder and air is drawn in past valve 6. The cycle is then repeated. Tank 3 holds a considerable volume of air or other gas and because of this it smooths out the pulsations in the flow of gas. Tube 43 being restricted in diameter also smooths out the pulsations and a combination of valve 37, tank 3 and tube 43 gives a

continuous and uninterrupted flow of gas at substantially constant pressure. Because of the location of valves 6 and 38, they are not subjected to the heat within cylinder 1, and although they are usually made of rubber, they do not deteriorate. The heating elements instead of being placed vertically are placed diagonally so that the heat rising is released quickly and is practically uniform around tube 8. The gas entering helically sweeps over the heated area, is rapidly and uniformly heated and flows out quickly, removing most of the heat from the cylinder, the latter having insulation at the top and most of the side. Therefore, it cools rapidly and immediately brings in a relatively large volume of air. Because tank 3 surrounds the cylinder and has insulation at the top, the outside is always cool and there is no danger of any individual being injured by the heat in the cylinder.

In the embodiment shown in Fig. 5, there are provided two cylinders 1 and 1', substantially identical with that shown in Fig. 1. They are both connected near their upper ends by pipe 45, having a constricted or capillary tube 46 therein. They are both located within tank 47. A check valve 37' similar to 37 is inserted between exit pipe 48 from cylinder 1 and pipe 49 entering tank 47.

In operation there may be a single winker button arrangement for both of the cylinders or they may have their individual buttons. In either case, heated air from cylinder 1' passes through pipe 45 into cylinder 1. Heated gas therefrom joins it and the mixture passes out through pipe 48 and valve 37', then through pipe 49 into tank 47 and out through outlet 50 similar to outlet 41 of Fig. 1. The sweep of gases over the top of cylinders 1 and 1' carries away heat that may have radiated from the top of said cylinders, thus keeping the entire device cool.

When a pump of this type is operated in connection with a filter in an aquarium, and the filter becomes clogged, the flow of air may become restricted, resulting in heating of the pump to a relatively high temperature. This leads to eventual deterioration of the pump. Fig. 6 shows a device for safeguarding the pump when the filter is clogged. Aquarium 50 has pump 51 mounted thereon by bracket 52. A vertical tube 53 has an exit gooseneck 54 for a mixture of water and air, and an inverted filter cup 55 in the gravel 56 in the bottom of the aquarium. A capillary tube 57 from pump 51 is connected to tube 58 for causing air flowing from the pump to enter at 59 at an upward angle. A tube 60 connected to tube 57 has its lower end below point 59.

In the normal operation of the filter, air flowing up in tube 53 carries water being filtered in cup 55 out of gooseneck 54. No air passes out of end 61 of tube 60 but water rises therein. When the filter becomes clogged, the back pressure forces the water out of tube 60 and the air then flows continuously out of end 61. The heated air in pump 51 continues to flow and the pump does not overheat.

The invention is based upon a combination of three factors which, in cooperation, produce the full effectiveness of the pump described herein. They include the check valve which prevents backwash of air into the cylinder, the gas tank or balancing chamber to equalize and iron out the pulsations, and the restricted outlet or restraining hose or pipe at the outlet from the tank. They permit rapid cycles of heating the air and expelling it from the cylinder and cause a continuous flow of air through both an aerator and filter device in the aquarium. Usually the winker operates at, say, 28 to 35 cycles per minute with highly satisfactory results.

There are no moving parts such as pistons or shafts, and no parts that wear out, such as bearings or diaphragms. The pump is completely soundless, does not develop noise in long use, and it requires practically no attention or repairs. It supplies an uninterrupted and smooth flow of air. The valves, being on the outside of the tank are readily replaceable, if the rubber thereof should deteriorate with time. The pump unit is readily

mountable on an aquarium by a bracket attached to the tank.

Various changes in the details may be made without departing from the principles herein set forth. For instance, tube 8 may be extended to near the top of cylinder 1 and openings 10 may be placed near the top of said tube. The insulating mica members 16 and 23 may be mounted on the outside of the tube itself or on a support or post attached thereto or mounted in other ways within the cylinder; all such mountings are included in the term "mounted on the outside of said tube" as stated in the claims.

I claim:

1. A thermal pump for gases comprising a vertical cylinder, a tube extending into the bottom of said cylinder, said tube having a plurality of lateral openings, electric heating elements mounted on the outside of said tube, an exit for gas at the top of said cylinder, a check valve at the entrance end of said tube and a check valve at said exit, and means for intermittently energizing said heating elements, and a tank for gas surrounding said cylinder, the exit from said cylinder entering said tank.

2. A thermal pump for gases comprising a vertical cylinder, a tube extending into the bottom of said cylinder, said tube having a plurality of lateral openings, electric heating elements mounted on the outside of said tube, an exit for gas at the top of said cylinder, a check valve at the entrance end of said tube and a check valve at said exit, and means for intermittently energizing said heating elements, and a tank for gas surrounding said cylinder, the position of said valves being outside said tank, the exit from said cylinder entering said tank.

3. A thermal pump for gases comprising a vertical cylinder, a tank for gas surrounding said cylinder, a tube extending into the bottom of said cylinder, said tube having a plurality of lateral openings, electric heating elements mounted on the outside of said tube, said elements extending from bottom to top of said tube and return, leads connected to the ends of said elements, an exit for gas at the top of said cylinder, a check valve at the entrance end of said tube and a check valve at said exit, and means for intermittently energizing said heating elements, the exit from said cylinder entering said tank.

4. A thermal pump for gases comprising a vertical cylinder, a tank for gas surrounding said cylinder, a tube extending into the bottom of said cylinder, said tube having a plurality of lateral openings, electric heating elements mounted on the outside of said tube, said elements extending from bottom to top of said tube and return, leads connected to the ends of said elements, the upper end of said elements being laterally displaced from the lower end thereof, an exit for gas at the top of said cylinder, a check valve at the entrance end of said tube and a check valve at said exit, and means for intermittently energizing said heating elements, the exit from said cylinder entering said tank.

5. A thermal pump for gases comprising a vertical cylinder, a tube extending into the bottom of said cylinder, said tube having a plurality of lateral openings, electric heating elements mounted on the outside of said tube, an exit for gas communicating with top of said cylinder, a check valve in the entrance end of said tube and a check valve in said exit, and means for intermittently energizing said heating elements, and a tank for gas surrounding said cylinder, said exit having a portion projecting through said tank, a return pipe from said portion connected to the top of said tank, said second mentioned check valve being in said portion.

6. A thermal pump for gases comprising a vertical cylinder, a tube extending into the bottom of said cylinder, said tube having a plurality of lateral openings, electric heating elements mounted on the outside of said tube, an exit for gas communicating with top of said cylinder, a check valve in the entrance end of said tube and a check valve in said exit, and means for intermittently

5

energizing said heating elements, and a tank for gas surrounding said cylinder, said exit having a portion projecting through said tank, a return pipe from said portion connected to the top of said tank, an outlet pipe from the top of said tank.

7. A thermal pump for gases comprising a vertical cylinder, a tube extending into the bottom of said cylinder, said tube having a plurality of lateral openings, electric heating elements mounted on the outside of said tube, an exit for gas communicating with top of said cylinder, a check valve in the entrance end of said tube and a check valve in said exit, and means for intermittently energizing said heating elements, and a tank for gas surrounding said cylinder, said exit having a portion projecting through said tank, a return pipe from said portion connected to the top of said tank, an outlet tube from the top of said tank having a constricted part therein to prevent surges.

8. A thermal pump for gases comprising a vertical cylinder, a tube extending into the bottom of said cylinder, said tube having a plurality of lateral openings, electric heating elements mounted on the outside of said tube, an exit for gas at the top of said cylinder, a check valve at the entrance end of said tube and a check valve at said exit, and means for intermittently energizing said heating elements, and a tank for gas surrounding said cylinder, a second cylinder within said tank having a gas inlet tube and heating elements, and a connection for gas between said cylinders at the upper end thereof, said connection being constricted.

9. A thermal pump for gases comprising a vertical cylinder, a tank for gas surrounding said cylinder, a tube extending into the bottom of said cylinder, said tube

6

having at least one lateral opening, electric heating elements mounted on the outside of said tube, an exit for gas communicating with top of said cylinder, a check valve in the entrance end of said tube and a check valve in said exit, and means for intermittently energizing said heating elements, a discharge tube connected to said exit and adapted to supply gas to an aerator at a point below a liquid level, a pressure release tube also connected to said exit and extending a substantial distance below said point, the exit from said tube entering said tank.

10. A thermal pump for gases comprising a vertical cylinder, a tube extending into the bottom of said cylinder, said tube having at least one lateral opening, electric heating elements mounted on the outside of said tube, an exit for gas communicating with top of said cylinder, a check valve in the entrance end of said tube and a check valve in said exit, and means for intermittently energizing said heating elements, a tank for gas surrounding said cylinder and a connection for gas therebetween, a gas exit pipe from said tank, and a restricted opening through said pipe.

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