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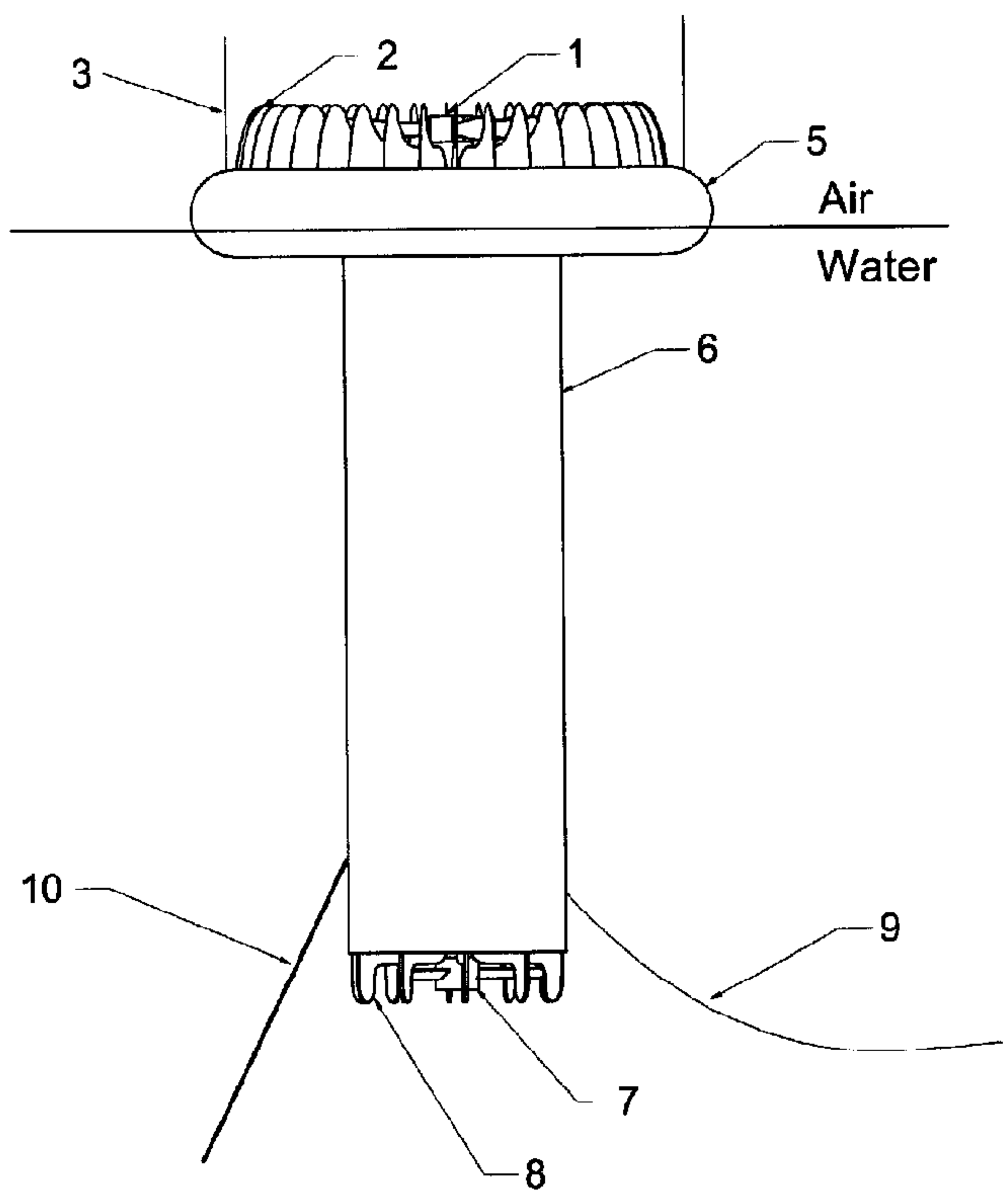
(72) Inventeur/Inventor:
HEINRICHS, ARTHUR D., CA

(73) Propriétaire/Owner:
HEINRICHS, ARTHUR D., CA

(74) Agent: NA

(54) Titre : GENERATRICE S'APPUYANT SUR LA DIFFERENCE ENTRE LA TEMPERATURE DU RESERVOIR ET DE L'AIR AMBIANT POUR PRODUIRE DE L'ELECTRICITE

(54) Title: RESERVOIR TEMPERATURE DIFFERENTIAL ELECTRICAL GENERATOR



(57) Abrégé/Abstract:
Typically, solar power electrical generation is restricted by the physical dimensions of the solar collector and/or the reflecting materials used to redirect the solar energy toward the collector. This system provides a method to remove the size restriction of a solar collector by utilizing a reservoir, such as a body of water, to collect the total solar energy absorbed by the reservoir and convert its accumulated thermal energy into electrical power. The system uses the temperature difference between the reservoir and the surrounding air to extract the energy.

Abstract

Typically, solar power electrical generation is restricted by the physical dimensions of the solar collector and/or the reflecting materials used to redirect the solar energy toward the collector. This system provides a method to remove the size restriction of a solar collector by utilizing a reservoir, such as a body of water, to collect the total solar energy absorbed by the reservoir and convert its accumulated thermal energy into electrical power. The system uses the temperature difference between the reservoir and the surrounding air to extract the energy.

Reservoir Temperature Differential Electrical Generator

This invention provides a method to extract the solar energy collected in any reservoir such as a lake or river and convert the stored thermal energy into electrical power.

Background of Invention

Solar energy is normally collected using panels that convert sunlight directly into electricity by using the light of the sun to act on substrates or by using the heat of the sun to warm a liquid for heating. The energy gathered by these collectors are limited by their surface area and by the sunlight they receive. Under optimal conditions, the insolation of the collected energy from the sun is about 1000 Watts per square meter. The average energy collected over time such as a day, week or month is generally much less than the optimal because the sun does not shine during the night as well as clouds will attenuate the energy received by the collector. This makes traditional solar collection impractical as a source for high energy needs because the land use requirements become excessive.

Wind power is more practical as a source of energy as wind is often available twenty-four hours a day and the energy collected per square meter is generally much higher than the energy that would be collected directly from a solar panel. Wind indirectly uses solar energy with the sun creating heat in the atmosphere over many cubic meters causing expansion and ultimately wind which in turn powers a windmill. Although wind power is a plentiful source of renewable energy, it uses a lot of land, can be considered an eyesore and has been known to be deadly for birds.

This invention, similar to wind energy, uses the thermal energy of the sun indirectly by using the accumulated heat stored in a reservoir such as a lake by using the temperature differential between the lake and the atmosphere. Rather than using the wind created by the temperature differential of different regions in the atmosphere, this invention utilizes the difference of temperatures in the atmosphere with the surrounding water. One advantage of using a lake to collect the solar energy is many cubic meters of heated water is in abundant supply and the generator required to utilize the stored energy can be much smaller then the area used by the lake. At night, the lake is usually warmer than the ambient air but during the day, the temperature of the lake is usually cooler. The temperature differential exists as the lake contains the average temperature of the environment as heated by the sun over time whereas the ambient air more or less holds the instantaneous temperature which fluctuates rapidly but seldom is the same temperature as the lake.

The long term air temperature patterns of a region and the temperatures of a lake can be easily monitored and locations chosen that will generate consistent and reliable power for extended periods. When the ambient air and the lake temperature are equal, no power will be generated but these events can be mitigated by networking multiple generators over many lakes and by finding bodies of water that have different temperatures for reasons such as different depths, flow, or size.

Description of Prior Art

Current processes that rely on renewable energy ultimately can be traced back to the sun. Solar power panels convert the sun's electromagnet energy into usable energy. Wind power comes from the uneven heating patterns of the sun onto the earth. Turbines are set up that capitalizes on this temperature differential by capturing the airflow that results. Systems have been created that takes energy from waves caused by wind. Hydroelectric power uses the potential energy difference of water at different elevations to create power. This power also can be traced back to the sun as water follows the rain cycle which includes evaporation, condensation and precipitation, all caused by the sun. This invention uses the principle that a lake is essentially a heat sink and directly takes the thermal energy collected by the lake from the sun and converting it into useful power. There are systems in place that can create energy from any temperature differential such as a Sterling Engine that utilizes the principles of a heat pump but no one has optimized the process so that energy can be efficiently extracted from lakes or other reservoirs.

Summary of the Invention

The invention pertains to the process of generating electricity from the difference in temperature of a liquid reservoir and the ambient air. The entire reservoir absorbs the radiation from the sun and holds the thermal energy much longer than the surrounding air. When the air is warmer than the reservoir, the air is used to warm a fluid that is subsequently cooled by the reservoir. When the air is cooler than the reservoir, the air is used to cool the fluid which is subsequently warmed by the reservoir. The continuous external warming and cooling of the fluid can be harnessed to generate motion which in turn creates mechanical energy and is subsequently converted into electrical energy.

The generator is typically located on a body of water, such as a lake or river, and is designed to be situated on the surface of the water either floating and tethered to an anchor or secured directly to the bottom of the reservoir with a part of the structure elevated above the water surface. A radiator assembly is employed above the water surface as a heat-exchanger to either heat or cool the self contained working fluid to the same temperature of the ambient air. A fan may be also utilized to create air movement to prevent the heat-exchanger from using stale air and reducing the efficiency of the heat-exchanger. Similarly, another heat-exchanger is located at some depth under the surface which will be in contact with the water in the reservoir which will normally be a different temperature than the surface air. Where there is no motion of water near the heat-exchanger, a propeller may be used to move fresh replacement liquid next to the heat-exchanger.

This invention provides a method to convert the solar energy absorbed by a body of water into electrical energy. Water is a much better conductor of heat than air which enables a relatively small generator to harness the thermal energy of the entire body of water which perhaps covers a large area. The energy required to heat 1 cubic meter of water 1 degree is approximately 1.163 kilowatts-hours. Thus a small lake that is 1 km in diameter and 10 meters deep that is 3 degrees different from the ambient air has an approximate potential of 27 gigawatt-hours of energy that can theoretically be harnessed and used for electrical generation. As this generator can be located completely offshore, valuable land can also be conserved or rezoned and the eyesore of having many structures such as windmills is minimized.

The average difference in temperatures between the air and the reservoir is expected to be only a few degrees. Although current Sterling Engines can be utilized to create mechanical energy with as little as ½ degree difference in temperature, this invention also proposes the use of a working fluid with a boiling point that is close to the temperature of the reservoir.

The boiling point of the working fluid can be altered by several degrees by changing the pressure of the working fluid. In the cool state, the working fluid will be a liquid and in the warm state, the working fluid will be a gas. In order to fine tune the boiling point of the working fluid so that the boiling point of the fluid remains optimal for the environmental conditions, the fluid is contained in a large chamber that can have its volume altered thereby affecting its pressure and boiling point.

The volume of a gas is much larger than the volume of the same liquid with the same mole count and this difference in volume can be harnessed to create mechanical energy which in turn can be converted to electrical energy through a standard generator that converts mechanical motion into electricity.

The electrical energy generated by the mechanical movement caused by the continuous boiling and condensing of the working fluid is then transferred to a station on land via conductive wires where the electricity can be conditioned to the correct voltage and frequency for distribution into the electrical power grid.

Brief Description of the Drawings

Figure 1 shows an overview of the generator.

Figure 2 demonstrates a typical deployment of the generator.

Figure 3 shows a top view of the air heat-exchanger used to boil or condense the working fluid.

Figure 4 shows a side view of the air heat-exchanger used to boil or condense the working fluid.

Figure 5 shows a bottom view of the liquid heat-exchanger used to boil or condense the working fluid.

Figure 6 shows a side view of the liquid heat-exchanger used to boil or condense the working fluid.

Figure 7 shows a cut a way view of the generating detailing its operation.

Figure 8 shows how the heat engine is used to generate mechanical motion.

Figure 9 is a block diagram showing the inputs used by the generator to create mechanical motion.

Description of the Preferred Embodiment

As depicted in Figure 1, the generator assembly is placed on a reservoir such as a lake and electrically connected to the shore. The generator is built to float 5 in the water and it will have warning lights mounted on rods 3 to help protect against damage from inattentive boaters. The top part of the generator as shown in Figure 3 and Figure 4 is above the water level where surface air can be accessed and used to either heat or cool a working fluid such as ammonia or some other refrigerant. The surface area of this airborne heat-exchanger will be maximized and designed to take advantage of the wind to replace the heated or cooled air that is next to the heat-exchanger 2. A fan 1 powered by an electrical motor 14 will be used in the situation when there is insufficient air movement in order to keep the heat-exchanger operating efficiently. The purpose of the heat-exchanger is to alter the temperature of the working fluid to be similar to the ambient air temperature.

Most of the generator assembly 6 is under water. If the above airborne heat-exchanger is used to heat the working fluid, then the submerged heat-exchanger will be used to cool the working fluid. Alternatively, if the airborne heat-exchanger is used to cool the working fluid, the submerged heat-exchanger will heat the working fluid. The surface area of the submerged heat-exchanger 8 as in Figure 5 and 6 will also be designed to take advantage of water currents in order to replace the stale water next the heat-exchanger. Where required, a propeller 7 will be used to create a current to aid in the operation of the heat-exchanger.

In the preferred embodiment, the generator is free floating and fastened in position by using an anchor 10. The produced electricity is transmitted to a power station 11 on shore by a transmission wire 9 where the electricity can be conditioned to the correct frequency and voltage and sent to the power grid 12. Multiple generators 13 as shown in Figure 2 can be in the same reservoir and networked where the reservoir is of sufficient size.

The working fluid is chosen such that its boiling point is between the ambient temperature of the water and air when the fluid is pressurized by the compression module 30. The fluid is mostly contained in a compression chamber 29 as shown in Figure 7. When the boiling point of the fluid needs to increase to match changing environmental conditions, the compression chamber 29 compresses the working fluid by pumping 34 reservoir liquid through the inlet 33 and into chamber 32 which is separated from the working fluid 29 by a sliding barrier 31. As more fluid is pumped into chamber 32, the barrier 31 moves and compresses the working fluid 29 which is tied into the heat-exchanger and heat engine assembly via connection 28. When the boiling point needs to decrease, opposite action is performed by removing liquid from chamber 32 into the reservoir thereby increasing the size of chamber 29 and reducing the pressure. The average size of chamber 29 will be mathematically calculated in order to be optimized for the operating environment which the generator is located in and the average operating pressure and working fluid chosen for the specific generator.

The working fluid is circulated by a pump 18 through the top air heat-exchanger 2 via a connector 17 which is internally linked to the air heat-exchanger. The working fluid is also circulated by a pump 25 to the bottom water heat-exchanger 8 via a connector 27 which is internally linked to the water heat-exchanger. The two pumps 18 and 25 are for circulating the working fluid between the two heat-exchangers and the heat engine 26.

By choosing a fluid that boils between the temperature of the ambient air and the surrounding water while under pressure, the generator can utilize the heat of vapourization of a fluid which is defined as the energy required to convert a fluid from a liquid state to a gas state. In a situation where the water is warmer than the surrounding air, the thermal energy of the surrounding water can be absorbed by the working fluid by warming the fluid above its boiling point through the water heat-exchanger 8 and turning it into a vapour which uses dramatically more volume at the same pressure. A portion of this expanding energy can be captured by the heat engine by moving a piston 23 which is connected to a rod 19 that in turn powers an electrical generator 16. The vapour can be subsequently condensed by circulating it through the air heat-exchanger 2. In this scenario, the temperature of the water in the lake will eventually be reduced to the temperature of the surrounding air.

The greater the temperature differential between the water and the air, the greater the amount of energy that can be removed from the system and converted into electrical power. The heat engine moves a piston back and forth in a linear motion. This back and forth motion of the rod 19 does the actual work which the electrical generator will utilize to convert mechanical work into electricity for distribution. A linear motion generator could be used or gearing employed to convert the linear motion into rotary motion for use by a common electrical generator.

Figure 8 demonstrates how the heat engine works. In Fig. 8A, the pressurized working fluid from the warmer heat-exchanger is channelled to the upper chamber 20 by control valve 22. As the fluid is circulated through the warmer heat-exchanger, the fluid turns to gas and expands pushing the piston 23 down. In Fig. 8B, the working fluid has expanded to its potential and has pushed the piston to its low position. At this point (Fig. 8C), valve 22 switches and redirects the warmer fluid to the lower chamber and valve 21 simultaneously switches and redirects 35 the now expanded working gas to the cooler heat-exchanger where the gas will eventually condense and require less volume moving the piston back up. The piston will continue to rise (Fig. 8D) until it reaches its starting position (Fig. 8A) and the cycle repeats. At the same time this is happening, the opposite is happening in the lower chamber 24 so fluid and gas is always being circulated and either warmed or cooled.

To control the process of heating and cooling the working fluid, an electronic data processor is required. Figure 9 shows the inputs required by the data processor to enable the generator assembly to produce electricity. These inputs come by using various sensors 50 and analyzing and processing 51 all the data and then sending commands to the controller 52. The processor needs to know the pressure 36 of the working fluid to determine its boiling point. It also needs to know the outside air temperature 37 and outside water temperature 38 in order to correctly adjust the pressure using the compressor 57. Water current speed 39 and wind speed 49 is also used to determine if the fan 53 or propeller 54 needs to be activated. The air inlet 40 and air outlet 41 sensor in conjunction with the water inlet 42 and water outlet 43 sensor will alert the processor as to the correct timing for adjusting the valves 55 that direct the fluid flow into the heat engine. The heat pump number one 44 and the heat pump number two 45 sensors indicate the speed at which pump 25 and 18 is circulating the fluid through the system and allows for fine tuning by permitting speed adjustments 56 to the pumps. The piston position 46 also gives the processor feedback as to how the system is operating and the amount of mechanical energy being delivered to the electrical generator module. The data processor also needs to know the electrical requirements 47 of the power station so it can produce the correct amount of electricity 48 at peak efficiency.

The Embodiments Of The Invention In Which An Exclusive Property Or Privilege Is Claimed Are Defined As Follows:

1. A temperature differential energy conversion unit comprising:

   A) A unit placed in or beside a body of water that uses the temperature differential of the said water and the ambient air;

   B) A working fluid that is utilized in said unit to transfer heat from the ambient air to the said water;

   C) A means for varying the pressure of said working fluid in order to maintain a boiling point of said working fluid between the dynamically changing temperature of the ambient air and said water;

   D) An electrical generator powered by the expansion of said working fluid caused by its boiling;

   E) A heat exchanger optimized to transfer energy between the ambient air and said working fluid;

   F) A second heat exchanger optimized to transfer energy between the said water and said working fluid;

   G) A pump to move the said working fluid in liquid state into the heat exchanger of higher temperature;

   H) A means of moving the said water and ambient air through the respective heat exchangers to facilitate the transfer of energy of the said working fluid with that of the embedding medium.

2. A unit as set forth in claim 1 where said working fluid has its pressure adjusted by a compressor and relief valve.

3. A unit as set forth in claim 1 where said working fluid has its pressure adjusted by a chamber of variable size which alters the working fluids total volume.

4. A system for generating power comprising multiple units as set forth in claim 1.

5. A unit as set forth in claim 1 that uses either natural wind or water currents or a mechanical device such as a propeller or a fan to move air or said water through said heat exchangers.

Figure 1

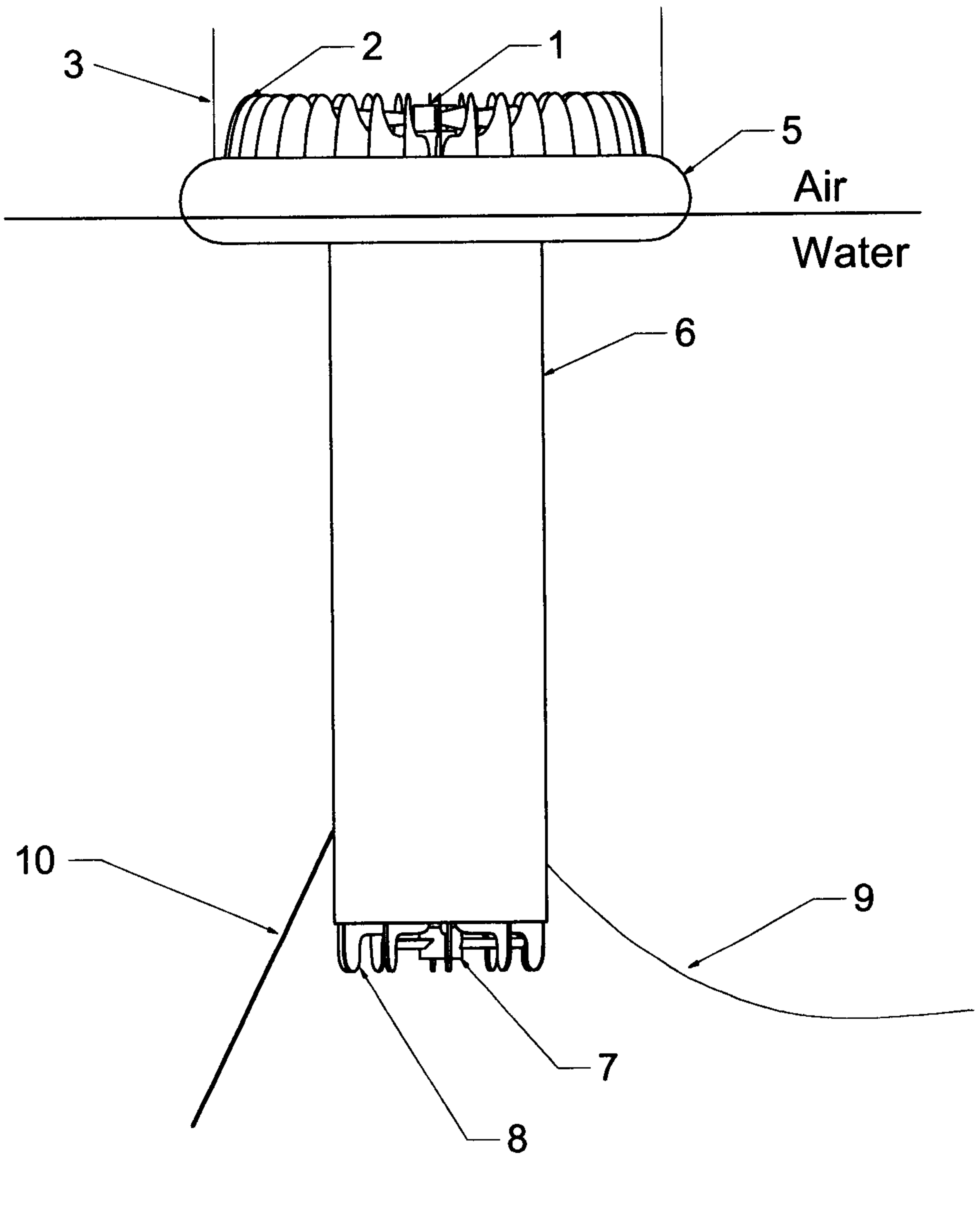
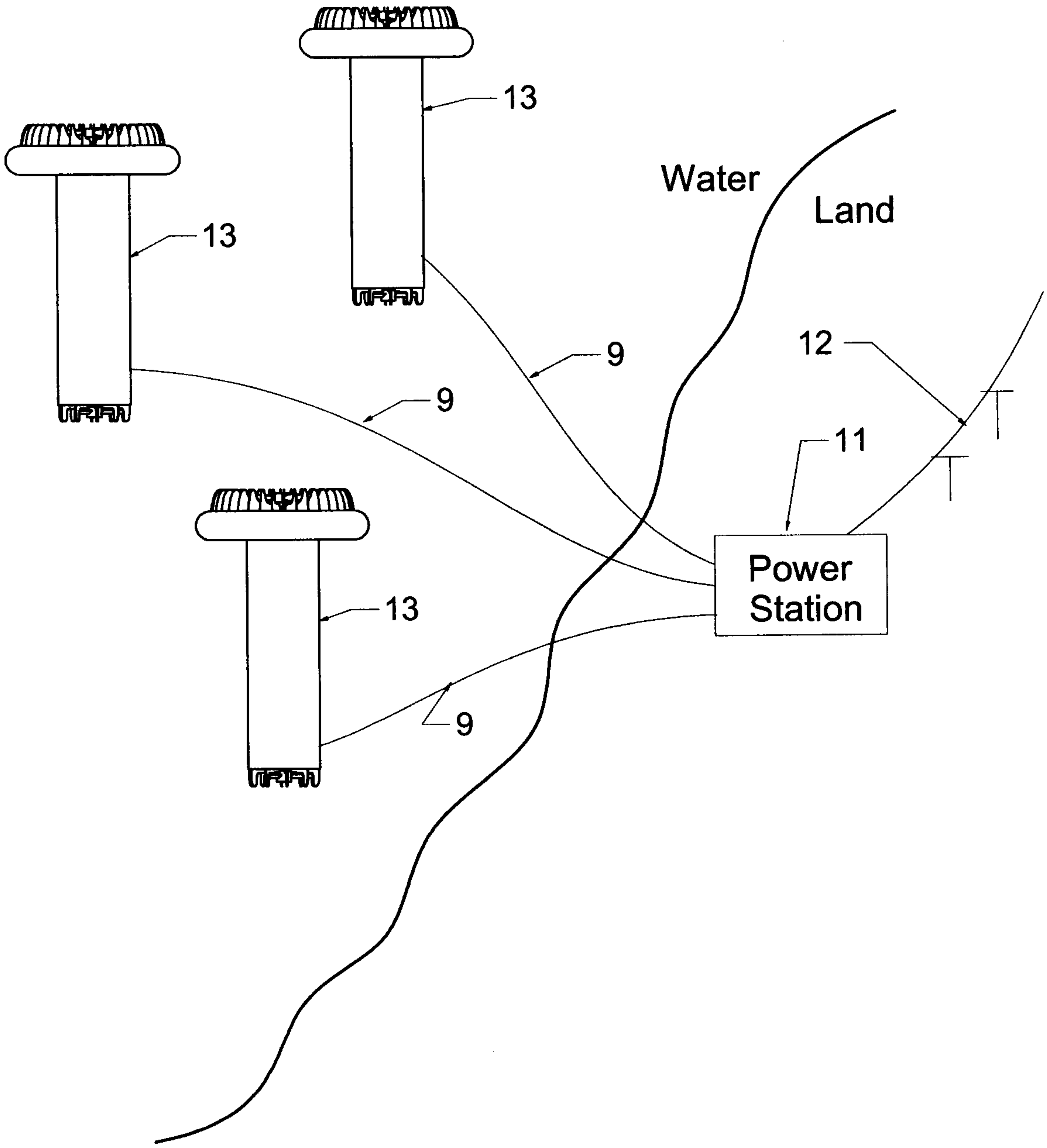


Figure 2



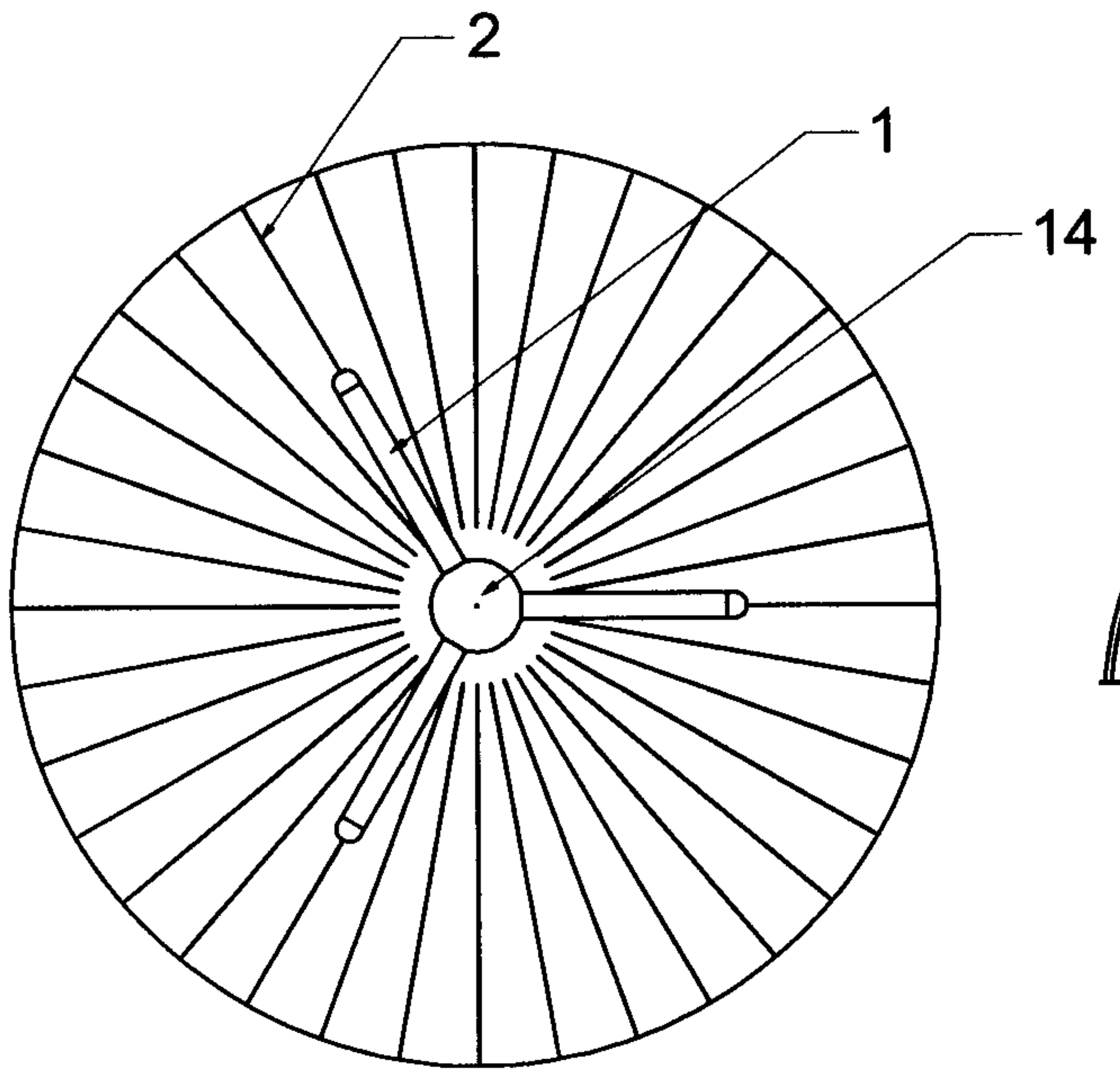
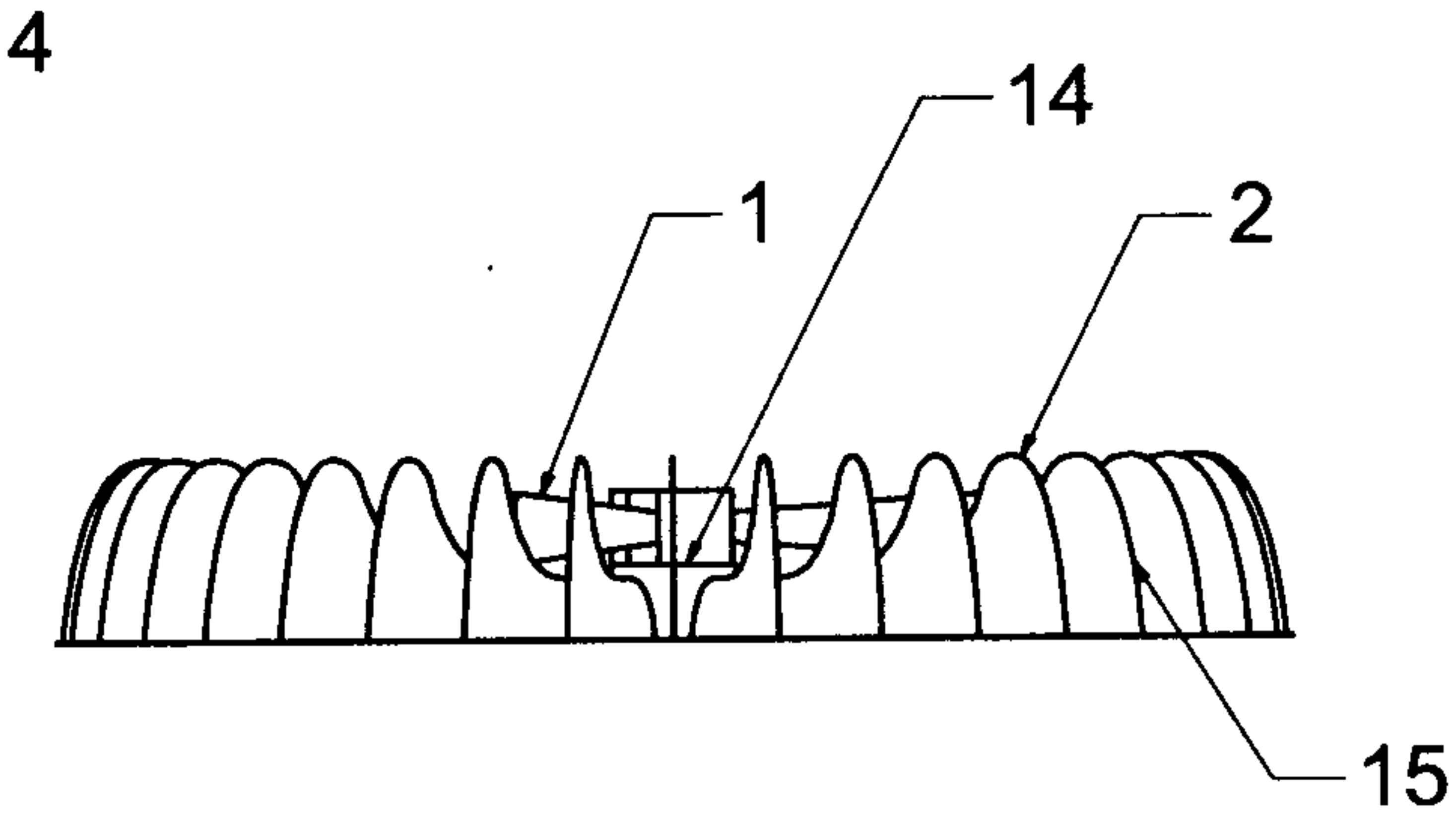


Figure 3



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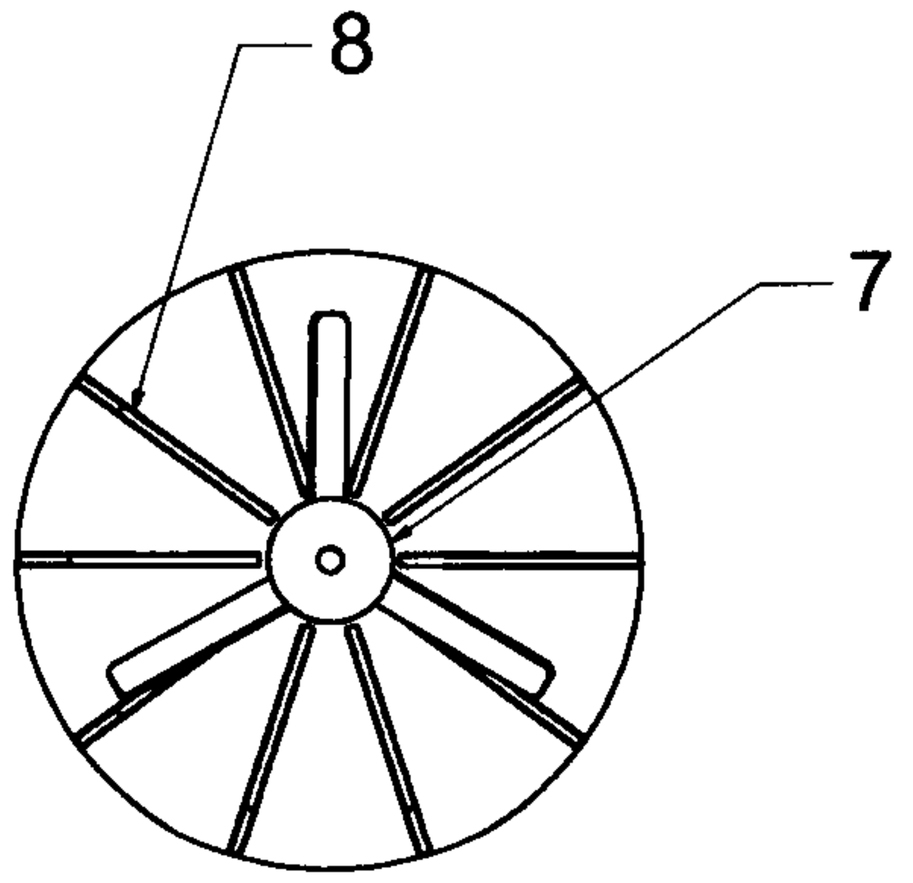


Figure 5

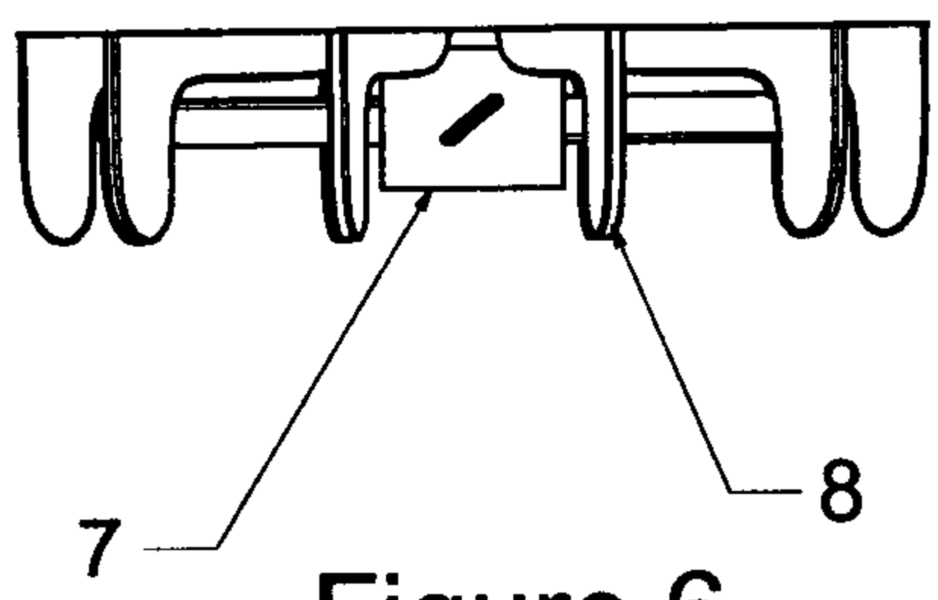


Figure 6

Figure 7

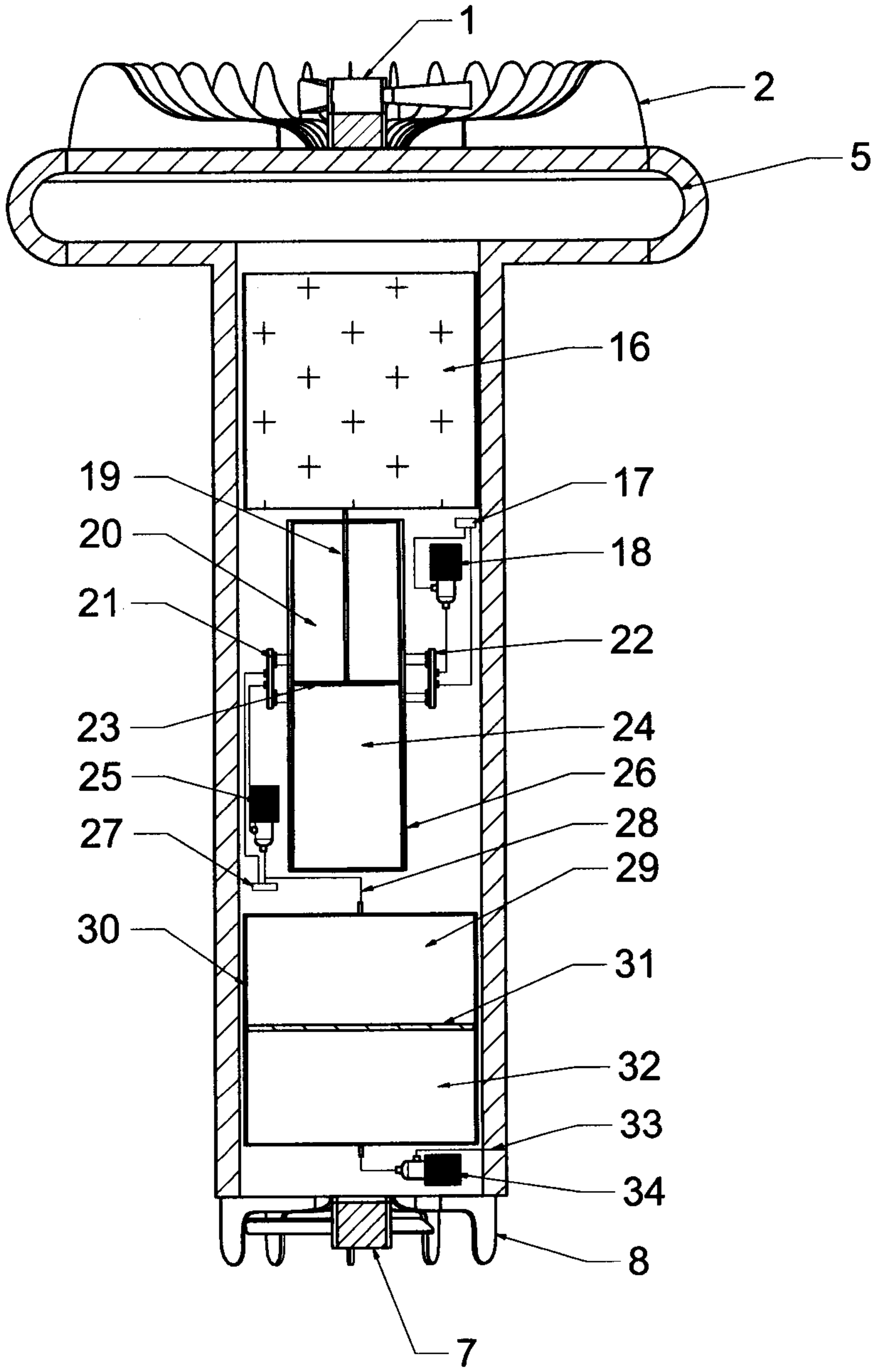


Figure 8

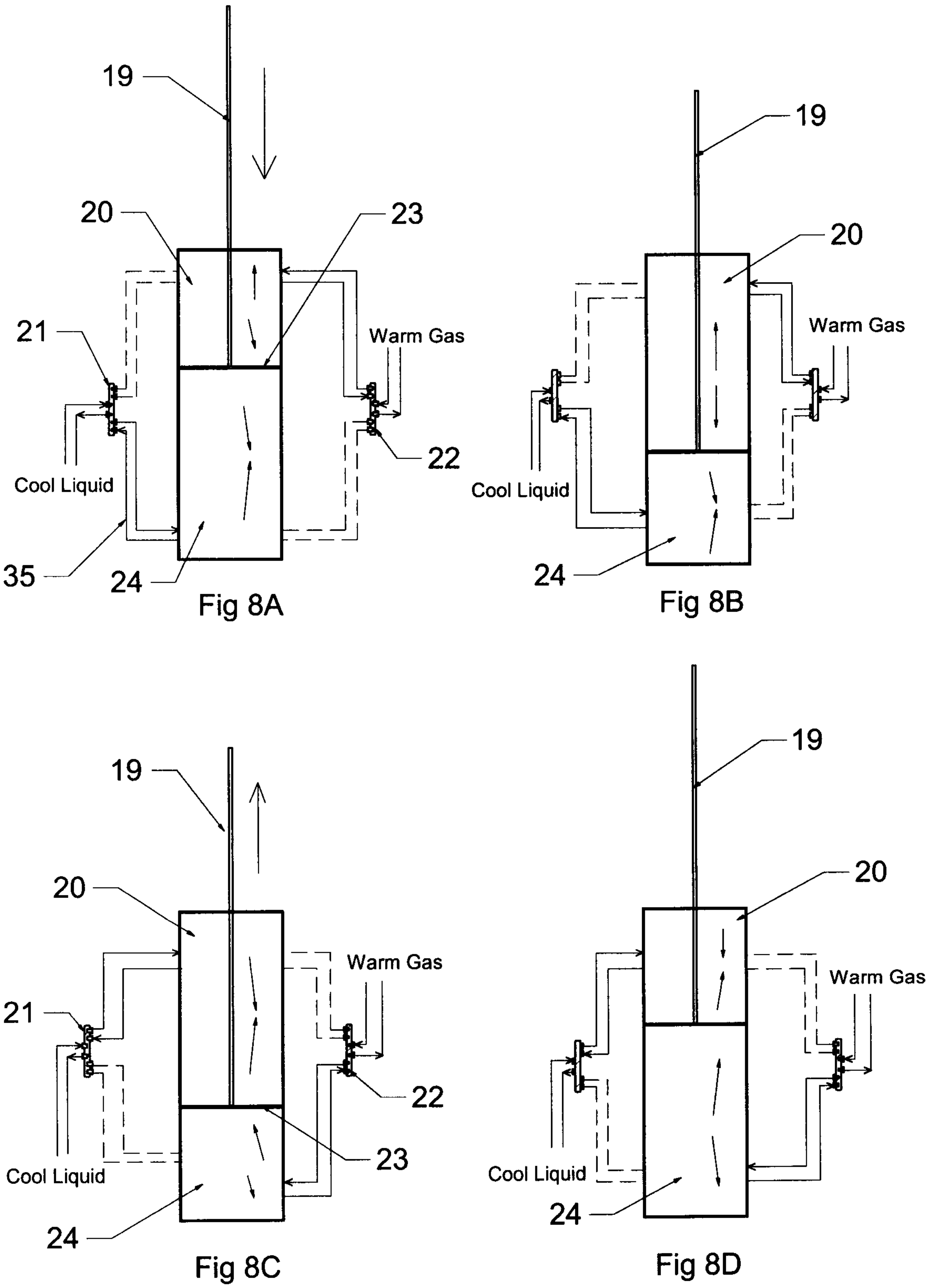


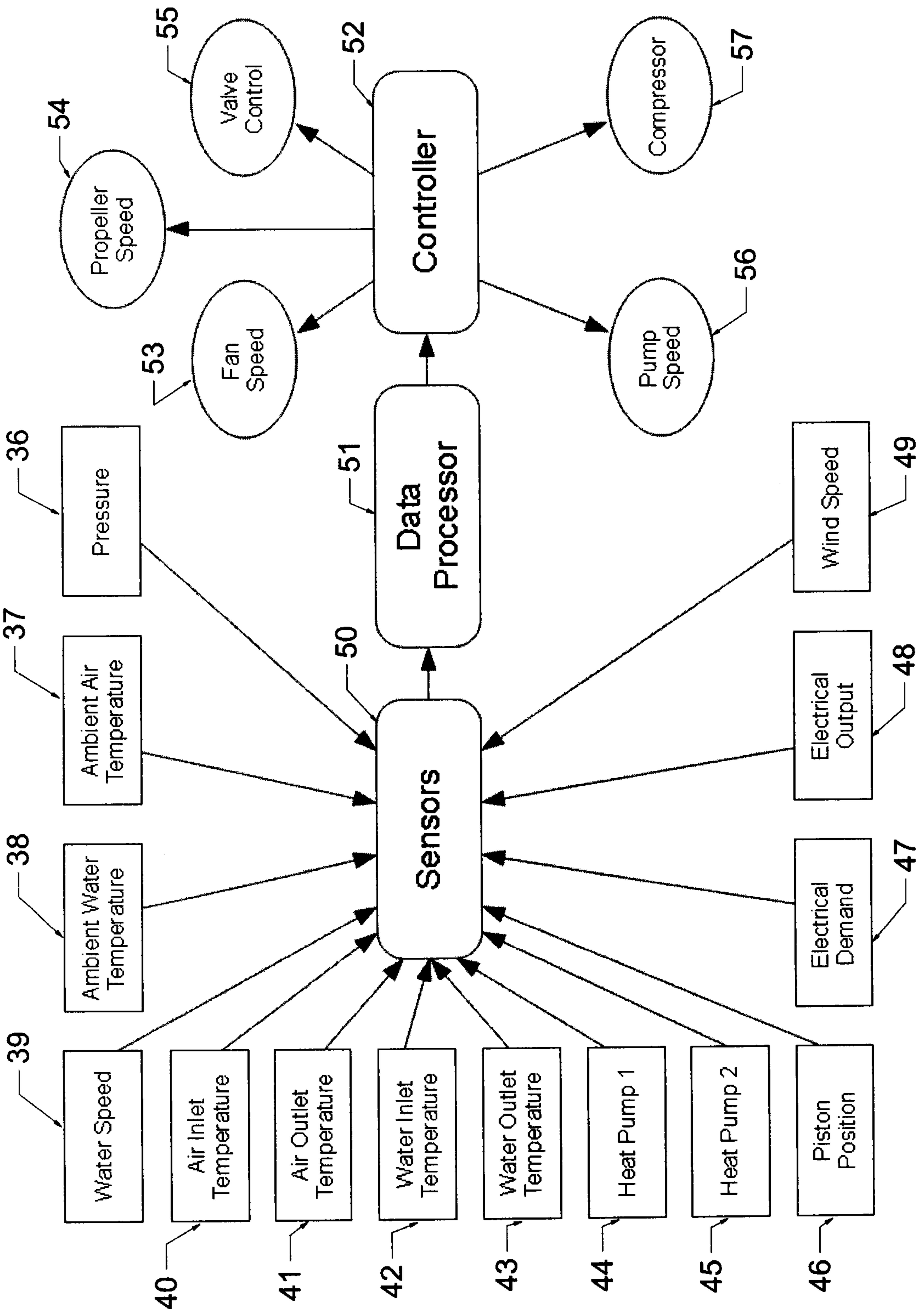
Fig 8A

Fig 8B

Fig 8C

Fig 8D

Figure 9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Data Processor
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Controller
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Fan Speed
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Propeller Speed
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Valve Control
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Pump Speed
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Compressor
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Pressure
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Ambient Air Temperature
37
Ambient Water Temperature
38
Water Speed
39
Air Inlet Temperature
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Air Outlet Temperature
41
Water Inlet Temperature
42
Water Outlet Temperature
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Heat Pump 1
44
Heat Pump 2
45
Piston Position
46
Electrical Demand
47
Electrical Output
48
Wind Speed
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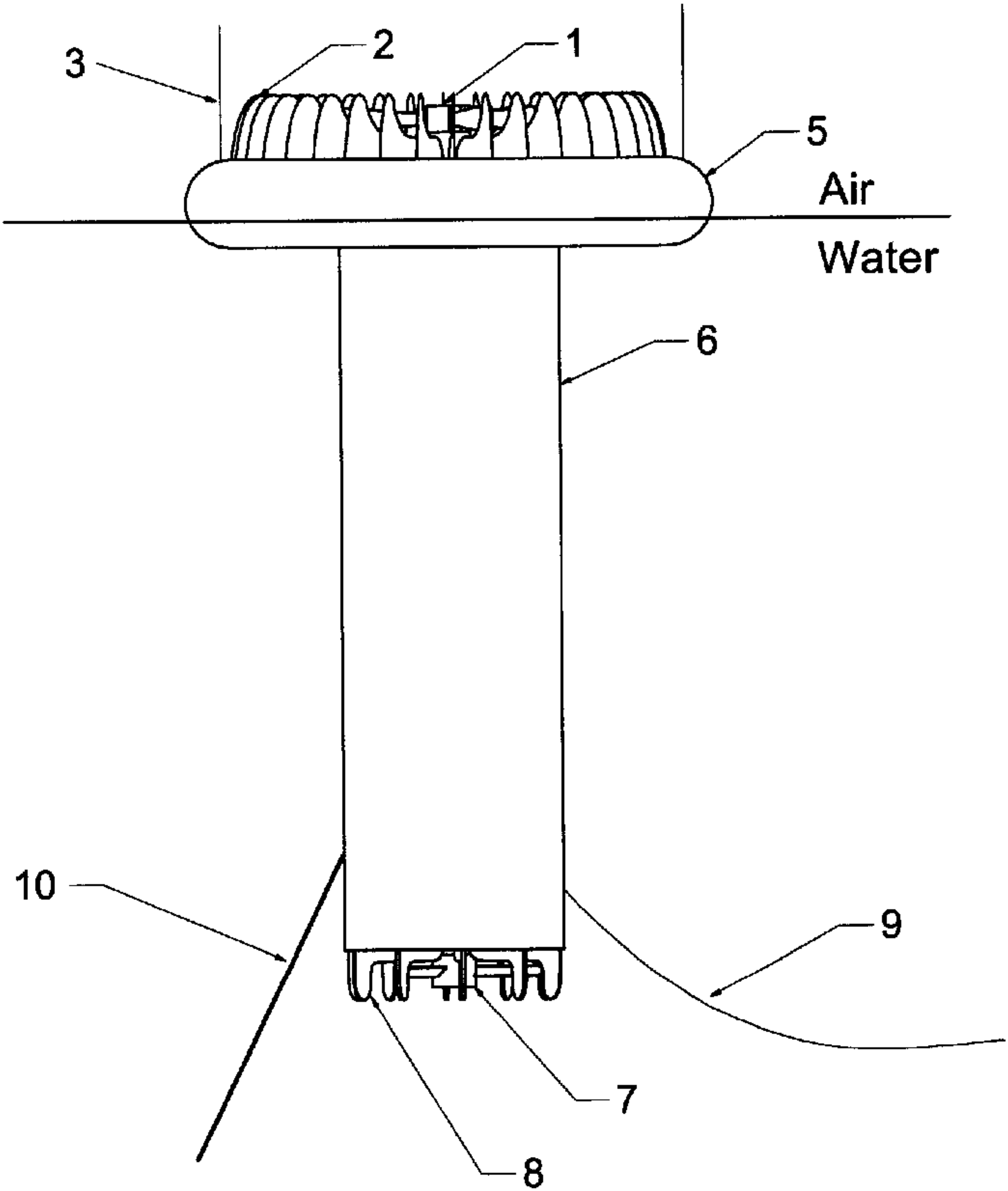
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