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(54) **APPARATUS FOR THE PRODUCTION OF ELECTRICAL ENERGY BY FLOTATION**

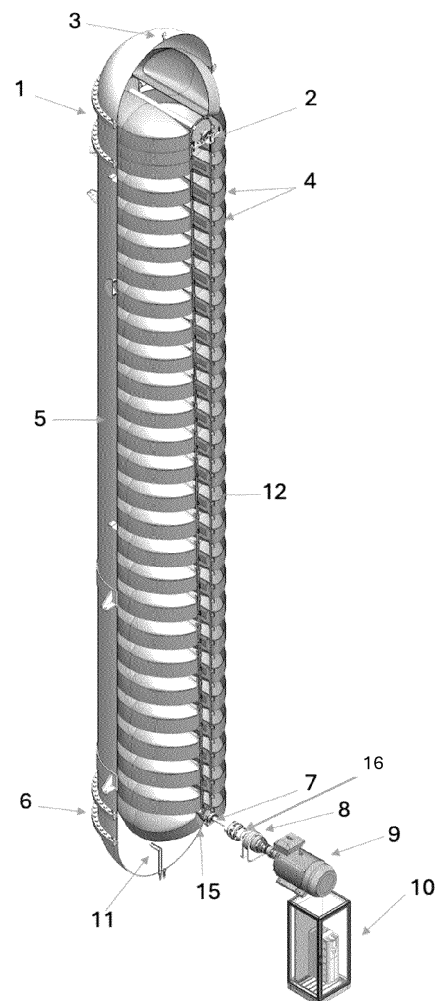
(57) The invention relates to an apparatus for the production of electrical energy comprising:

- A liquid-filled chamber (5) including a lower part (6) and an upper part (1),
- a drive mechanism comprising a lower axis (15), an upper axis (2), a driving line (12) and bowls (4) attached to the driving line (12),
- an electric generator (9) comprising a rotating axis (16),
- at least one electrical connector configured to connect the generator (9) to an electrically operable appliance,
- a driving fluid injection nozzle (11) located within the lower part (6),

wherein said generator rotating axis (16) and said lower or upper axis (15,2) merge into a single rotating axis.

The invention also relates to a method for using such an apparatus.

Figure 1



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## Description

### Field of invention

**[0001]** The present invention generally relates to the production of electricity by non-polluting methods.

### Background

**[0002]** There are several ways of generating electrical energy, among which we can find those that are produced by the transformation of mechanical energy into electrical energy by means of an electric generator or alternator.

**[0003]** In this type of energy, the origin of the source of the mechanical energy determines the classification of the energy according to the pollution produced. Electrical energy produced by the movement of the wind (wind energy), or by a circulation of water (hydraulic energy) are some of the two most common clean energies that use mechanical force to convert it into electrical energy by means of turbines.

**[0004]** The turbines used in each case are designed according to the fluid and the medium in which they move, and it is normal to use the kinetic force of a moving fluid (gas or liquid) to make the aforementioned turbines move. Going back to the previous examples, wind energy uses the kinetics of wind to move a blade turbine and hydraulic energy uses the kinetics of water to move a hydraulic turbine. These turbines will take into account flow, speed and pressure in their designs.

**[0005]** In the two examples mentioned, natural resources are used to provide the mechanical energy necessary for it to be used, but on other occasions these turbines are used to take advantage of kinetic energy from non-natural sources such as a steam plant powered by coal (thermal power plants) or radioactive material (nuclear power plants). In these cases, steam is used exclusively for energy production, but in some circumstances, steam is produced for another purpose and a power plant is installed as waste that uses this steam waste to produce energy. These are the so-called co-generation plants, which despite the fact that the primary source is not clean, the production of energy is a clean form of recovery without increasing pollution.

**[0006]** In this sense, we can find that in industry there are numerous situations in which we have a fluid at high pressure or temperature which is not necessary in its entirety to be used and that we can take advantage of to convert it into energy, which otherwise would not be used, being wasted energy.

**[0007]** It is therefore desirable and important to find as many ways as possible to convert these waste energies into usable energies using clean methods and without increasing pollution levels.

### General description of the invention

**[0008]** A first objective of the present invention is to

provide an apparatus and a method for the industrial production of electrical energy from the buoyant force of fluids injected under pressure into other non-mixable fluids of higher density.

**[0009]** A second objective of the present invention is to optimize the use of pressurized gases for the production of electrical energy without polluting emissions.

**[0010]** The inventive concept is based on the use of buoyancy force imparted by a fluid, mainly gas, in a fluid medium of higher density, mainly liquid.

**[0011]** The invention, more precisely, consists of an apparatus for the production of electrical energy comprising:

- A liquid-filled chamber including a lower part and an upper part,
- a drive mechanism comprising a lower axis, an upper axis, a driving line and bowls attached to the driving line,
- an electric generator comprising a rotating axis,
- at least one electrical connector configured to connect the generator to an electrically operable appliance,
- a driving fluid injection nozzle located within the lower part,

wherein said generator rotating axis and said lower or upper axis merge into a single rotating axis.

**[0012]** Using the same rotating axis for operating driving mechanism and the generator significantly simplifies the apparatus. It furthermore improves the yield of generator.

**[0013]** The chamber lower part contains the driving fluid injection nozzle that is connected to a fluid pipe, in such a way that bubbles can be generated within the chamber and directed upwards due to the buoyancy force acting on the bubbles; the drive mechanism is arranged to be driven by rising bubbles; and that the generator is adapted to be driven by the drive mechanism;

**[0014]** The invention also refers to a method for producing electrical energy with an apparatus as defined previously and comprising the following steps:

- injecting a driving fluid in said chamber via said injection nozzle,
- moving upward said bowls with the force generated by ascending bubbles formed by said driving fluid,
- actuating said generator with said the said single rotating axis.

**[0015]** More specific embodiments of inventions are disclosed in the dependent claims.

**[0016]** As mentioned above, the present invention is based on the observation that a lower density fluid in higher density medium moves with the same force as a higher density medium in a lower density fluid, but in the opposite direction. The difference in density between the

two non-mixable fluids causes them to move within each other until they reach a balance of density, as if they were two fluids, regardless of their state (gaseous or liquid). The same would happen with two liquids or two gases with very different densities. The difference in density is proportional to the force generated by the movement of the fluid.

**[0017]** If the injected fluid is a gas and the chamber fluid is a liquid, the difference in density is much greater. Consequently, the force imparted to the gas bubbles in the liquid is relatively important, to such an extent that the force resulting from the upward motion of the gas bubbles can activate a driving mechanism, such as a wheel-like mechanism, and thus could provide a mechanical power to an electric generator.

**[0018]** In a preferred embodiment of the invention, the gas injection unit, drive mechanism, and electric generator are in the same volume, immersed in the same liquid. In a preferred embodiment, the liquid is water.

**[0019]** Once the pressurized driving fluid has exited the injection nozzle in the form of bubbles, it expands and rises rapidly and is directed towards the upper part of the drive mechanism. This mechanism is composed of bowl-shaped paddles or similar hollow containers that can be attached to a chain, belt or wheel. The containers located just above the injection nozzle begin to rise due to the upward thrust produced by the driving fluid, as they are trapped inside, moving upwards and allowing the subsequent containers to trap more floating driving fluid, thus driving the mechanism.

**[0020]** The number of bowls attached to each chain or strap may vary depending on the height/depth of the chamber. When the first driving fluid-filled bowls reaches the top of the drive mechanism, it rotates around the top axis, turning around, thus releasing the driving fluid and letting the cavity fill with the chamber liquid as it is immersed back into it. This point marks the level of liquid required to take advantage of the maximum buoyancy force inside the device. This action continues as long as the floating driving fluid continues to flow, pushing the bowls upwards through the mechanism.

**[0021]** The driving fluid can be discharged to the outside, recovered for storage, or diverted from the top of the drive mechanism, for later use or to re-enter another device if the outgoing pressure of the gas is sufficient.

**[0022]** Each driving line preferably carries bowls fixed along its entire length, with the spacing between two adjacent bowls optimized to capture as much of the floating driving fluid as possible without blocking or interfering with the next. Its length must be determined to maintain the mechanical power necessary to generate as much of the electrical energy as possible. This energy can be used to drive other appliances or auxiliary systems, for example, to compress gases for storage or to drive an atmospheric water generator that extracts from ambient air.

**[0023]** In another realization, the electric generator is not inside the chamber. Rather, it is located on the outside

of the lower area connected to the lower axis of the drive mechanism by means of a mechanical seal that allows the chamber to be watertight. This system allows maintenance to be carried out on the electro components of the generator without the need to access the chamber, but requires the installation of a device that allows the motive force to be removed from the lower axis, withstanding sufficient pressure so that there is no loss of water and the axis is not braked.

**[0024]** In another embodiment, the driving line is a wheel of sufficient dimensions to accommodate as many bowls as necessary to generate the maximum possible electricity with the amount of driving fluid injected.

**[0025]** In another embodiment, the device is a modular system consisting of a series of interconnected modules equipped with the same type of mechanism that drives the electric generator and the drive mechanism. This modular system is advantageous because it allows for higher throughput without increasing the height/depth of the appliance, and uses a driving fluid production unit to produce the driving fluid, such as a gas, that runs through the first module and are subsequently redirected from the upper chamber to the lower chamber of the next module without being consumed in the process.

**[0026]** In another embodiment, the drive mechanism is slightly angled to reduce power losses due to driving fluid bubbles not being captured under the bowls, and the electric generator is located within the upper axis, which has an enlarged diameter to increase angular momentum as it rotates driven by the chains or belts. This configuration provides greater efficiency also by reducing friction of the mechanism.

**[0027]** In another embodiment, the chamber is not closed and the mechanism assembly is completely immersed in liquid, acting only as a structural support function between the upper and lower part. This application is useful to be used mechanism inside a lake, ocean, swimming pool, etc.

**[0028]** First, the present invention is not restricted to any specific geography or weather condition. It is operable day or night, all year round, above or even below the surface. Secondly, the entire apparatus of the present invention may be submerged in large bodies of water such as lakes or oceans. Thirdly, the driving fluid injection nozzle can be converted into a pressurized gas generation system by electrolysis by making it independent of the need for a pressurized gas source. Fourthly, the mechanism can work with any fluid, gas or liquid, as long as there is a clear difference in densities, they are not mixable and do not enter into a chemical reaction between them. Fifth, the present invention does not cause noise or visual pollution, unlike photovoltaic and wind power plants.

## **Detailed description of the invention**

**[0029]** Invention will be better understood in this chapter, with some examples and the following figures:

Figure 1 is a perspective view of the apparatus according to the invention

Figure 2 is a front and side view of the apparatus

Figure 3 is a view of the lower part with the detail of a gas nozzle

Figure 4 is a view of the upper part with the detail of the mechanism bracket

Figure 5 is the perspective view of the detail of the generator connection to the bottom axis of the mechanism.

#### Numerical references used in the figures

##### [0030]

- 1 . Upper part of the liquid chamber
- 2 . Upper axis of the drive mechanism
- 3 . Gas outlet
- 4 . Bowl
- 5 . Liquid chamber
- 6 . Lower part of the liquid chamber
- 7 . Mechanical seal
- 8 . Speed multiplier
- 9 . Generator
- 10 . Generator speed controller
- 11 . Gas injection nozzle
- 12 . Driving chain
- 13 . Chamber liquid
- 14 . Driving fluid
- 15 . Lower axis of the drivemechanism
- 16 . Generator axis

[0031] Unless otherwise defined, all technical and scientific terms used herein have the same meaning as is commonly understood by someone with ordinary skill in the art to which this invention belongs. In addition, the materials, methods, and examples are illustrative only and are not intended to be restrictive.

[0032] In the example illustrated in Figures 1 and 2, the apparatus according to the invention essentially consists of a column that is composed of a vertically oriented central chamber 5 filled with water 13, a chamber upper part 1 and a chamber lower part 6. In the lower part 6 is installed a gas injection nozzle 11 and a lower axis of the drive mechanism 15. At the upper part 1 is a gas outlet 3 and the upper axis of drive mechanism 2. Within the chamber 5 is a chain 12 and bowls 4 attached to the chain 12. The lower axis 15 extends on the outside of the chamber 5, to form a generator axis 16 that goes through a mechanical seal 7 that guarantees the watertightness of the chamber 5. The generator axis 16 furthermore is linked to a generator 9 via a multiplier 8. An electronic speed controller 10 is connected to the generator 9.

[0033] As can be seen in Figure 3, when the bowls 4 return to the chamber lower part 6, they open their opening angle, facilitating the entry of gas 14 inside and being retained by each bowl 4. The speed of the chain 12 and the inlet flow rate of the gas 14 determine how much gas

is accumulated in each bowl 4.

[0034] Figure 4 shows the chamber upper part 1 with the gas outlet 3. When the bowls 4 reach the the upper axis 2, they open, letting all the gas escape and initiating their falling displacement.

[0035] As it can be seen in the figures, the sprocket of the lower axis 15 is smaller in diameter than the sprocket of the upper axis 2. This difference causes the bowls 4 in their ascension movement to move towards the outside of the mechanism, facilitating the collection of any gas bubbles that have come out of bowls 4 located below.

[0036] Of course, invention is not limited to those examples and figures, but covers any alternative that is defined in the claims.

#### Claims

1. . Apparatus for the production of electrical energy comprising:

- A liquid-filled chamber (5) including a lower part (6) and an upper part (1),
- a drive mechanism comprising a lower axis (15), an upper axis (2), a driving line (12) and bowls (4) attached to the driving line (12),
- an electric generator (9) comprising a rotating axis (16),
- at least one electrical connector configured to connect the generator (9) to an electrically operable appliance,
- a driving fluid injection nozzle (11) located within the lower part (6),

wherein said generator rotating axis (16) and said lower or upper axis (15,2) merge into a single rotating axis.

2. . Apparatus according to claim 1 wherein said generator rotating axis (16) merges with said lower axis (15).

3. . Apparatus according to claim 1 and 2 wherein the generator (9) is located on the outside of the chamber (5) and comprising a mechanical seal (7) located around said single rotating axis and configured to prevent any water leakage from the chamber (5).

4. . Apparatus according to anyone of the previous claims comprising several driving lines and wherein each bowl (4) is attached to said lines.

5. . Apparatus according to anyone of the previous claims, wherein the generator (9) is integrated within the upper axis (2) or the lower axis (15).

6. . Apparatus according to anyone of the previous claims comprising several generators connected

to the said single rotating axis.

7. . Apparatus according to anyone of the previous claims that is configured to be operated through said nozzle (11) by any driving fluid, gas or liquid, that has a lower density than the liquid contained in said chamber (5). 5
8. . Apparatus according to anyone of the previous claims wherein said chamber is a swimming pool, a reservoir, a lake or an ocean. 10
9. . Apparatus according to anyone of the previous claims wherein the driving line (12) is inclined vertically in such a way as to increase the number of bubbles captured by the bowls. (4) 15
10. . Apparatus according to anyone of the previous claims wherein said driving line (12) is made of one or several chains. 20
11. . Apparatus according to claim 10 said lower and upper axis (15,2) comprise sprockets and wherein the sprocket diameter of the upper axis (2) is greater than the sprocket of the lower axis (15). 25
12. . Apparatus according to anyone of the previous claims 1 to 9 wherein said driving line (12) is made of one or several wheels. 30
13. . Apparatus according to anyone of the previous claims comprising a driving fluid return line that is configured to transfer the driving fluid located in the upper part (1) back to said nozzle (11). 35
14. . A plurality of interconnected apparatuses according to anyone of the previous claims that are operated by a single driving fluid line flowing through said nozzles (11) and driving fluid outlets. 40
15. . Method for producing electrical energy with an apparatus as defined in anyone of the previous claims comprising the following steps:
  - injecting a driving fluid in said chamber (5) via said nozzle (11), 45
  - moving upward said bowls (4) with the force generated by ascending bubbles formed by said driving fluid,
  - actuating said generator (9) with said the said single rotating axis. 50
16. . Method according to claim 14 comprising an additionally step consisting in re-using the driving fluid that is located in the upper part (1). 55

Figure 1

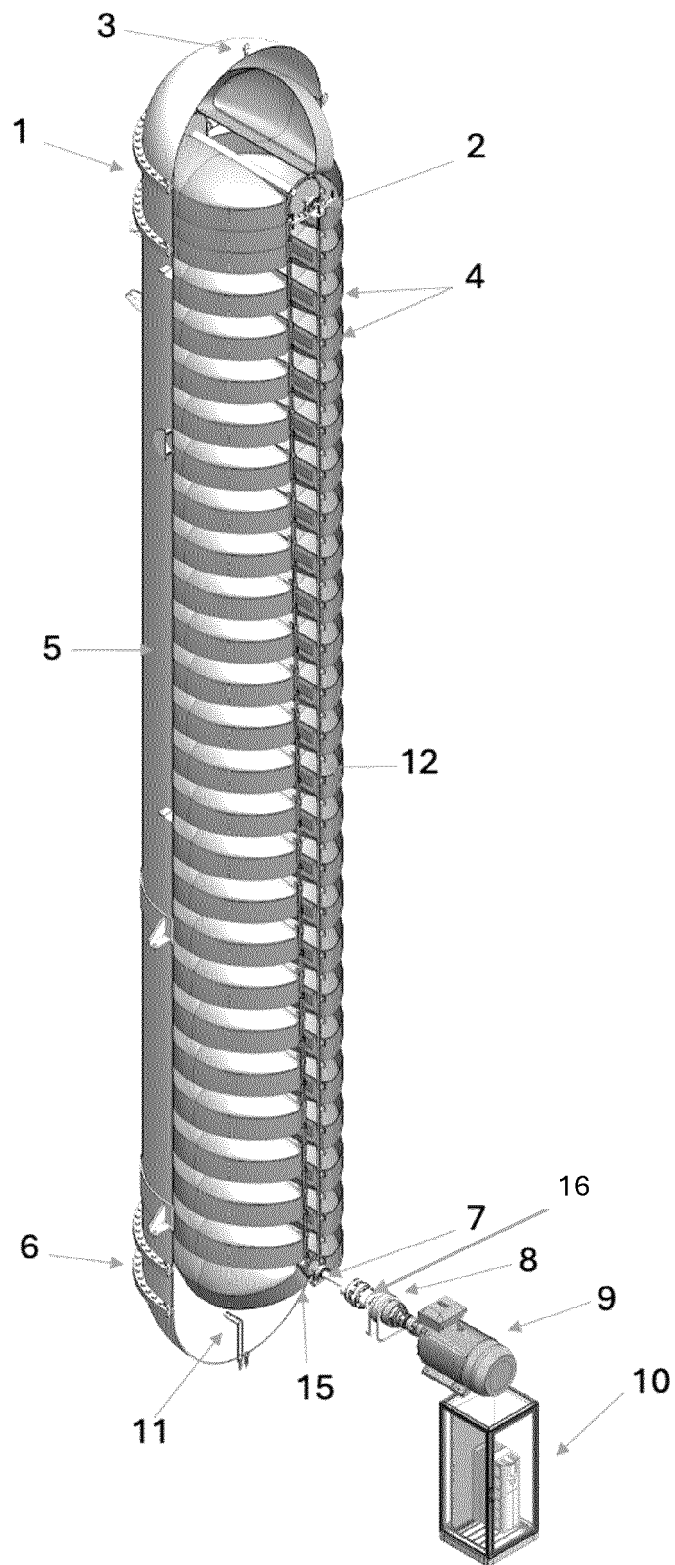


Figure 2

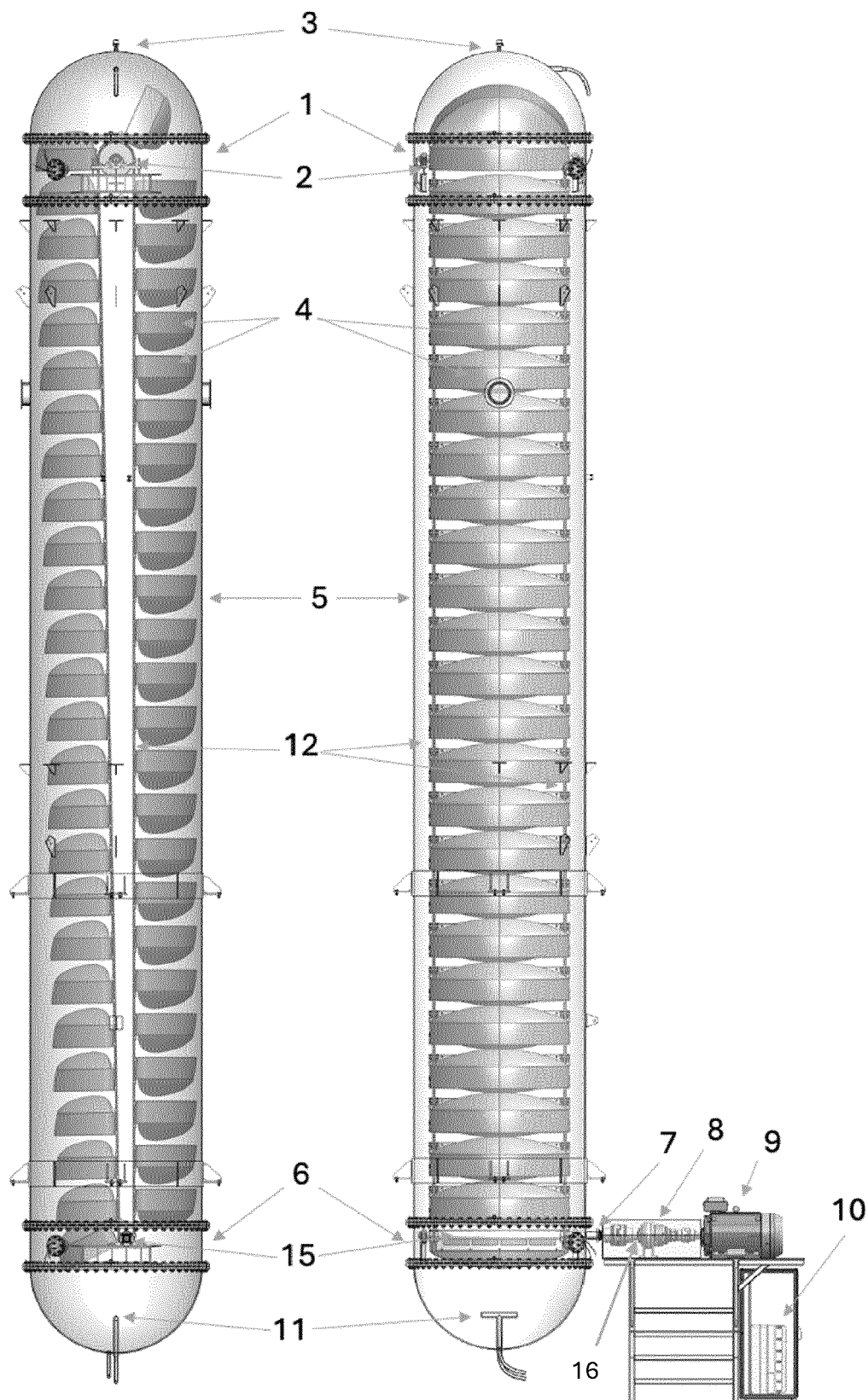


Figure 3

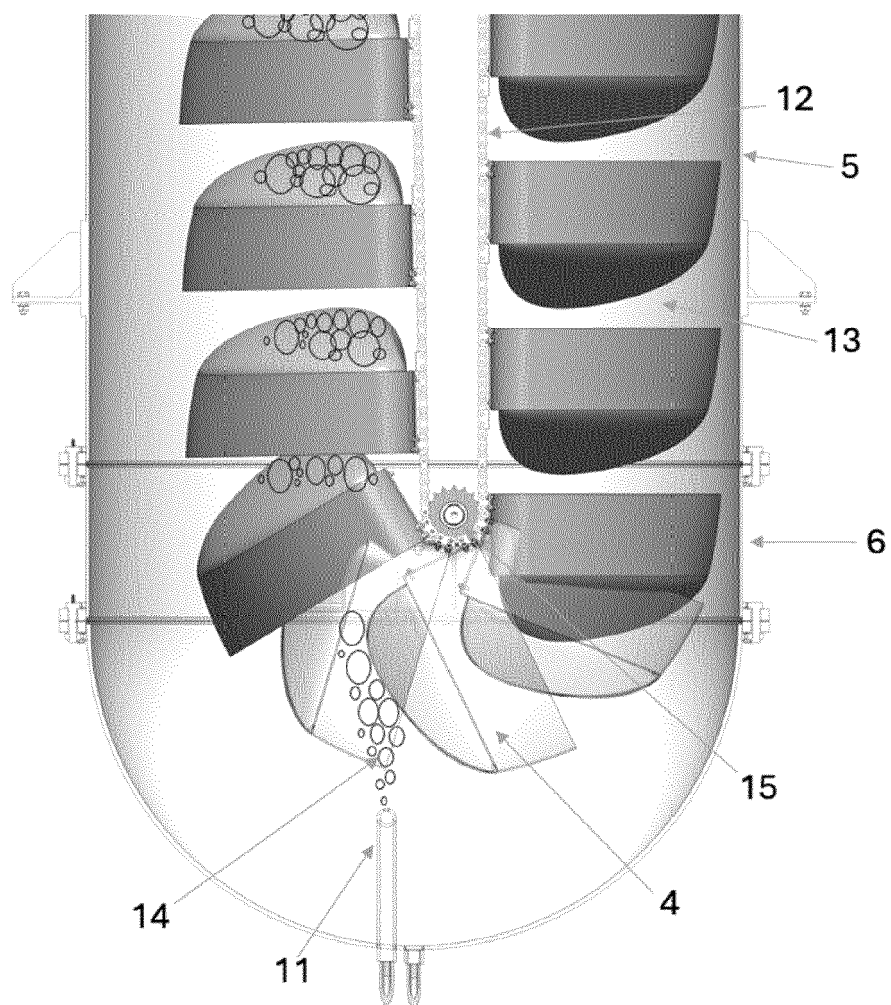


Figure 4

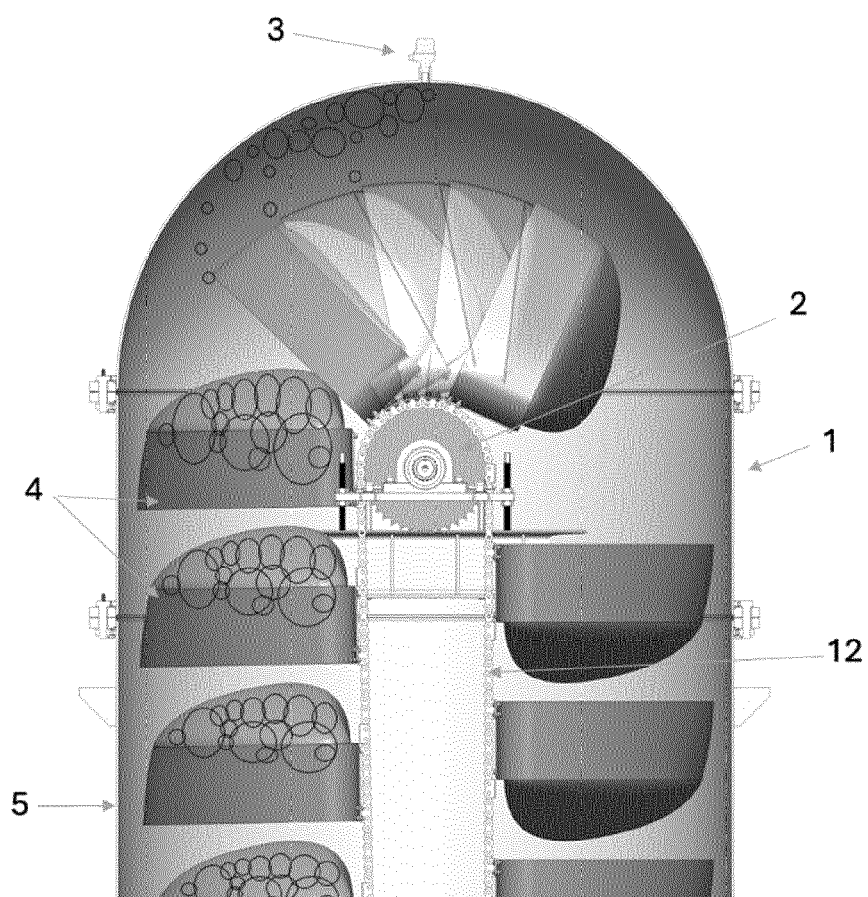
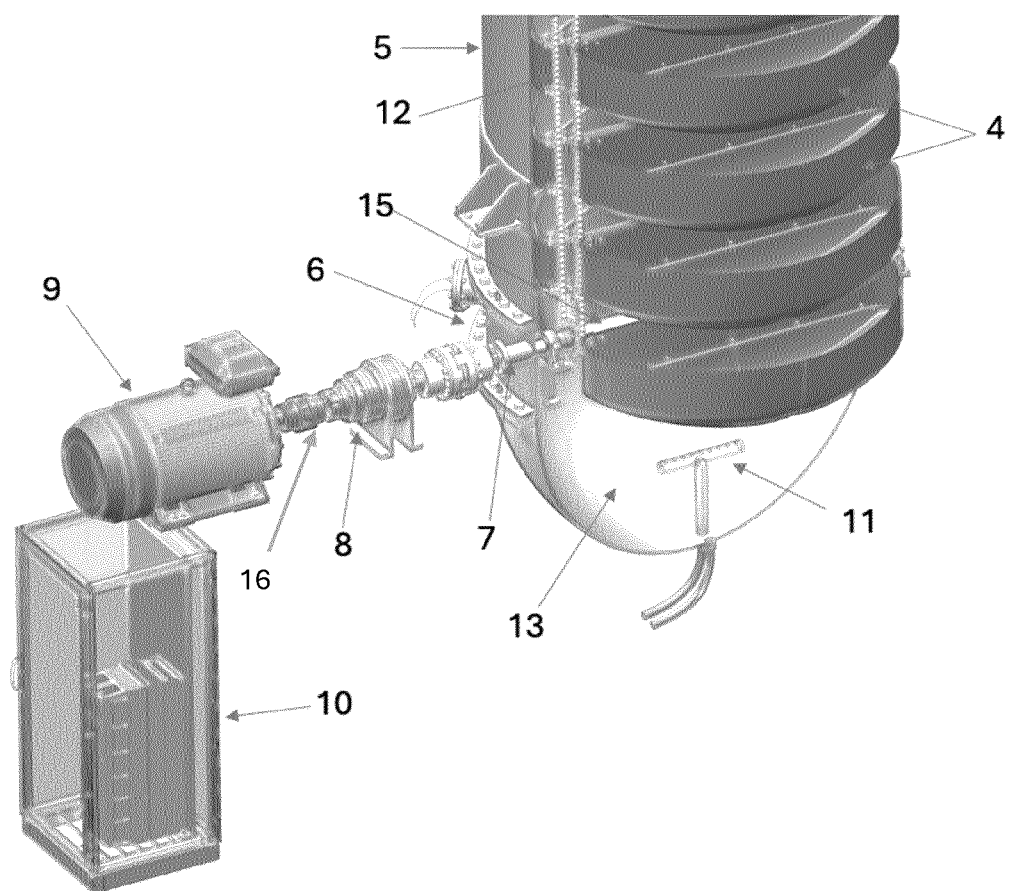


Figure 5





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