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Titre: Plant and process for desalting marine water by reverse osmosis, by means of hydrostatic pressure.

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Abrégé:

The invention relates to a plant for desalting marine water by reverse osmosis. The desalting plant comprises a salted water tapping point (1), slated water transporting means (2), salted water column forming means (3), reverse osmosis desalting means (4) which are situated in the area of the lower end (3b) of the salted water column (3) and which may be situated above or under the sea surface, the salted water transporting means (5) and brine conveying means (6). The means (3) which form the salted water column have a height such that its weight exerts a pressure which contributes substantially to generate the reverse osmosis phenomenon, so that the salted water is separated into desalted water and brine. The plant includes at least one salted water head tank (7) located at a predetermined height at the upper zone (3) of the water column (3), said head tank (7) being in fluid communication with said water column. The invention also relates to the corresponding process.

TITLE OF THE INVENTION

PLANT TO DESALINATE SEA WATER BY REVERSE OSMOSIS. BY
NATURAL PRESSURE AND METHOD TO DESALINATE SEA WATER BY
REVERSE OSMOSIS, BY NATURAL PRESSURE

TECHNICAL FIELD OF THE INVENTION

5 The present invention fits in the technical field of waste water potabilization and sea water desalinization. More specifically, the invention provides a desalinization system that allows the obtainment of fresh or purified
10 water with an installation of reduced construction cost that allows purified or desalinated water to be obtained at a low energy cost and without complicated maintenance operations.

BACKGROUND OF THE INVENTION

15 The desalinization of salt water and the purification of waste water is conventionally done by two general systems, in other words, the evaporation of water and collection with recondensation of steam and filtration of water, through filters or, in the case of reverse osmosis
20 desalinization, through semipermeable membranes.

Desalinization by osmosis is used in sea water potabilization equipment in ships and in different coastal areas, in desalinization plants used to provide the population and/or agriculture with fresh water.

25 Reverse osmosis desalinization implies that the salt water must be forced through filters or membranes applying a great pressure (approximately 70 atmospheres) whose creation requires a high energy consumption, aside from expensive and relatively complex equipment. This especially
30 affects large desalinization plants that supply large amounts of fresh water in coastal areas whose construction requires very high investments and whose maintenance is complex and costly, which results in, along with the above mentioned high energy consumption, the high price of the
35 desalinated water.

In order to overcome the high energy cost, Spanish patent ES-A-488,215 describes a water desalinization plant by a reverse osmosis hydrostatic system which by means of some wells drilled in the subsoil, establishes a water column whose weight exerts a pressure on the osmotic modules so that the phenomenon of reverse osmosis is produced, thus replacing the impeller pumps of traditional plants. However, this plant though it reduced the energy cost of the cubic meter of desalinated water regarding the energy cost of traditional desalinization plants, it still required high energy costs.

OBJECT OF THE INVENTION

The present invention is used to overcome the above cited inconveniences of conventional desalinization plants as well as to reduce even more the energy cost of the cubic meter of desalinated water and the plant construction costs. Besides, another object of the invention is to provide the possibility that the desalinization installations have a substantial flexibility with regard to operation, location, maintenance and repairs.

DETAILED DESCRIPTION OF THE INVENTION

As indicated in its title and as defined in the claims, the present invention refers to a reverse osmosis desalinization plant which in order to create the necessary pressure in the reverse osmosis modules takes advantage of the pressure that the weight of an established salt water column exerts on said modules. The desalinization plant is located on land. The reverse osmosis modules can be placed at sea level itself or at a lower level with regard to sea level, depending on the possible topographic location of the plant that determines the necessary height of the salt water column in order to obtain the required pressure in the modules.

A main characteristic of the desalinization plant is that it has an elevated head tank for the accumulation of

salt water. Said tank allows the accumulation of a certain amount of salt water, that is pumped during those hours in which the electric rates are cheaper, in such a way that the plant operates the rest of the day without needing to consume electric energy and the energy consumed for pumping turns out to be cheaper. Besides, it makes it possible to ensure a constant stable pressure on the osmotic modules upon not depending on the constant operation of a series of pumps, such as in the case of traditional plants.

On the other hand, elevating the head tank allows the brine resulting from the reverse osmosis process to rise to a certain height by natural pressure without the need of any pumping. This produces, on the one hand, the advantage that it is not necessary to include pumps exposed to the great corrosive aggressivity of the brine and, on the other hand, that said head tank, upon comprising a water reserve, allows the carrying out of maintenance and repair operations, without having to stop the operation of the desalinization plant.

In a preferred embodiment of the desalinization plant of the present invention, the possible orographic characteristics of the land close to the sea due to the location and construction thereof can be taken advantage of. In other words, one can take advantage of the height of a mountain close to the sea high enough to place water columns that exert enough hydrostatic pressure on the osmotic modules for desalinization in a plant located above sea level. In this case, the plant is built either substantially inside the mountain with its pipelines located in wells or vertical shafts, or else, it could be built outside the mountain placing the different pipelines along the profile of the mountain, therefore, remaining inclined and not vertical. In this way the need to drill very deep wells in the subsoil is avoided as well as to build underground galleries at said depth that turn out to

be expensive and costly to maintain.

Likewise if the height of the mountain does not suffice to establish the entire water column above the sea surface, wells can be drilled in the subsoil to house the pipelines, therefore, part of the water column remains above the sea surface and part remains below it. The water column can also be established above the sea surface placing the osmotic modules at this same level and complementing the difference of height by means of an impelling pump at the inlet of the osmotic modules.

According to another advantageous embodiment of the present invention there are means to generate electric energy that take advantage of the residual energy of the brine, since the brine comes out of the reverse osmosis modules with a high pressure although lower than when entering. The electric energy generating means can be comprised of a turbine coupled to a generator. Said turbine is moved by the brine that comes out directly from the reverse osmosis modules or else by the brine that has been previously accumulated in a high tank. The brine rises up to said tank thanks to the residual pressure that it has when coming out of the modules.

In this way the electric energy consumption in pumping can be combined with the electric energy production in such a way that the resulting cost is minimal, either because the electric energy produced is returned to the commercial network in those hours when the rate is the highest, or else because said generated electric energy is used for the supply itself of the plant.

Thus, the desalinization plant of the present invention in accordance with the above mentioned preferred embodiment is basically located in a mountain close to the sea at a sufficient height of about 750 meters, and the reverse osmosis modules are placed at the same level as sea level, building the plant outside or inside the mountain.

In this case, the plant basically has the following elements:

- a salt water inlet provided with the pumps needed to pump the water to the high head tank;
- 5 - the conduits or pipelines needed to transport the salt water, the desalinated water and the brine;
- an elevated head tank to store salt water and that has a specific accumulation capacity;
- preferably, a high tank to accumulate brine;
- 10 - reverse osmosis modules with semipermeable membranes located at a level equal to sea level;
- preferably, electric energy generating means comprised of a turbine coupled to a generator;
- preferably sea water pretreatment means at the
- 15 outlet of the high head tank;
- the galleries and tunnels needed for access and maintenance of the installations as well as all the necessary auxiliary equipment.

20 The level at which the high head tank is located for accumulation of salt water is that in which the height of the water column that is established under said tank is such that the pressure exerted by said column turns out to be sufficient to produce the phenomenon of reverse osmosis in the modules.

25 Likewise, the level at which the high tank is located to accumulate brine is the same as the maximum height that the brine is capable of reaching by natural pressure without the need of pumping.

30 In this way, the operation of the plant and the process to desalinate salt water is the following:

- The salt water from the sea is collected by the salt water inlet and is pumped to the head tank. This pumping is preferably produced during the hours when the electric rate is reduced.
- 35 - At the same time, the salt water is constantly

coming out of the elevated head tank, being pretreated and passing to the ducts or pipelines that establish the water column over the reverse osmosis modules.

- As the phenomenon of reverse osmosis is produced in said modules typically 45% of the flow of crude water in desalinated water and 55% of the flow of crude water in brine are obtained.

- Said brine rises, by virtue of the residual pressure that it has when coming out of the modules, up to the high brine tank (in the case that there is one), where it can be accumulated.

- Subsequently and according to the needs of the plant or the possibilities of returning energy to the commercial system, said brine can be allowed to drop from said tank for the purpose of moving the turbine and producing electric energy that can be used to meet the needs of the plant itself or be returned to the network. Subsequently, the brine is poured into the sea.

- The desalinated water is either sent directly to the commercial water distribution system or else it can be accumulated in a tank.

When the ground close to the sea is not high enough, the water column can be partially (or entirely) made in perforations in the ground, in other words, under the level of sea level. Besides, as a complement (in the event that the column itself cannot exert enough pressure so that the phenomenon of reverse osmosis is produced) the pressure on the reverse osmosis modules can be increased by pumps, that increase the pressure that the salt water column exerts.

The result of the described process is that the total energy cost of the cubic meter of desalinated water is substantially reduced, either by the self-generation of electric energy or by the compensation of the different electric rates corresponding to consumption and to the production and return of this energy to the commercial

network.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 is a schematic view of a first preferred embodiment of the invention.

5 Figure 2 is a schematic view of a second preferred embodiment of the invention.

Figure 3 is a schematic view of a third preferred embodiment of the invention.

10 Figure 4 is a schematic view of a fourth preferred embodiment of the invention.

Figure 5 is a section of a possible embodiment of the main pipelines that houses the ducts or channels to transport the salt water, pretreated salt water and brine.

Figure 6 is a fifth embodiment of the invention.

15 Figure 7 is a sixth embodiment.

Figure 8 is an embodiment of the underground part of an embodiment according to figures 5 and 7.

EMBODIMENTS OF THE INVENTION

20 Hereinafter and referring to the figures, a description is made of four preferred embodiments of the invention.

Just as one can see in figure 1, the desalinization plant according to a first embodiment has the reverse osmosis modules (4) with their corresponding semipermeable membranes (14), located at the same level as sea level. 25 The plant can be built taking advantage of the suitable characteristics as to the height of a geographical feature close to the sea, such as a mountain, in such a way that the salt water column (3) that is established over the reverse osmosis modules (4), remains above sea level and 30 the reverse osmosis modules with a height such that their weight exerts enough pressure on the modules so as to produce the phenomenon of reverse osmosis.

35 The desalinization plant has a salt water inlet (1) and some pumping means (8) to pump salt water from said

inlet (1) to a high head tank (7) through some salt water ducting means (2). From said head tank (7), the salt water is passed through some pretreatment means (8) that condition the salt water. Then, the salt water column (3) is established over the reverse osmosis modules (4) that are located close to the bottom end (3b) of the salt water column (3). The height of the salt water column (3) measured from the pretreatment means (9) to the reverse osmosis modules (4) corresponds in figure 1 to the sum of levels B and C. The pressure exerted by the weight of this water column is enough so as to produce the phenomenon of reverse osmosis, by means of which one part, typically 55%, of the salt water introduced in the well is converted into brine that is loaded with all the salts present in the salt water and it comes out of the reverse osmosis modules (4) at a high pressure. The remaining 45% corresponds to desalinated water that comes out of the reverse osmosis modules (4) at a lower pressure.

The brine is led through the brine ducting means (6) up to the brine tank (11) or directly to the electric energy generating means (10). Since the brine has a high pressure when coming out of the modules (4), it is capable of rising by natural pressure and without the need of pumping to the brine tank (11), that is found at level C. The brine stored in said brine tank (11) can be used later to generate electric energy by means of electric energy generating means (10). Likewise, the brine can be directly passed from the outlet of said osmosis modules to the electric energy generating means (10). The brine is then returned to the sea.

The desalinated water is led through the ducting means (5) to a tank (not shown) or directly to the commercial water system.

Nowadays, the pressure that the reverse osmosis modules require is about 70 kg/cm. To achieve this

pressure the height B+C of the water column (3) has to be about 700 m. Therefore, the pretreatment means (9) would be located at a height of 700 m. The elevated head tank (7) would remain located with regard to the pretreatment means (9) and the top end (3a) of the salt water column (3) at a height A of 40 m., the total height thereof being (A+B+C) with regard to the reverse osmosis modules equal to 740 m. With this arrangement of heights, the brine has when coming out of the reverse osmosis modules, a pressure of about 69 kg/cm², which implies that the brine can rise without the need of pumping to a height C of 640 m., where the brine tank (11) is located.

The desalinization plant can be built in such a way that the accumulation capacity of the head tank is equivalent to 2/3 of the total salt water treated daily. The brine tank would have an accumulation capacity in accordance with the needs of the generation of electric energy. In this preferred embodiment the capacity could correspond to 5/6 of the total brine generated daily. Therefore, the operation of the plant in accordance with this first preferred embodiment could be the following: the salt water is pumped to the head tank when the electric rates are reduced. The brine is accumulated in its corresponding tank using it later on to move the electric energy generating means, returning the energy generated to the commercial network or else using it to feed the pumps and auxiliary equipment of the plant. Likewise, the brine can be used directly when it comes out of the reverse osmosis modules (4) to move the electric energy generating means without previously accumulating it in the tank.

Figure 2 illustrates a second preferred embodiment of the desalinization plant basically identical to the first embodiment, in which the reverse osmosis modules (4) are located under the level of sea level. Therefore, part of the salt water column (3) will be under sea level and part

of it will be above sea level. This embodiment is suitable when the characteristics of the geographic feature do not suffice to reach the necessary height above sea level.

As the reverse osmosis modules (4) are below sea level, it is necessary to raise the desalinated water to the surface, which is achieved by pumping means (12). In order to feed these pumping means (12) the electric energy generated by the generating means (10) can be used.

Figure 3 illustrates a third preferred embodiment of the invention. In this embodiment the reverse osmosis modules (4), just like the embodiment of figure 1, are located at the same level as sea level, but the height of the salt water column (3) is lower than that level whose weight exerts enough pressure so that the phenomenon of reverse osmosis is produced. To achieve the total necessary pressure in the modules, pumping means (13) that provide the difference of pressure between that which the water column produces and the required pressure, are included.

In this embodiment, there is no brine tank (11), causing the brine to pass directly from the outlet of the modules (4) to the electric energy generating means (10), which in turn feed the pumping means (13).

In figure 4 one can see a fourth preferred embodiment essentially identical to the embodiment shown in figure 2 and that is different as it includes an underground tank (15) for desalinated water. Said tank is located at height D that is elevated with regard to the reverse osmosis modules (4). Said height D is such that the desalinated water can reach said tank without having to be pumped thanks to the pressure that it has when coming out of the modules. For an input pressure of 70 kg/cm^2 in the modules, the pressure of the desalinated water tends to be from 1 to 1 kg/cm^2 , which implies that height D at which the tank (15) is located is about 10 to 20 m.

The desalinated water can be accumulated during a specific period of time in order to pump it to the surface later on.

The plant of the embodiment of figure 1 as well as the plant of the embodiment of figure 3 can be built outside or inside the geographic feature. In the event that it is built inside, the plant would include a series of tunnels or galleries. The salt water ducting means (2), the brine ducting means (6) and the means to establish the water column (3) could be built, as one can see in figure 5, with a plurality of essentially vertical pipelines (16) placed in the inside periphery of a main essentially vertical pipeline (17) with a diameter larger than the previous ones.

Likewise, if the construction is outside, the different pipelines and the ducting means can be placed inclined following the profile of the geographic feature where the plant is located.

Figure 6 shows a fifth embodiment of the present invention. According to this embodiment, the desalinization plant likewise comprises some first wells (104) that receive salt water from the sea. In the base of these first wells (104) there are batteries of semipermeable membranes of the type adequate to carry out the phenomenon of reverse osmosis. While the wells (104) are full of salt water, the phenomenon of reverse osmosis is produced by means of which one part, typically 55%, of the salt water introduced in the well is converted into liquid wastes ("backwater" or brine) that is loaded with all the salts present in the salt water and it comes out of the membranes system (105) at a high pressure, for example about 68 Atm. in the event that the water column over the membranes (105) has a height of about 702 meters (being based on a sea water density of 1.03 gr/cm^3 , creating a pressure of 70 Atm. in the base of the wells (104) where the membranes

(105) are located.

The remaining 45% of the flow of salt water introduced in the wells is converted into totally salt-free drinking water with a residual pressure that is relatively low at the outlet, of 1 to 2 Atm. having a water column of about 702 meters over the membranes (105).

This means that exactly at the same rate as the salt water from the sea and once subjected to the same pretreatment systems (116) as in a conventional plant, the water is introduced into the first wells (104), almost half of the water is converted into fresh water, while the brine rises, taking into account the density thereof (some 1.06 gr/cm³ in the event that the salt water introduced in the vertical wells (104) is normal sea water), by a second battery of wells (109) built next to the first wells (104) that receive the salt water, at some 646 m. (as the intake first wells (104) have a depth of 702 m) over the output level of the membranes (105).

For the purpose of avoiding the pumping of the brine from the static level that it reaches inside the second wells (109) up to the surface and therefore the energy cost that this pumping would involve, as well as the cost itself of some very expensive and delicate pumps as brine has to be pumped, in the preferred embodiment shown in figure 6, the device is designed in such a way that the brine reaches the drain through the mouth of the second wells (109) of the second battery by natural pressure. In order to achieve this effect, it is necessary to increase the load in the mouth of the first salt water injection wells (104), and once the density of sea water is considered, by 63 m. For this purpose, the desalinization plant has been provided with a head tank (117) that once the different densities of the fluids that we are dealing with as well as the load losses produced in the system are considered, it would be placed some 70 m. above the level of the mouth of

the wells, for the purpose of attaining a constant pressure in the membranes (105), which is fundamental for the good operation and duration thereof, at the same time that it achieves that the brine reaches the surface without any type of pumping. Logically, upon using the head tank (117) placed at a certain height with regard to the surface, the depth of the first wells (104) that receive the crude salt water can be reduced in correspondence with said height.

The sea salt water, once subjected to the pertinent pretreatment in a pretreatment system (116), is pumped by pumps (118) to the head tank (117).

The fresh water that, typically, in the case described could correspond to 45% of the total crude water, comes through the membranes at a residual pressure of 1 to 2 Atm., which represents between 10 and 20 m. of height over the output level of the membrane system. From this depth, the water is pumped, through a third well system (107) to a surface tank (110), that remains ready for the distribution thereof.

According to a sixth embodiment of the invention, shown in figures 5, 7 and 8, the first wells (104), second wells (109) and/or third (107) wells for salt water, brine and desalinated water, respectively, can be housed inside a main well (19) with a larger diameter. The first wells (104), second wells (109) and third (107) wells can, in this case, be comprised by pipelines located in said main well (19) and/or by inside vertical walls of the first well (19), by means of which ducts corresponding to said first wells (104) second wells (109) and third (107) wells are formed.

In figure 7 one can see, schematically, the desalinization plant according to a sixth embodiment. This corresponds essentially to the embodiment illustrated in figure 6, but it includes the main well in which the first wells (104), second wells (109) and third (107) wells are

located. This way of making the structure of the wells can facilitate the practical implementation of the wells, with the subsequent reduction of the costs involved. In figure 7, one can also see an underground desalinated water tank (115).

In figure 8 one can see a perspective view of an embodiment of an underground part of the present invention according to the embodiment shown in figure 7. A larger well (119) comprises a first well (104) and a second well (109), separated by a vertical wall that divides the inside of said larger well (19) into two. The first well (104) and second (109) well are communicated by their bottom part with a desalinization chamber (112), inside of which the semipermeable filters or membranes (105) are housed. The semipermeable filters or membranes (105) are, according to this embodiment, placed between a first essentially horizontal duct (123) that communicates with the first well (104) and an essentially horizontal duct (124) that communicates with the second well (109). The desalinization chamber (122) has a desalinated water outlet that communicates by means of a duct (125) with a fourth well (126) and, through this, with a desalinated pumping chamber (121) that communicates with a series of underground desalinated water tanks (115). The desalinated water pumping chamber (121) may be located at a certain height (for example, 15 meters) above the desalinated water output level of the filters or membranes (5), given that the water comes out of them under a certain pressure and, therefore, it can rise up to the desalinated water pumping chamber (121) without the need of pumping. From the underground desalinated water tanks (115) and the pumping chamber (121), the desalinated water is pumped to the surface through ducts or second wells (107), housed inside the fourth well (126). The fourth well (126) can also house a lift (112).

The energy production cost of a cubic meter of surface drinking water ready for subsequent distribution can be calculated for example for a plant according to the second preferred embodiment described above and with a production of 200,000 m³/day. This calculation is based on the commercial equipment existing nowadays.

With the suitable dimensions of the underground fresh water tank (115) and of the head tank (117), enough water can be stored in these tanks so as to pump the salt water up to the head tank (117) and the pumping the fresh water to the surface can be done mainly at night, which implies the possibility of using night electricity rates. The plant production during the day can therefore be done essentially without any pumping given that the liquid wastes go up to the surface through the second wells (109) with the need of any pumping.

Basically, one can calculate an energy cost of 0.7 Kw.h corresponding to the consumption of the pumps that in the first operating stage take the water from the sea and by means of a filtering system free it of impurities. This consumption is the maximum, that nowadays and for the worst filtering conditions corresponds to a classic plant. In addition, a consumption of 0.50 Kw.h to lift all the crude salt water to the head tank is calculated.

Finally, one can calculate a consumption of 2.01 Kw.h to raise desalinated drinking water from a depth of 640 m. to the distribution tank.

The total consumption therefore corresponds to 3.21 Kw.h.

Presently, in a conventional desalinization plant and due to the need to pump 100 % of the crude water through the membrane system at a pressure of 70 Atm., a minimum is consumed, for the same filtering conditions and considering the maximum recovery of energy that can be obtained in the turbine pumps that are conventionally used, the

corresponding total consumption amounts to 4.6 Kw.h.

As one can see, the energy savings that is achieved by the present invention is substantial.

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5 CLAIMS

1. Desalinization plant, that comprises
 - at least one salt water inlet (1, 101);
 - means to lead the salt water coming from said salt water inlet (2);
 - 10 - means to establish a salt water column (3, 104);
 - reverse osmosis desalinization means (4, 105) located in the area of the bottom end (3b) of said water column (3, 104), said reverse osmosis desalinization means (4, 105) being located at a level below sea level;
 - 15 - means to lead desalinated water (5, 107) coming from said reverse osmosis desalinization means (4, 105);
 - means to lead brine (6, 109) coming from said reverse osmosis desalinization means (4, 105); wherein
 - 20 - said means to establish a salt water column (3, 104) have a height so that the weight of said salt water column exerts a pressure that substantially contributes to the production of the phenomenon of reverse osmosis in the reverse osmosis desalinization means (4, 105), so that the
 - 25 salt water is separated into desalinated water and brine; characterized in that
 - it includes at least one salt water head tank (7, 117) located at a certain height above sea level, said head tank (7, 117) being in fluid communication with said water column, said head tank (7, 117) being located at a
 - 30 sufficient height so that the brine reaches the surface without the need of pumping said brine.
2. Desalinization plant according to claim 1
- 35 characterized in that there are pumping means (8, 118) to pump salt water from said salt water inlet to said head

tank (7, 117).

3. Desalinization plant according to claim 2 characterized in that the head tank (7, 117) has a salt water accumulation capacity that suffices so as to supply the desalinization plant with salt water during a substantial amount of time without having to receive water from the pumping means (8, 118).

4. Desalinization plant according to claim 3, characterized in that said accumulation capacity corresponds to $2/3$ of the total salt water treated daily.

5. Desalinization plant according to any of the above claims, characterized in that it includes water pretreatment means (9, 116) for pretreatment of salt water coming out of the head tank (7, 117) said pretreatment means being located at an intermediate height between the salt water head tank (7, 117) and the top area (3a) of the salt water column (3, 104).

6. Desalinization plant according to claim 5, characterized in that the water pretreatment means (9, 116) are located approximately 40 meters under the head tank (7, 117).

7. Desalinization plant according to any of the above claims, characterized in that the salt water column (3, 104) has a height of approximately 700 meters.

8. Desalinization plant according to any of the above claims, characterized in that that head tank is located approximately 740 meters above the reverse osmosis desalinization means.

9. Desalinization plant according to any of the above claims, characterized in that it includes means to generate electric energy (10) by means of taking advantage of the residual energy of the brine.

10. Desalinization plant according to claim 9 characterized in that said electric energy generating means (10) consist of at least one turbine coupled to a generator

that is operated by the brine coming from the reverse osmosis desalinization means.

11. Desalinization plant according to any of the claims 9-10, characterized in that it includes a brine tank (11) to store brine located at a level higher than the level of the reverse osmosis desalinization means (4, 105).

12. Desalinization plant according to claim 11, characterized in that the brine ducting means (6, 109) lead said brine from the outlet of the reverse osmosis desalinization means (4, 105) to the brine tank (11).

13. Desalinization plant according to claim 11, characterized in that the brine ducting means (6, 109) lead said brine from the outlet of said reverse osmosis desalinization means (4, 105) to the turbine.

14. Desalinization plant according to claim 12, characterized in that the level at which the brine tank (11) is located is such that the brine reaches said tank without the need of pumping.

15. Desalinization plant according to any of the claims 11-14, characterized in that the accumulation capacity of said brine tank (11) corresponds to 5/6 of the total brine generated daily.

16. Desalinization plant according to any of the claims 11-15, characterized in that reverse osmosis desalinization means (4, 105) are located at an intermediate level between the level of the sea surface and a level of 640 m. under the sea surface.

17. Desalinization plant according to any of the previous claims, characterized in that the height of the salt water column (3, 104) is such that the weight of said water column exerts enough pressure so as to produce the phenomenon of reverse osmosis in the reverse osmosis desalinization means (4, 105.)

18. Desalinization plant according to claim 16, characterized in that the brine coming from the brine tank

(11) operates the turbine of the electric energy generating means (10) for a certain amount of time.

19. Desalinization plant according to claim 17, characterized in that it includes pumping means (12) to
5 pump the desalinated water coming from the reverse osmosis desalinization means (4, 105) to the surface.

20. Desalinization plant according to claims 18 or 19, characterized in that the energy needed to pump the desalinated water to the surface is obtained at least
10 partially from the electric energy generating means (10).

21. Desalinization plant according to claim 9 or 10, characterized in that the height of the salt water column (3, 104) is lower than the height needed so that the weight of said water column exerts enough pressure so as to
15 produce the phenomenon of reverse osmosis in the reverse osmosis desalinization means (4).

22. Desalination plant according to claim 21, characterized in that the pressure needed to produce the phenomenon of reverse osmosis in the reverse osmosis
20 desalinization means (4, 105) is achieved by complementing the pressure exerted by the salt water column (3, 104) with the pressure exerted by at least one pump (13.)

23. Desalinization plant according to claim 22, characterized in that the energy needed to operate said
25 pump (13) comes from the electric energy generating means (10).

24. Desalinization plant according to any of the above claims, characterized in that the reverse osmosis desalinization means (4, 105) comprise filters or semi-
30 permeable membranes (14.)

25. Desalinization plant according to any of the above claims, characterized in that it comprises a tank (15, 110, 115) to collect desalinated water.

26. Desalinization plant according to claim 25,
35 characterized in that said tank (15, 110, 115) is elevated

above said reverse osmosis desalinization means (4, 105) at a height so that the desalinated water reaches said tank by natural pressure without the need of pumping.

27.- Desalinization plant according to any of the
5 claims 1-26, characterized in that the salt water ducting means, (2), the brine ducting means (6, 109) and the means to establish the water column (3, 104) consist of a plurality essentially vertical pipelines (16) located in
10 the inside periphery of a main essentially vertical pipeline with a larger diameter than the previous ones.

28. Desalinization plant according to claim 27, characterized in that said main pipeline (17, 119) with a larger diameter includes a free inside space (18) for a sliding platform (19).

15 29.- Desalinization plant according to any of the claims 1-26, characterized in that the brine ducting means and the means to establish the water column, include first and second wells made in the ground.

20 30. Desalinization plant according to any of the claims 1-26, characterized in that said desalinization plant is underground communicating the head tank (7, 117) with the reverse osmosis desalinization means (4, 105) by pipelines housed in vertical perforations.

25 31.- Method to desalinate water by reverse osmosis,, by natural pressure, according to which

- salt water is introduced into at least one duct in which reverse osmosis desalinization means (4, 105) have been provided for, said reverse osmosis desalinization means being located at a level below sea level;

30 - the reverse osmosis desalinization means (4, 105) being located in such a way that the salt water column (3, 104) that is located above said reverse osmosis desalinization means in said duct, exerts pressure which substantially contributes to the production of the
35 phenomenon of reverse osmosis in the reverse osmosis

desalinization means (4, 105), obtaining desalinated water and brine;

characterized in that

- before introducing the salt water in said duct, the
5 salt water is led to an elevated head tank (7, 117),
located at an adequate height so that the brine coming from
the reverse osmosis desalinization means reaches the
surface without the need of pumping said brine.

32. Method according to claim 31, characterized in
10 that the brine resulting from the reverse osmosis process
is used to move at least one turbine that is coupled to an
electric generator, using the electric energy generated for
its own consumption and/or to return it to the network.

33.- Method according to any of the claims 31 or 32,
15 characterized in that the salt water is pumped to the
elevated head tank (7, 117) for a certain amount of time.

34. Method according to claim 33, characterized in
that the salt water that is led to the elevated head tank
(7, 117) is stored in said tank for a period of time
20 complementary to the amount of time corresponding to the
pumping of salt water.

35. Method according to claim 34, characterized in
that said certain amount of storage time of salt water
corresponds to $2/3$ of the total daily operating time.

25 36. Method according to any of the claims 31-35,
characterized in that the brine coming from the reverse
osmosis desalinization means (4, 105) is led before being
taken to the turbines, to an elevated brine tank (11)
located at a height such that said brine rises up to said
30 tank by natural pressure without the need of pumping.

37. Method according to claim 36, characterized in
that said brine is stored in said brine tank (11) for a
specific amount of time.

38. Method according to claim 37, characterized in
35 that said amount of time corresponds to $5/6$ of the total

daily operating time.

39. Method according to claim 38, characterized in that said brine is used to move the turbines for an amount of time that corresponds to $1/6$ of the total daily
5 operating time.

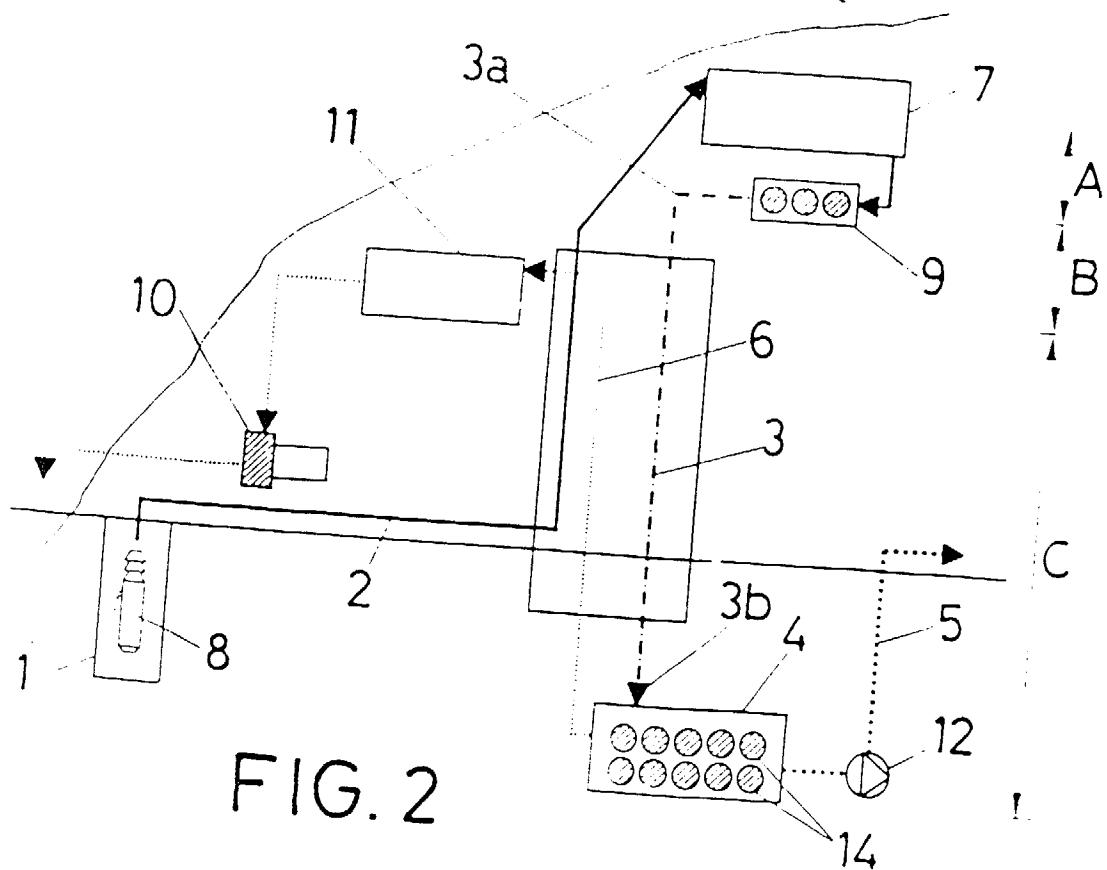
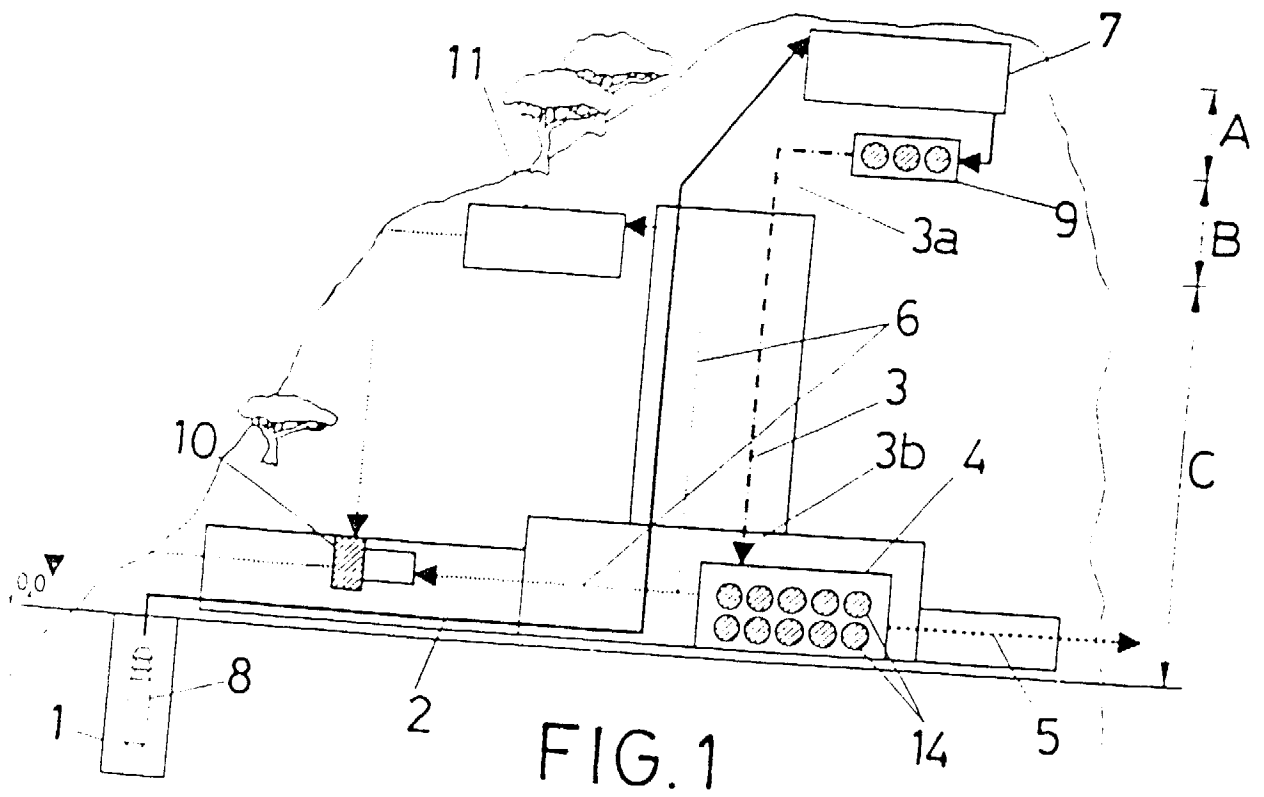
40. Method according to any of the claims 36-39, characterized in that the electric energy generated is used to feed a pump (12) to remove desalinated water when coming out of the reverse osmosis desalinization means (4, 105).

10 41. Method according to any of the claims 31-39, characterized in that the electric energy produced is used to feed a pump (13) that impels the salt water and that complements the pressure exerted by the weight of the salt water column (3, 104).

15 42. Method according to any of the claims 31-41, characterized in that it takes advantage of the possible topographic location of the desalinization plants to establish the level at which

- the reverse osmosis desalinization means (4, 105);
- 20 - the elevated salt water head tank (7, 117);
- the turbines

are located in such a way that it allows that the difference between the electric energy consumption used by the pumps and the electric energy production produced by
25 the turbines is minimal.



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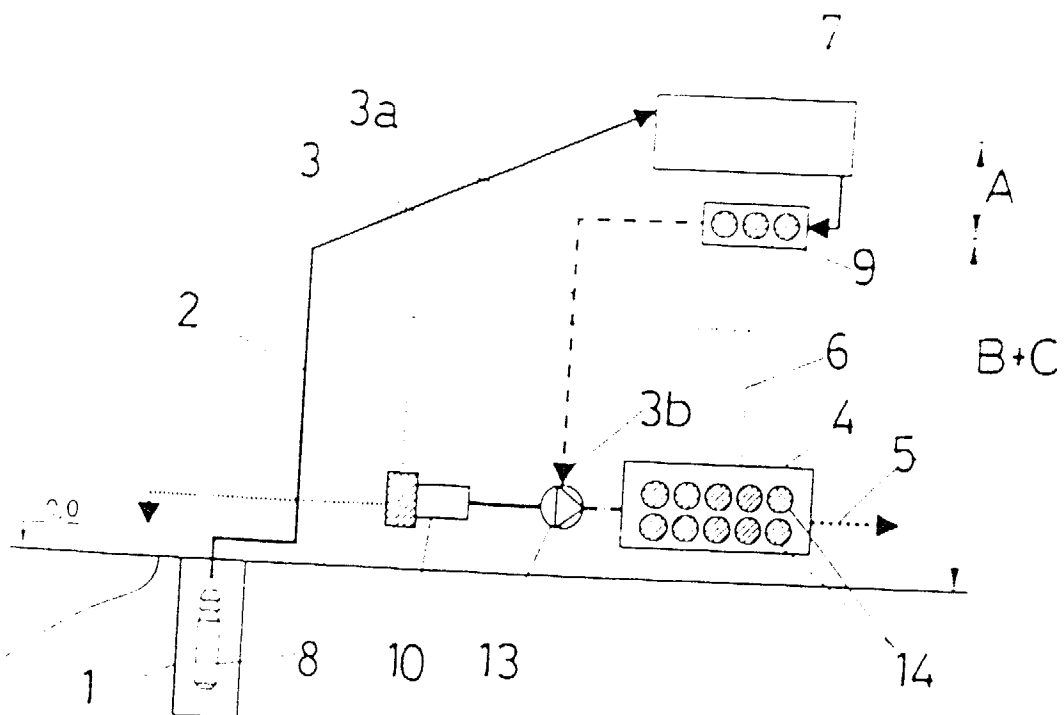


FIG. 3

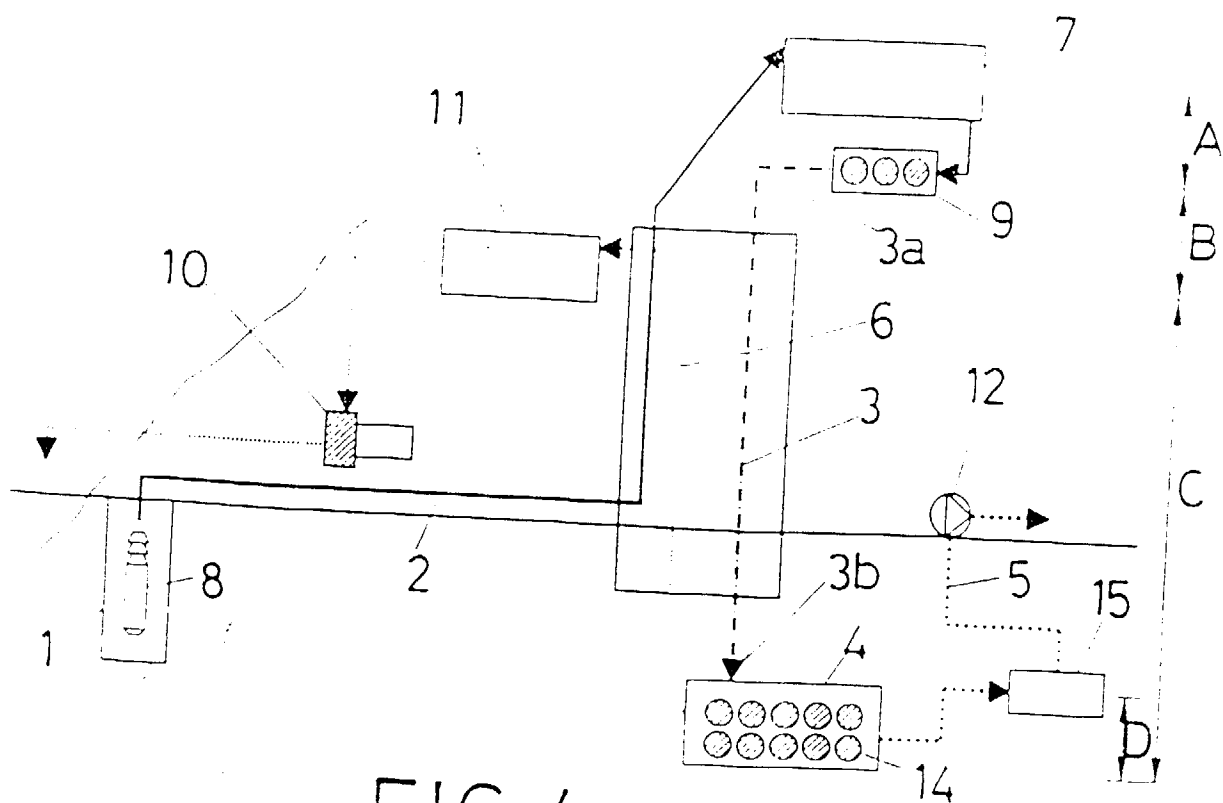


FIG. 4

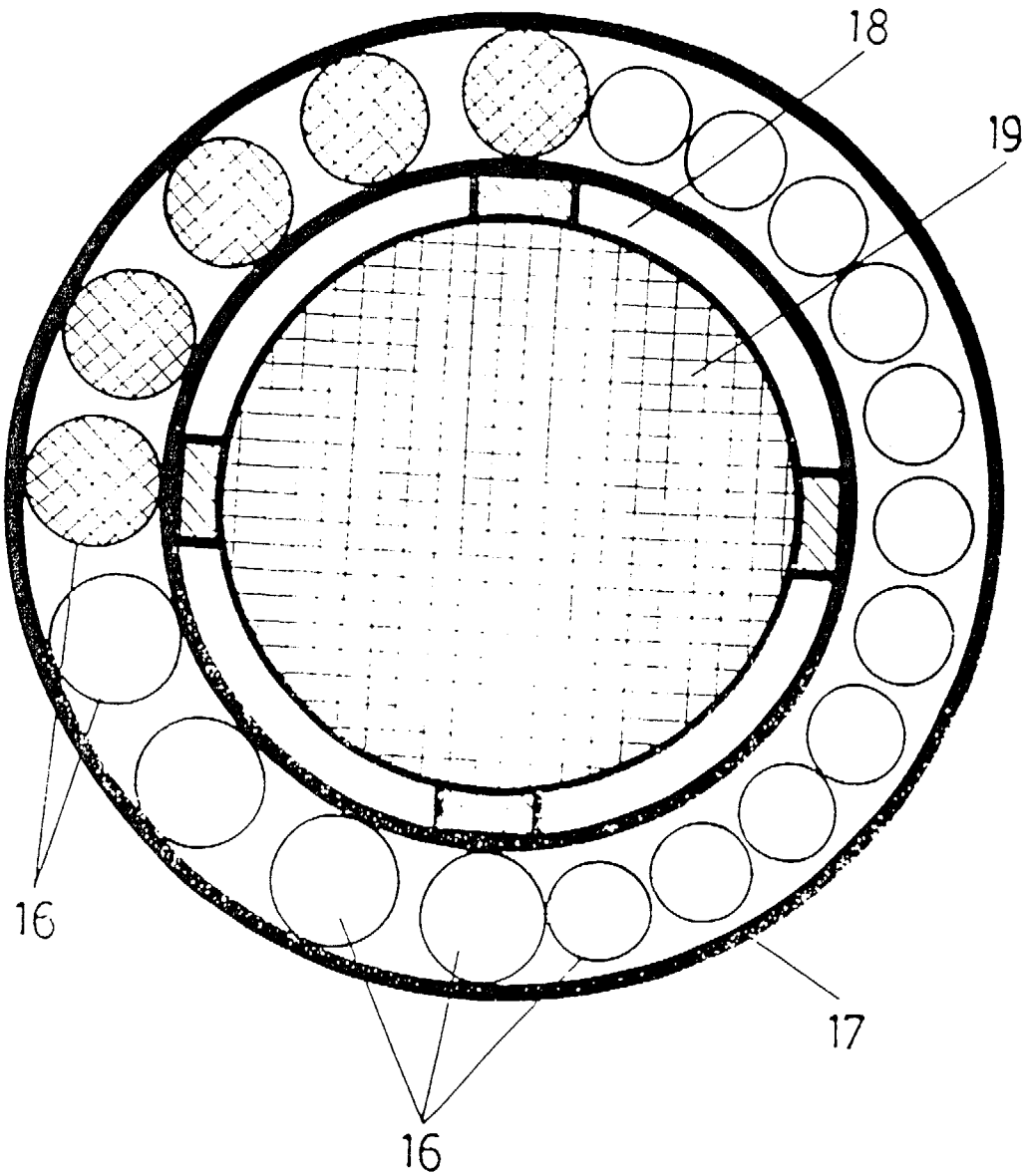


FIG. 5

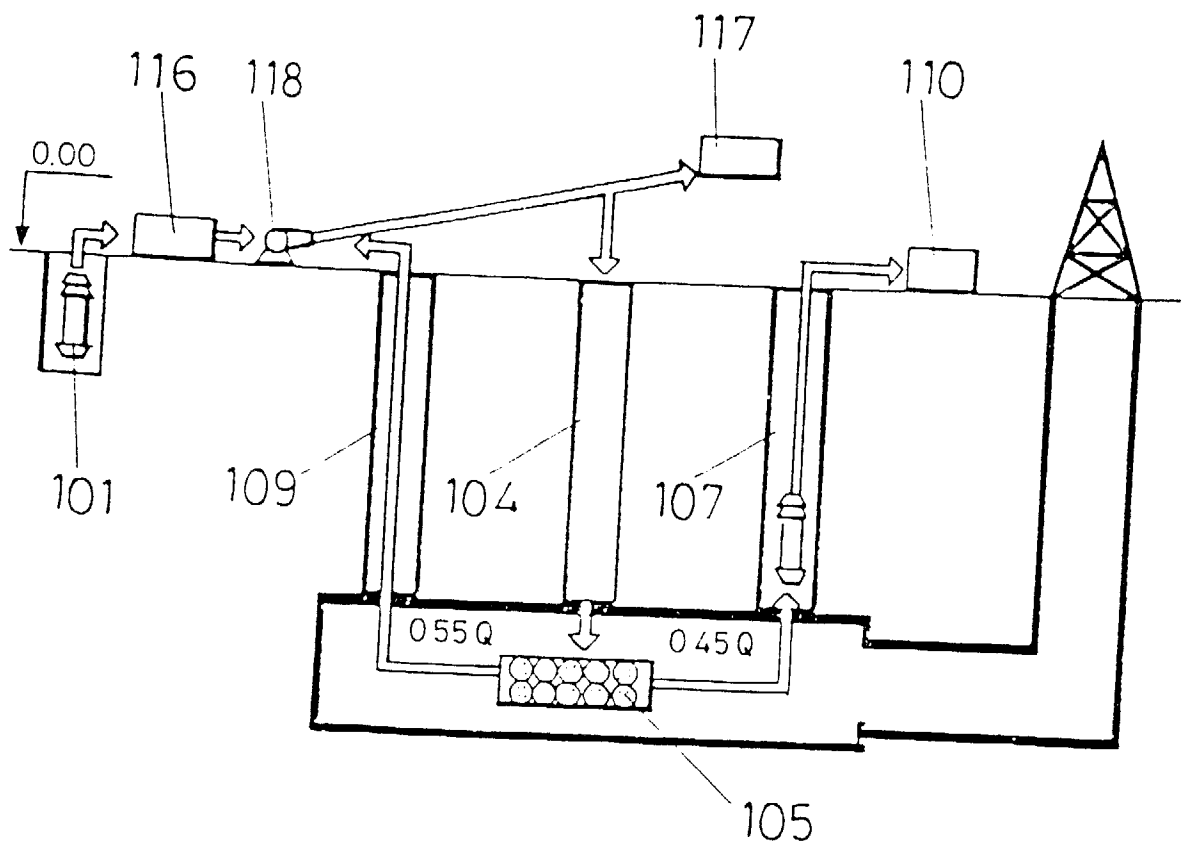


FIG.6

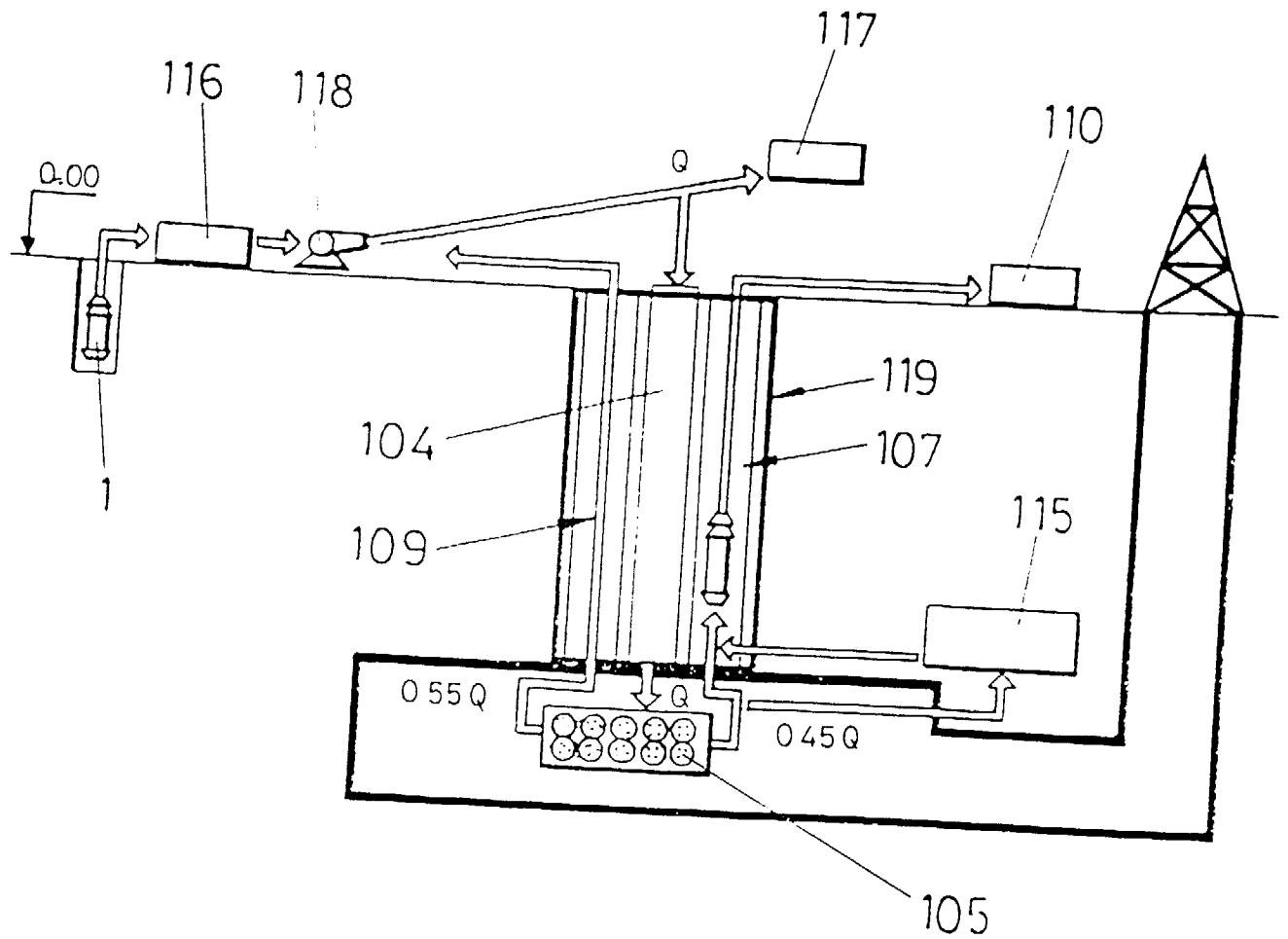


FIG. 7

