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(54) **Title**: WATER PURIFICATION AND DISINFECTION SYSTEM AND METHOD OF USE

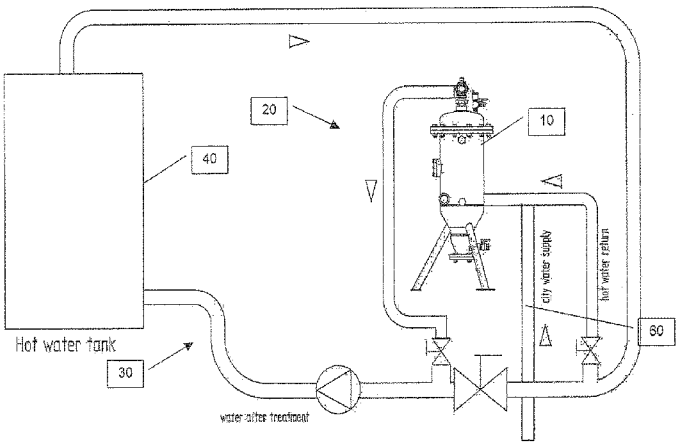


FIG. 1

(57) **Abstract**: A water purification and disinfection system for treating water in a substantially closed circulating water system, in which the water purification and disinfection system includes an electrolysis tank deployed in a side branch of a main flow path of the substantially closed circulating water system in such a manner that substantially all the water in the substantially closed circulating water system passes through the electrolysis tank. Also disclosed is an electrode configuration for use in the electrolysis tank of a water purification and disinfection system. The electrode configuration includes positive and negative electrical contact bars extending into the electrolysis tank, and positive and negative electrodes deployed such that the positive electrodes are supported by both positive and negative electrical contact bars and are in electrical communication only with the positive electrical contact bar, and the negative electrodes are supported by both positive and negative electrical contact bats and are in electrical communication only with the negative electrical contact bar.

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APPLICATION FOR PATENT

Inventor: Zvi Livni, Motti Karin, Omer Livni, Genish RaHamim

Title: Water Purification and Disinfection System and Method of Use

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to water purification and disinfection systems and, in particular, it concerns a water purification and disinfection system for treating water in a substantially closed circulating water system that uses electrolysis to produce free chlorine and other oxidants such as, but not limited to ozone (O_3) and hydrogen peroxide (H_2O_2), in which all of the water in the system is exposed to the electrolysis process.

It is known in substantially closed circulating hot water systems to maintain a water temperature of 65°-70°C. However, these temperatures are dangerously high use in human contact situations such as baths and showers.

In an attempt to provide pure disinfected water without extreme heat, it has been suggested in the prior art to perform electrolysis on a portion of the water in the system so as to produce enough free chlorine to disinfect all of the water in the system. One drawback to such a system is ensuring that all of the untreated water is thoroughly mixed with the treated water so as to fully disinfect all of the water in the system.

There is therefore a need for a water purification and disinfection system for treating water in a substantially closed circulating water system that uses electrolysis to produce free chlorine and other oxidants such as, but not limited

to ozone (O_3) and hydrogen peroxide (H_2O_2), in which all of the water in the system is exposed to the electrolysis process.

SUMMARY OF THE INVENTION

The present invention is a water purification and disinfection system for treating water in a substantially closed circulating water system that uses electrolysis to produce free chlorine and other oxidants such as, but not limited to ozone (O_3) and hydrogen peroxide (H_2O_2), in which all of the water in the system is exposed to the electrolysis process.

According to the teachings of the present invention there is provided a water purification and disinfection system for treating water in a substantially closed circulating water system, the water purification and disinfection system comprising: (a) an electrolysis tank deployed in a side branch of a main flow path of the substantially closed circulating water system; and (b) a freshwater inlet is located upstream from the electrolysis tank; wherein fresh water entering the substantially closed circulating water system through the freshwater inlet lowers a temperature of water entering the electrolysis tank.

According to a further teaching of the present invention, substantially all the water in the substantially closed circulating water system passes through the electrolysis tank.

According to a further teaching of the present invention, the fresh water introduced into the substantially closed circulating water system through the

freshwater inlet passes through the electrolysis tank before entering the main flow path of the substantially closed circulating water system.

According to a further teaching of the present invention, the substantially closed circulating water system is a hot water system having a water temperature of 40°-55°C.

According to a further teaching of the present invention, there is also provided a free chlorine monitoring arrangement that provides data to a power control system so as tp regulate a current supplied from a power source to electrodes in the electrode tank in order to maintain an optimal free chlorine level in the substantially closed circulating water system.

There is also provided according to the teachings of the present invention, a water purification and disinfection system for treating water in a substantially closed circulating water system, the water purification and disinfection system comprising: (a) an electrolysis tank deployed in a side branch of a main flow path of the substantially closed circulating water system; and (b) a freshwater inlet is located upstream from the electrolysis tank; wherein substantially all the water in the substantially closed circulating water system passes through the electrolysis tank.

According to a further teaching of the present invention, fresh water entering the substantially closed circulating water system through the freshwater inlet lowers a temperature of water entering the electrolysis tank.

According to a further teaching of the present invention, the fresh water introduced into the substantially closed circulating water system through the

freshwater inlet passes through the electrolysis tank before entering the main flow path of the substantially closed circulating water system.

According to a further teaching of the present invention, there is also provided a free chlorine monitoring arrangement that provides data to a power control system so as tp regulate a current supplied from a power source to electrodes in the electrode tank in order to maintain an optimal free chlorine level in the substantially closed circulating water system.

There is also provided according to the teachings of the present invention, an electrode configuration for use in the electrolysis tank of a water purification and disinfection system, the electrode configuration comprising: (a) at least a first positive electrical contact bar extending into the electrolysis tank; (b) at least a first negative electrical contact bar extending into the electrolysis tank; (c) at least a first positive electrode deployed in the tank such that the positive electrode is supported by both the positive electrical contact bar and the negative electrical contact bar, the positive electrode being in electrical communication only with the positive electrical contact bar; and (d) at least a first negative electrode deployed in the tank such that the negative electrode is supported by both the positive electrical contact bar and the negative electrical contact bar, the negative electrode being in electrical communication only with the negative electrical contact bar.

According to a further teaching of the present invention, the positive electrode is supported on the positive contact bar by a conductive support element and on the negative contact bar by a non-conductive support element

and the negative electrode is supported on the negative contact bar by a conductive support element and on the positive contact bar by a non-conductive support element.

According to a further teaching of the present invention, the at least a first positive electrical contact bar is configured as a plurality of positive electrical contact bars; the at least a first negative electrical contact bar is configured as a plurality of negative electrical contact bars; the at least a first positive electrode is configured as a plurality of positive electrodes; and the at least a first negative electrode is configured as a plurality of negative electrodes.

According to a further teaching of the present invention, the conductive electrode support elements and the non-conductive electrode support elements are deployed on the positive electrical contact bars and the negative electrical contact bars in pairs such that an electrode is supported between two corresponding electrode support elements, and the conductive electrode support elements and the non-conductive electrode support elements are deployed in opposite order on the positive electrical contact bars and negative electrical contact bars.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic illustration of a water purifying and disinfecting hot water supply system constructed and operational according to the teachings of the present invention;

FIG. 2 is a schematic illustration of the embodiment of FIG. 1 show with an electrode control system constructed and operational according to the teachings of the present invention;

FIG. 3 is a schematic illustration of a water purifying and disinfecting water cooling tower system constructed and operational according to the teachings of the present invention;

FIG. 4 is a schematic transparent side view of an electrolysis tank constructed and operational according to the teachings of the present invention;

FIG. 5 is a detail of the electrode arrangement according to the teachings of the present invention; and

FIG. 6 is a detail of FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is a water purification and disinfection system for treating water in a substantially closed circulating water system that uses electrolysis to produce free chlorine and other oxidants such as, but not limited to ozone (O_3) and hydrogen peroxide (H_2O_2), in which all of the water in the system is exposed to the electrolysis process.

The principles and operation of water purification and disinfection system according to the present invention may be better understood with reference to the drawings and the accompanying description.

It is well know in the art that the electrolysis process naturally produces disinfecting chemicals such as chlorine, ozone (O_3) and hydrogen peroxide (H_2O_2), by non-limiting example. It is also well know that disinfection reduces the level of all bacteria, including Legionella, to levels below the minimum health standard levels.

The unique electrolysis water purification and disinfection system of the present invention is preferably deployed in a closed substantially constantly circulating hot water supply systems where hot water must be supplied immediately when needed, without the lag time of waiting for the hot water to travel through the pipes from the hat heater to the point of delivery, as is the case in flow-through on demand systems as are common in private homes. Closed substantially constantly circulating hot water supply systems are commonly used in, but not limited to, hospitals, large hotels and industrial applications.

A closed substantially constantly circulating hot water supply system is well suited for the water purification and disinfection system of the present invention because a closed system helps to maintain a stable chlorine level in water circulating through the system and provides a stable flow of water through the electrolysis tank, which enhances and stabilizes the treatment.

As illustrated in Figures 1-3, the electrolysis tank **10** of the present invention is deployed in a side branch **20** of the main flow path **30** or the main flow of the water system being treated. In Figure 1, the main flow path **30** includes the hot water tank **40**. In Figure 2, the main flow path **30** includes the cooling tower **50**.

Water is constantly flowing through the electrolysis tank **10** and back into the main flow **30** of water in the system. While in the electrolysis tank **10**, the level of the disinfecting chemicals such as chlorine, oxygen and Ozone is increased and those chemicals are then carried into the main flow **30** of water. Depending on the size of the electrolysis tank **10** and the overall size of the full hot water system, substantially all of the water in the system will pass through the electrolysis tank **10** a number of times during a 24 hour period, thereby exposing all of the water in the system to the electrolysis process.

One unique feature of the present invention is to monitor the levels of the disinfecting chemicals, especially the level of chlorine, in the water entering the electrolysis tank **10** and adjusting the water treatment process so as to maintain a predetermined level of chemicals in the water as it exits the electrolysis tank **10**. It has been found that a return level of about 0.5 ppm of free chlorine ensures that the water in circulation has been disinfected. As illustrated in Figure 2, the water purification and disinfection system of the present invention includes free chlorine monitoring arrangement that has a sensor **100** and meter **102** that provide free chlorine level data to the power control system **104** that regulates the current supplied from the power source

106 to the electrodes 12a and 12b in order to maintain an optimal free chlorine level such as 0.5ppm, as a non-limiting example. It will be readily appreciated that increasing the current will increase free chlorine production and decreasing the current will lower production. While it is preferable to provide a power control system that varies the current as necessary to maintain the predetermined free chlorine level, a power control system that merely turns the power on if the free chlorine falls below to a predetermined lower level and turns the power off when it passes a predetermined upper level is within the scope of the present invention.

Further, as shown in Figure 1, any new water introduced into the system such as, but not limited to, from the city water supply 60 is introduced just upstream from the electrolysis tank 10 such that the new water passes through the electrolysis tank 10 and is thereby treated with the disinfecting chemicals before in enters the main flow 30 of the hot water system. A further advantage of introducing new water up stream from the electrolysis tank 10 is that the temperature of the water entering the electrolysis tank is lowered automatically by the in-flow of unheated water. It is know that electrolysis is more efficient at lower temperatures and it is advantageous to boost the efficiency of the electrolysis process, especially the production of free chlorine, at a time of influx of heretofore untreated water.

By treating all of the water in the system, including treating the new water before it enters the main flow of the system allows the water purification and disinfection system of the present invention to operate effectively and

provide safe clean hot water at temperatures much lower than the systems of the prior art that rely on high heat to kill bacteria. By non-limiting example, the water purification and disinfection system of the present invention safely operates at a water temperature of 40°-55°C, and preferably 40°-50°C. This is apposed to the water temperatures of 65°-70°C commonly used today in other closed circulating hot water supply systems in order to have a return temperature of 55°C as required by law in most countries, for such systems that rely solely of high water temperature for disinfection.

It will be readily appreciate that the lower operation temperature of the system of the present invention results in a safer hot system that is less expensive to operate than the systems of the prior art. There are several reasons for this, including but not limited to; less chance of injury to users due to excessively high water temperature; less chance of damage to the hot water supply system itself due to the lower operating temperature; considerable operational energy saving due to the lower operating temperature since the water in the system need not be raised to higher operating temperatures of the current prior art systems. This last point is particularly true in large hot water systems and it will be appreciated that the operations savings are proportionally related to the amount of water that must be heated to operational temperature.

The lower operating temperatures of the system of the present invention are of particular advantage now that many countries, including Great Britain, have begun requiring the installation of special mixing valves at the hot water outlet taps of water heating systems operating at temperatures above 43°C.

A further advantage of the water purification and disinfection system of the present invention over the systems that heat the water to temperatures of 65°-70°C, is the ability of the process of the present invention to treat all of the water in the system and to continue to provide disinfection after the water temperature has decreased. There are a number of problems in system in which extremely high water temperature is used to kill bacteria, such as Legionella for example, that include regions of non-circulation within the system and regions in which the temperature falls below the temperature necessary to kill the bacteria. An example would be between a shower head and the flow control valve for the shower. When finished showering, the valve is closed and at least some water remains in the pipe between the valve and the shower head. This water is no longer in the circulation flow of the hot water system and will cool and may provide opportunity for bacteria to grow. However, water treated according to the process of the present invention will continue to contain a high enough level of disinfecting chemicals to continue to kill bacteria even though the water in the length of pipe is no longer in the circulation flow of the hot water system.

Figure 2 illustrates the installation of the system of the present invention in a cooling tower system. Although the operational temperatures of cooling tower systems are generally in the range of 25°-40°C, the water purification and disinfection capability are equally proficient.

Although the systems of the present invention illustrated herein are systems in which the water is continuously circulating, the water purification

and disinfection features of the present invention may also be used to benefit in flow-through on demand systems, such as is common in a private home, as well. In such a system, the electrolysis tank of the present invention is deployed in the main flow path of the water system, such that all of the water in the system passes through the electrolysis tank.

Another unique feature of the present invention is illustrated in Figures 3 and 4. As seen here, the electrodes **14** are supported by a plurality of electrical contact bars **12**, that extend on at least on end out of the electrolysis tank **10**, thereby allowing for electrical connection to the electrical circuit of the system. Each of the electrical contact bars **12** are arranged in series such that the polarity of subsequent electrical contact bars **12** in the opposite of the proceeding electrical contact bar **12**. That is to say, as a non-limiting example, that if electrical contact bar **12a** is positive, electrical contact bar **12b** will be negative, electrical contact bar **12c** will be positive and electrical contact bar **12d** will be negative. It should be noted that the number of electrical contact bars **12** need not be limited to four and it is within the scope of the present invention to provide electrolysis tanks with whatever number of electrical contact bars **12** is suitable for any particular application.

As seen best in Figures 4 and 5, each of the electrical contact bars **12** is threaded to accommodate nuts **90** and **92**. Deployed on each of the electrical contact bars **12** between nuts **90** and **92** is a plurality of conductive and non-conductive electrode support elements **16** and **18** respectively, which may be implemented as washers. Electrode support elements **16** and **18** are deployed

on the electrical contact bars **12** in pairs such that an electrode is supported between the two corresponding electrode support elements. Further, the electrode support elements **16** and **18** are deployed in opposite order on the positive and negative electrical contact bars **12**. That is, the first pair of electrode support elements on positive electrical contact bars **12a** and **12c** are conductive electrode support elements **16**, while the first pair of electrode support elements on positive electrical contact bars **12b** and **12d** are non-conductive electrode support elements **18**, therefore, electrode **14a** is a positive electrode. The second pair of electrode support elements on positive electrical contact bars **12a** and **12c** are non-conductive electrode support elements **18**, while the second pair of electrode support elements on positive electrical contact bars **12b** and **12d** are conductive electrode support elements **16**, therefore, electrode **14a** is a negative electrode. The third pair of electrode support elements on positive electrical contact bars **12a** and **12c** are conductive electrode support elements **16**, while the third pair of electrode support elements on positive electrical contact bars **12b** and **12d** are non-conductive electrode support elements **18**, therefore, electrode **14c** is a positive electrode. This pattern is repeated for all of the electrodes.

To install the electrodes **14** on the electrical contact bars **12** nuts **92** are left loose and each electrode **14** is placed between a pair of electrode support elements. Once all of the electrodes **14** are in place, nuts **92** are tightened. This configuration greatly simplifies the process of mounting the electrodes over how this is currently done in the prior art.

It will be appreciated that the above descriptions are intended only to serve as examples and that many other embodiments are possible within the spirit and the scope of the present invention.

WHAT IS CLAIMED IS:

1. A water purification and disinfection system for treating water in a substantially closed circulating water system, the water purification and disinfection system comprising:

(a) an electrolysis tank deployed in a side branch of a main flow path of the substantially closed circulating water system; and

(b) a freshwater inlet is located upstream from said electrolysis tank;

wherein fresh water entering the substantially closed circulating water system through said freshwater inlet lowers a temperature of water entering said electrolysis tank.

2. The water purification and disinfection system of claim 1, wherein substantially all the water in the substantially closed circulating water system passes through said electrolysis tank.

3. The water purification and disinfection system of claim 1, wherein said fresh water introduced into the substantially closed circulating water system through said freshwater inlet passes through said electrolysis tank before entering said main flow path of the substantially closed circulating water system.

4. The water purification and disinfection system of claim 1, wherein the substantially closed circulating water system is a hot water system having a water temperature of 40°-55°C.

5. The water purification and disinfection system of claim 1, further including a free chlorine monitoring arrangement that provides data to a power control system so as tp regulate a current supplied from a power source to electrodes in said electrode tank in order to maintain an optimal free chlorine level in the substantially closed circulating water system.

6. A water purification and disinfection system for treating water in a substantially closed circulating water system, the water purification and disinfection system comprising:

(a) an electrolysis tank deployed in a side branch of a main flow path of the substantially closed circulating water system; and

(b) a freshwater inlet is located upstream from said electrolysis tank;

wherein substantially all the water in the substantially closed circulating water system passes through said electrolysis tank.

7. The water purification and disinfection system of claim 6, wherein fresh water entering the substantially closed circulating water system through said freshwater inlet lowers a temperature of water entering said electrolysis tank.

8. The water purification and disinfection system of claim 6, wherein said fresh water introduced into the substantially closed circulating water system through said freshwater inlet passes through said electrolysis tank before entering said main flow path of the substantially closed circulating water system.

9. The water purification and disinfection system of claim 6, further including a free chlorine monitoring arrangement that provides data to a power control system so as tp regulate a current supplied from a power source to electrodes in said electrode tank in order to maintain an optimal free chlorine level in the substantially closed circulating water system.

10. An electrode configuration for use in the electrolysis tank of a water purification and disinfection system, the electrode configuration comprising:

(a) at least a first positive electrical contact bar extending into the electrolysis tank;

(b) at least a first negative electrical contact bar extending into the electrolysis tank;

(c) at least a first positive electrode deployed in the tank such that said positive electrode is supported by both said positive electrical contact bar and said negative electrical contact bar, said positive electrode being in electrical communication only with said positive electrical contact bar; and

(d) at least a first negative electrode deployed in the tank such that said negative electrode is supported by both said positive electrical contact bar and said negative electrical contact bar, said negative electrode being in electrical communication only with said negative electrical contact bar.

11. The electrode configuration of claim 8, wherein said positive electrode is supported on said positive contact bar by a conductive support element and on said negative contact bar by a non-conductive support element and said negative electrode is supported on said negative contact bar by a conductive support element and on said positive contact bar by a non-conductive support element.

12. The electrode configuration of claim 8, wherein said at least a first positive electrical contact bar is configured as a plurality of positive electrical contact bars; said at least a first negative electrical contact bar is configured as a plurality of negative electrical contact bars; said at least a first positive electrode is configured as a plurality of positive electrodes; and said at least a first negative electrode is configured as a plurality of negative electrodes.

13. The electrode configuration of claim 10, wherein said conductive electrode support elements and said non-conductive electrode support elements are deployed on said positive electrical contact bars and said negative electrical contact bars in pairs such that an electrode is supported between two

corresponding electrode support elements, and said conductive electrode support elements and said non-conductive electrode support elements are deployed in opposite order on said positive electrical contact bars and negative electrical contact bars.

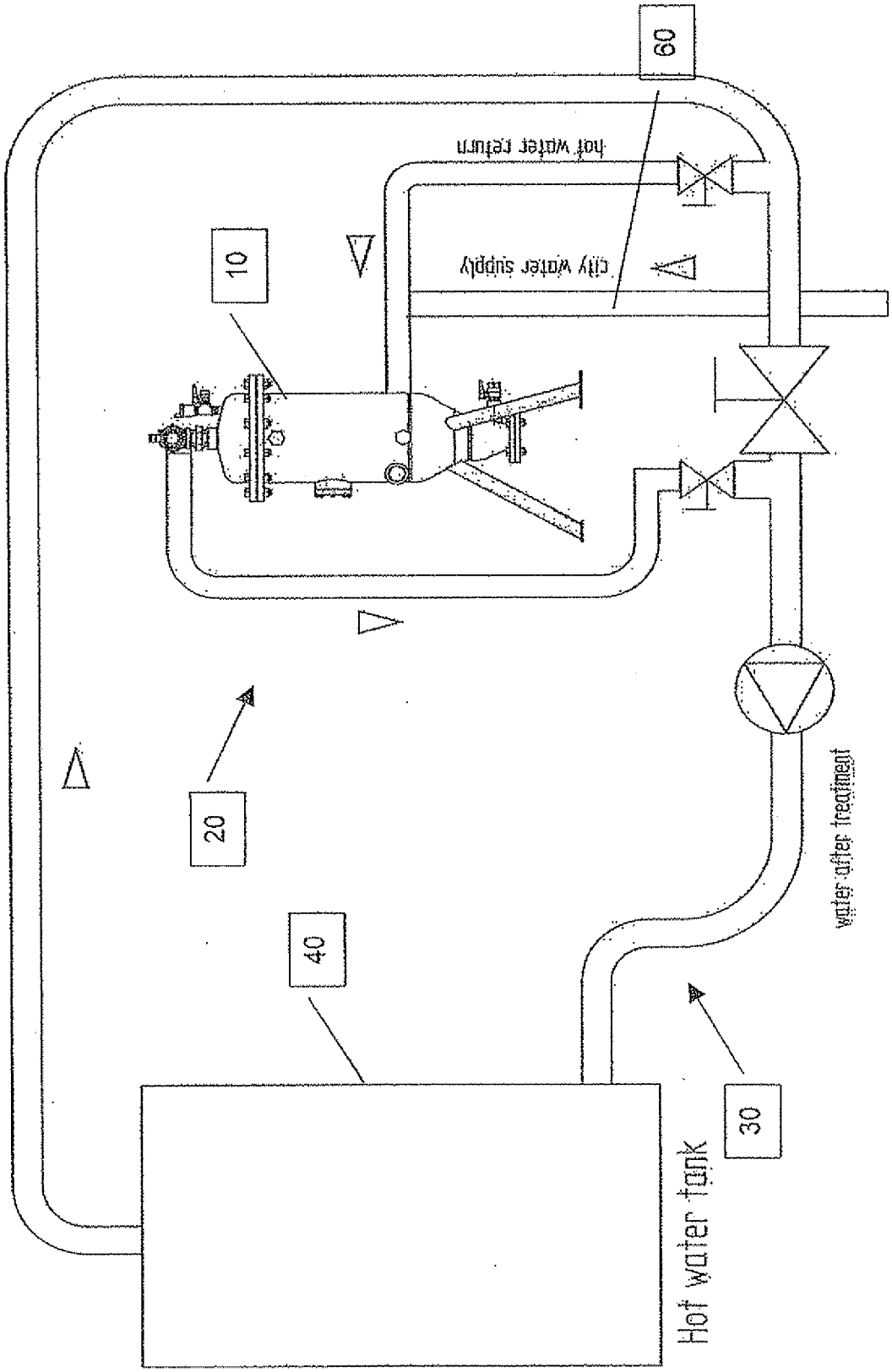

60
hot water return
city water supply
10
20
40
30
water after treatment
Hot water tank

FIG. 1

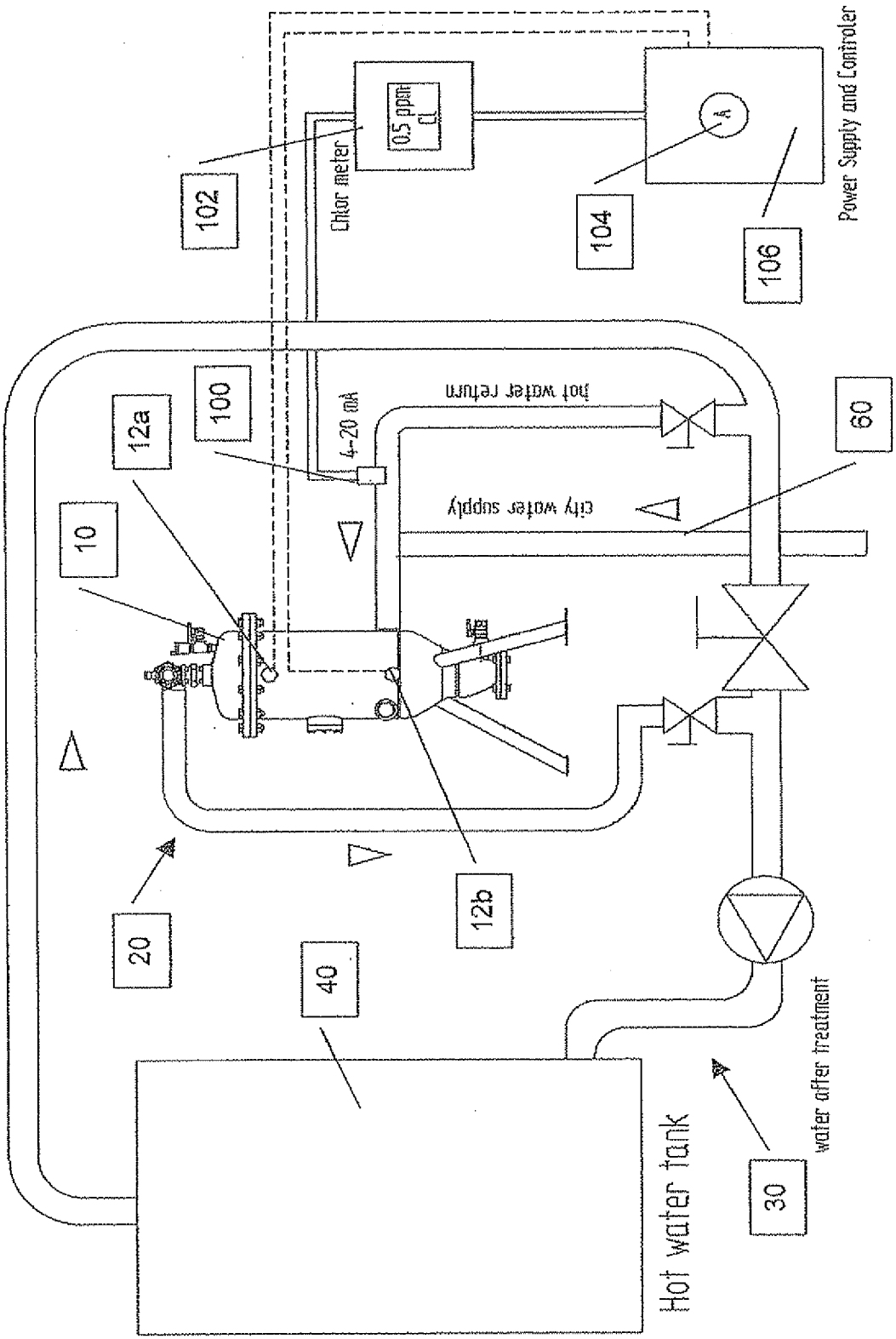

102
Chlor meter
0.5 ppm
Cl
104
A
106
Power Supply and Controler
100
4-20 mA
hot water return
60
12a
city water supply
10
12b
20
40
Hot water tank
30
water after treatment

FIG. 2

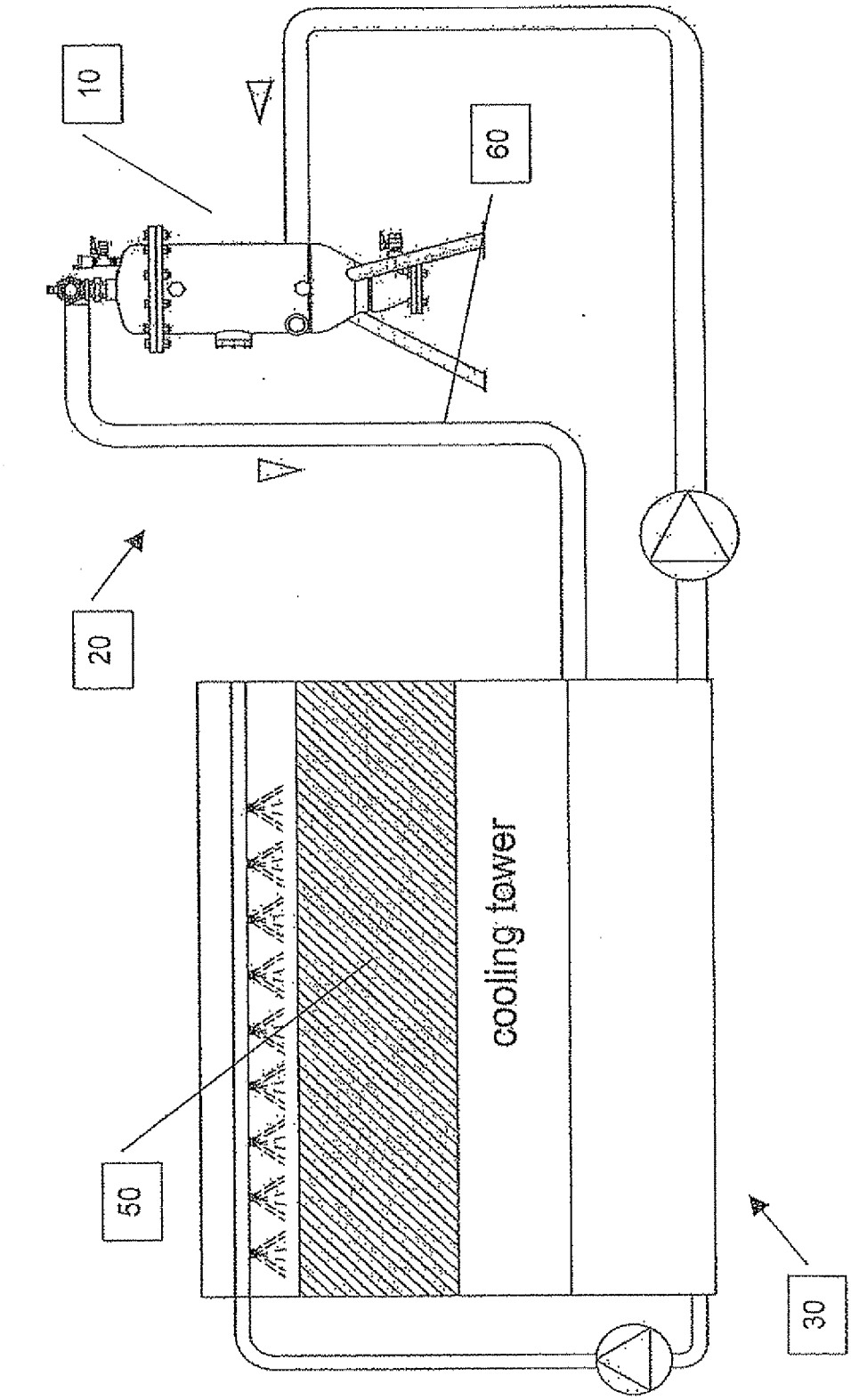


FIG. 3

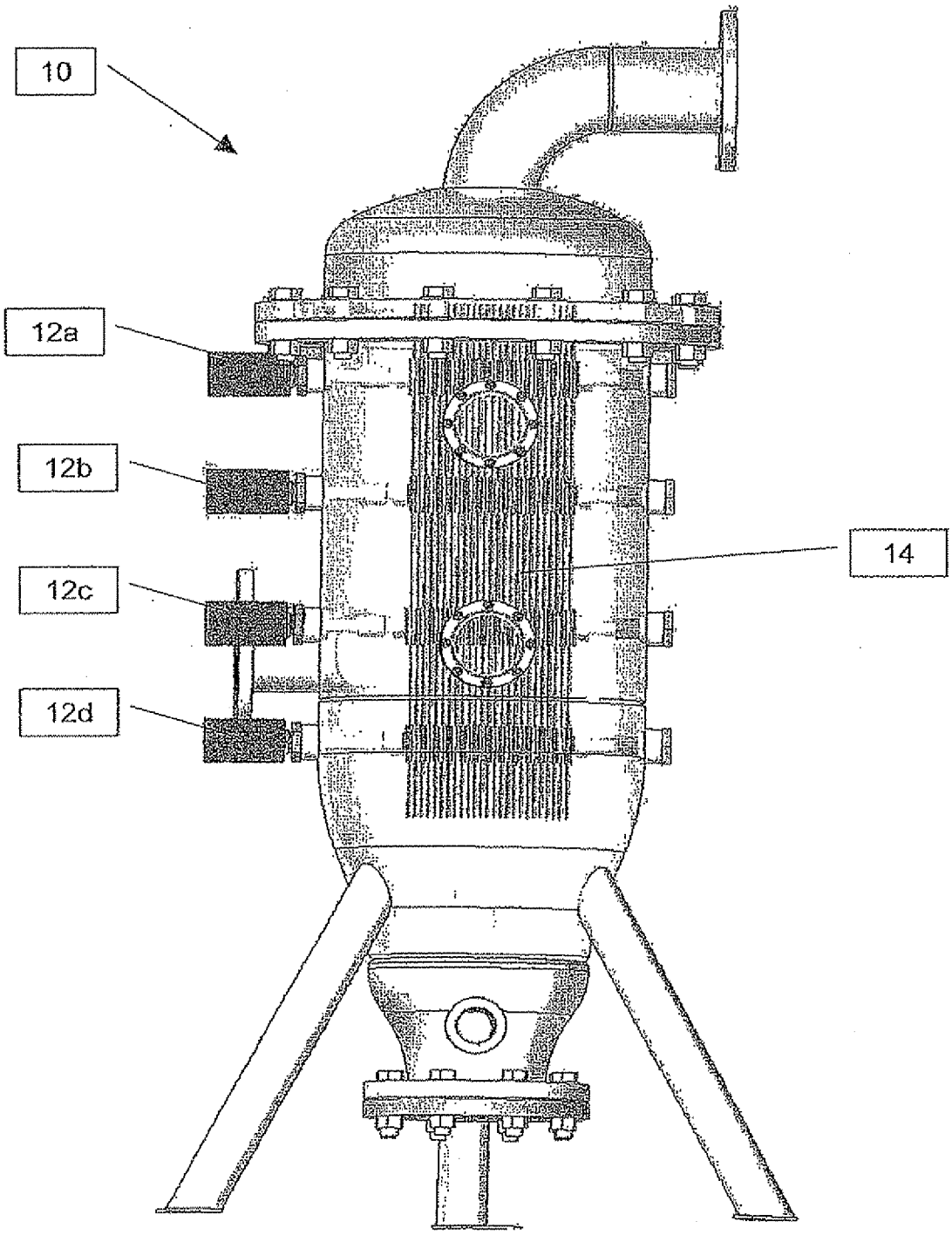


FIG. 4

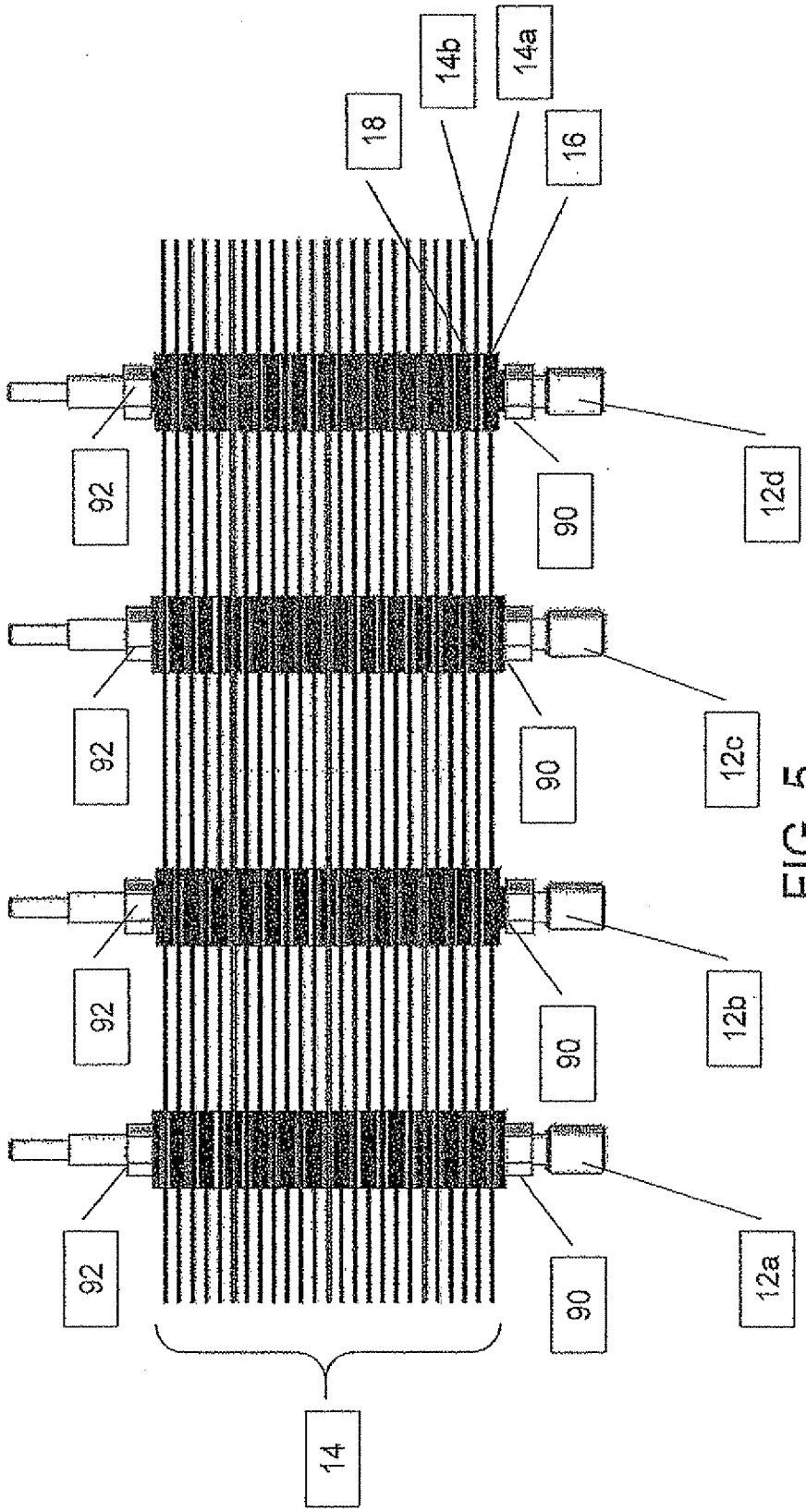


FIG. 5

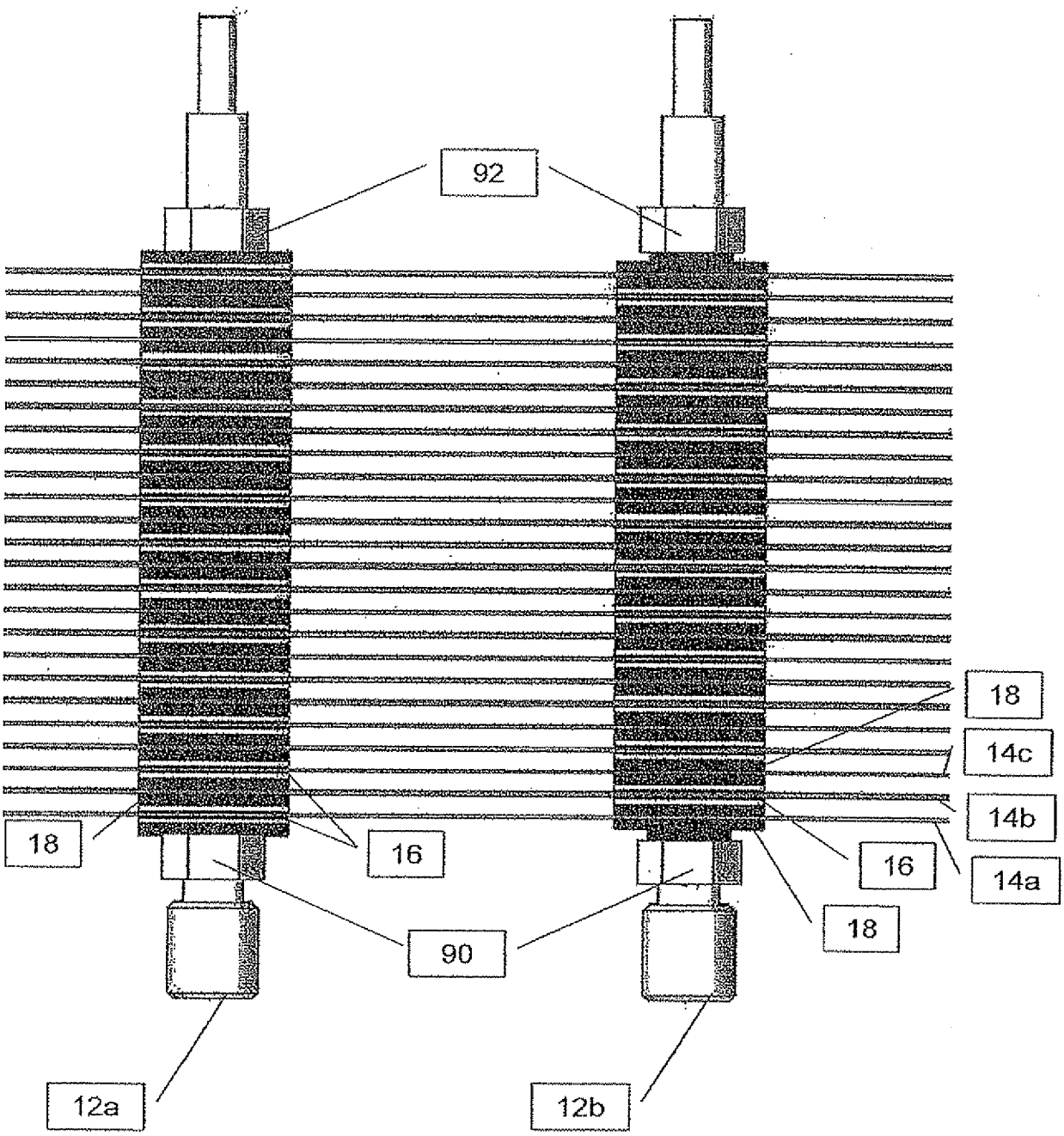


FIG. 6