United States Patent [19]

Schneider

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[54] **ARRANGEMENT FOR PRODUCING HEAT**

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[51] **Int. Cl.** **H05b 3/60,** F24h 1/16

[58] **Field of Search** 219/284–295, 219/326, 325, 271–276; 165/104–105

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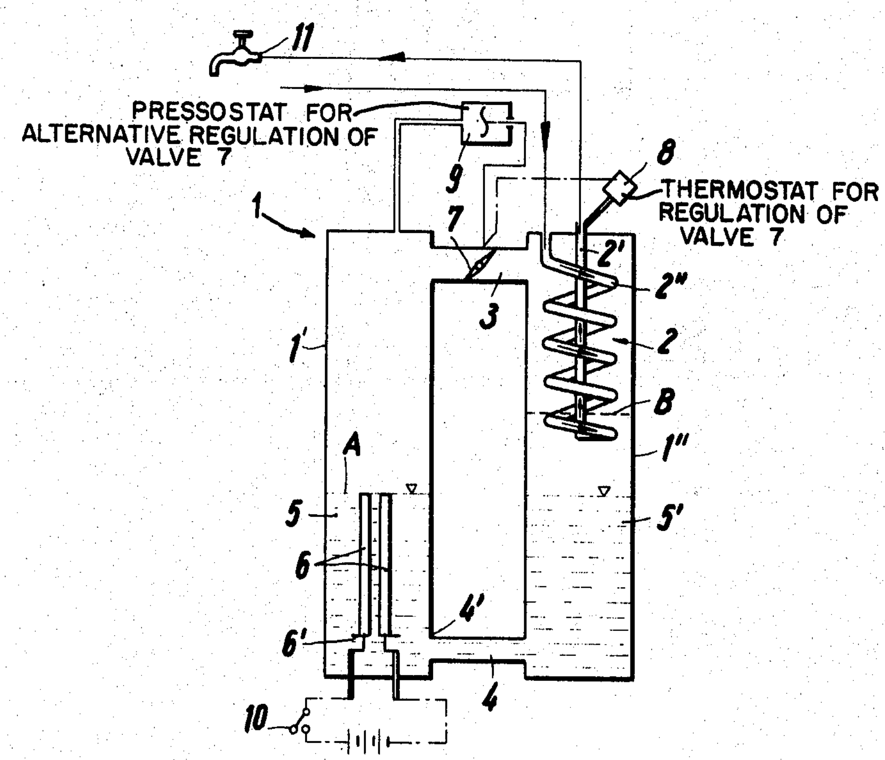
[57] **ABSTRACT**

Two chambers are provided which communicate with one another and each of which contains a quantity of liquid electrolyte and a quantity of electrolyte in vapor form. The vapor-containing portions of the chambers are connected with one another and the liquid-containing portions of the chambers are connected with one another. One of the chambers accommodates electrodes which can be connected with a source of electrical energy so as to cause heating of the electrodes and vaporization of the liquid electrolyte. The other chamber accommodates a heat-exchanger through which a medium to be heated may flow. A valve is interposed in the connection between the vapor-containing portions of the chambers and is responsive to the temperature of the medium to be heated. When heating of the medium is required, the valve opens to thereby permit vaporized electrolyte from the chamber accommodating the electrodes to flow into the other chamber and condense on the heat-exchanger. The heat given up by the condensed electrolyte is transferred to the medium. In one arrangement, a single heat-exchanger is provided and is located in the vapor-containing portion of its chamber. In another arrangement an additional heat-exchanger is provided in the same chamber and is located such that it is surrounded by the electrolyte which has condensed from the heat-exchanger located in the vapor-containing portion of the chamber. The additional heat-exchanger serves the purpose of preheating the medium. In a particularly compact arrangement, the electrodes and the heat-exchanger or exchangers are located in a single container, with the electrodes being concentrically arranged with the container and the heat-exchanger or heat-exchangers being of U-shaped configuration.

12 Claims, 3 Drawing Figures



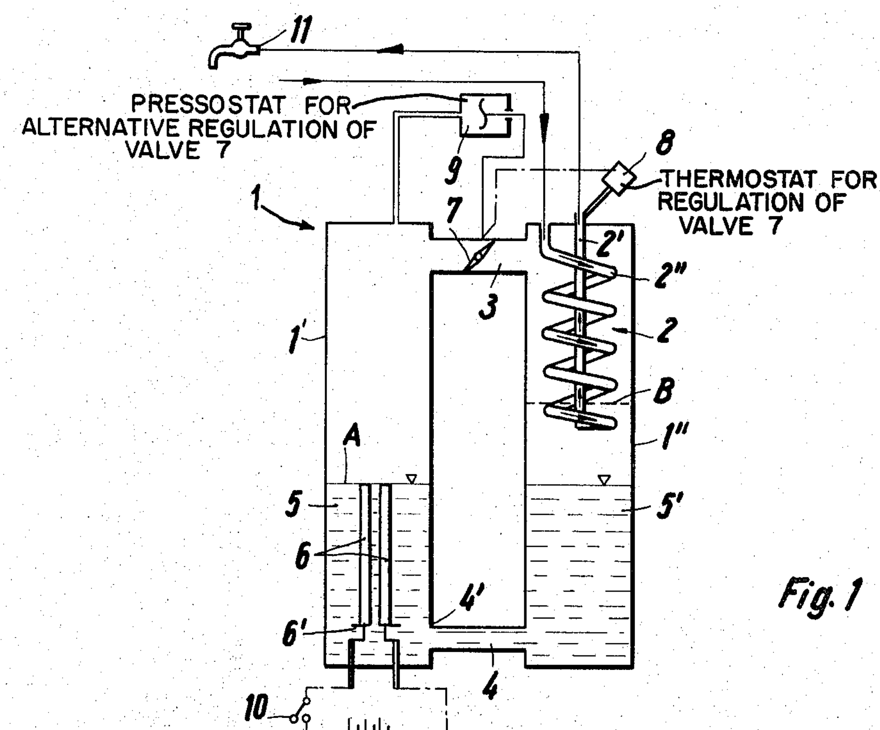
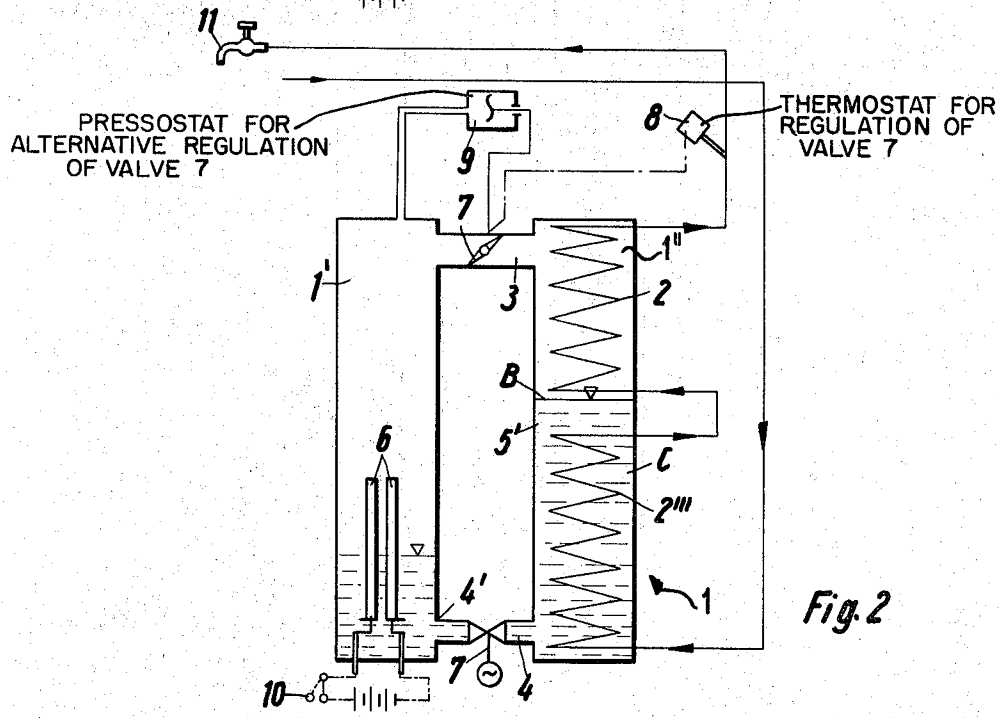

11
PRESSOSTAT FOR ALTERNATIVE REGULATION OF VALVE 7
9
8
THERMOSTAT FOR REGULATION OF VALVE 7
1
7
2'
2"
3
1'
2
B
1"
A
5
5'
6
4'
6'
4
10

Fig. 1


11
PRESSOSTAT FOR ALTERNATIVE REGULATION OF VALVE 7
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THERMOSTAT FOR REGULATION OF VALVE 7
7
1"
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Fig. 2

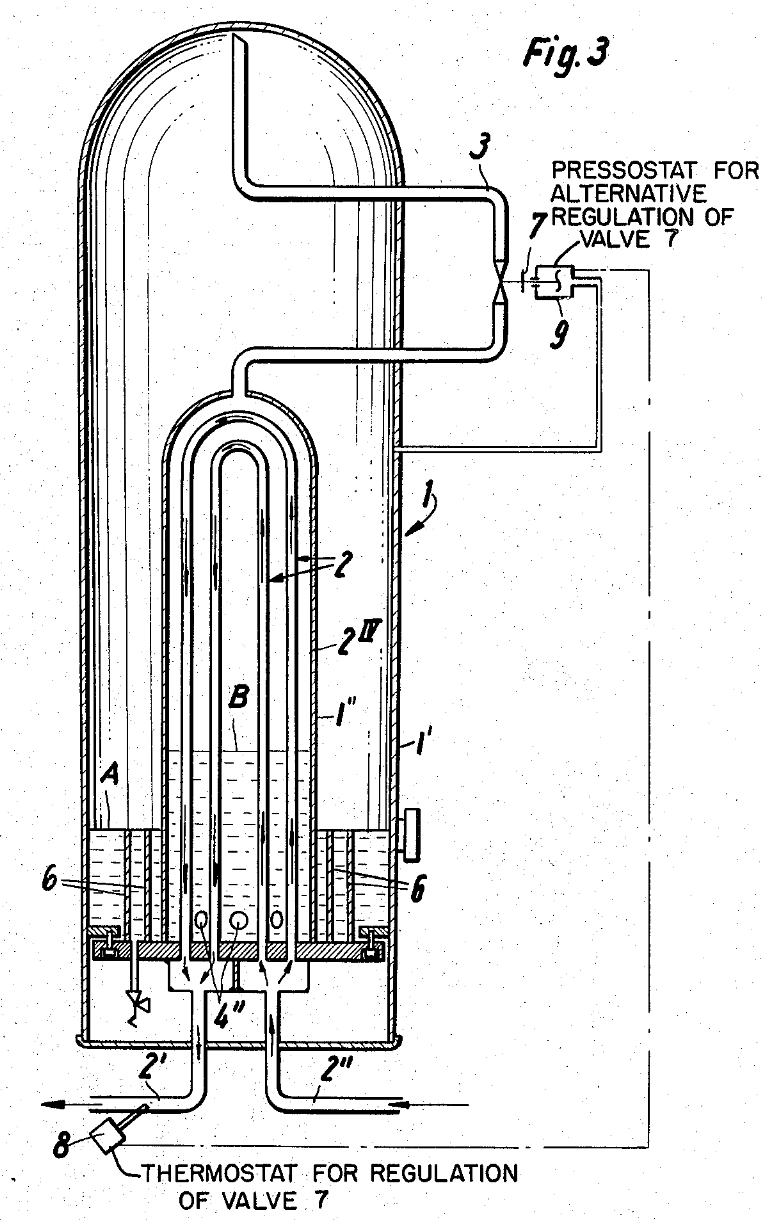
Fig. 3
3
PRESSOSTAT FOR ALTERNATIVE REGULATION OF VALVE 7
7
9
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2IV
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1''
1'
A
6
6
4''
2'
2''
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THERMOSTAT FOR REGULATION OF VALVE 7

ARRANGEMENT FOR PRODUCING HEAT

BACKGROUND OF THE INVENTION

The present invention is concerned with an arrangement for the production of heat, and, more particularly with an arrangement for the production of heat by means of electrical energy in container means containing an electrolyte and electrodes which are accommodated in the electrolyte, and wherein the electrolyte is associated with a heat exchanger.

Arrangements of this type are already known. The prior art provides for such an arrangement wherein the electrolyte is heated by the electrodes and an open system is provided in which the heated electrolyte is advanced by a pump via an arrangement of conductors into a heat exchanger. In the heat exchanger, the electrolyte yields the largest portion of its heat to water of the heat exchanger, for instance, the water of a swimming pool or the like.

This prior-art arrangement has certain disadvantages, one of which is the fact that it is always necessary to provide a pump to keep the electrolyte moving, and another one of which is the fact that the inertia of the complete heating system means that when the heat exchanger comes in contact with differential quantities of water to be heated, the temperature of the heating medium in the heat exchanger (which temperature is produced by the pumped electrolyte) will also fluctuate substantially. An additional disadvantage is the relatively poor heat transmissivity from a liquid to another liquid medium.

Another arrangement of this type is known from the art in which an electrolyte is heated by an electrode and flows, in the manner of a gravity feeding system, through the interior of a convoluted heat exchanger which transmits the heat to a non-conductive or non-combustible liquid surrounding its exterior. Such an arrangement is, of course, also quite reluctant in its response to changing conditions, and the controllability of such a system is virtually nonexistent. In addition, a poor heat transmissivity factor is obtained because here again heat is to be transmitted from one liquid (namely, the liquid electrolyte) to another liquid medium.

Finally, the prior art also proposes an arrangement for the cooking of foods or boiling of laundry which is surrounded by a steam containing space. The arrangement has an upwardly open electrode container located beneath the steam containing space and a bottom which is connected via a throttle valve, a closure valve and a return flow conduit with the bottom of the steam containing space. The electrode container and the steam containing space both contain electrolyte liquid. This arrangement also is an open system which means that the maximum temperatures that can be obtained are approximately 85° to 90°C. On the other hand, the steam or vapor will necessarily flow along, interalia, the cold surface of the electrolyte liquid at the bottom of the steam containing space, which means that especially when the installation is first placed into operation, the desired condensation at the wall of the steam containing space is replaced with predominant condensation at the surface of the electrolyte liquid at the bottom of the steam containing space.

SUMMARY OF THE INVENTION

It is, accordingly, a general object of the present invention to overcome the disadvantages of the prior art.

More particularly, it is an object of the present invention to provide an improved arrangement for the production of heat by the use of a heated electrolyte.

Another object of the invention is to provide such an arrangement in which high heat transmissivity factors between the electrolyte and the medium to be heated can be obtained.

An additional object of the invention is to provide such an arrangement in which a continuous proportion of control is obtained, that is, in which, for instance the removal of varying quantities of heated medium are possible at a constant selectable temperature, or in which the removal of a constant quantity of heated medium at differential temperatures can be achieved.

Another object of the invention is to provide such an arrangement in which no pump is necessary for circulating the electrolyte to and from contact with the heat exchanger.

In keeping with these objects, and others which will become apparent hereafter, one feature of the invention resides in an arrangement for producing heat which, briefly stated, comprises two vessels one of which contains a quantity of electrolyte in liquid and vapor phase and the other of which contains a quantity of electrolyte in vapor and liquid phase. A first flow connection is established between the vessels for vaporized electrolyte to flow from the one to the other vessel, and a second flow connection exists between the vessels for liquid electrolyte to flow from the other to the one vessel. Valve means is interposed in at least the first flow connection and constitutes the sole means for regulating the flow of electrolyte in either phase between the vessels. A heat exchanger is in one of the vessels and electrodes are arranged in the other vessel and are adapted to be connected with a source of electrical energy.

Thus, the present invention provides a closed system, rather than an open system as is known from the prior art.

Moreover, it does not require a pump because the flow is controlled exclusively by the single valve or the two valves which are provided.

With such an arrangement, a change in the phase of the electrolyte makes possible the transmission of heat to the heat exchanger at high values, thereby permitting the arrangement to have a much more compact structure than previously possible and, on the other, hand the valve or valves can be opened or closed in dependence upon certain desired factors, for instance, by a thermostat which opens and closes the valves in dependence upon a desired and preset water temperature of the medium to be heated, so that the heat exchanger is supplied with additional heating vapor, if additional heat is called for, without any delay.

It is particularly advantageous if the system is arranged in two cylindrical vessels which are connected by one conduit at the vapor side and by a second conduit at the liquid side of the electrolyte they contain. At least in the vapor side conduit, the valve will be arranged which has been mentioned above, and this valve can be controlled by the aforementioned thermostat, or it can be controlled by a pressostat (a pressure-measuring device) in dependence upon the vapor pressure of the electrolyte.

If in such an arrangement the valve is, for instance, closed and the electrodes are in operation to thereby heat the liquid electrolyte, then the electrolyte is pushed via the open conduit and the liquid side into the cylinder containing the heat exchanger, and the electrodes are therefore exposed to a continuously increasing extent until they reach a safety limit which may be controlled by a limit switch or the like. When a requirement develops, the thus stored quantity of vapor is freed by opening the valve in the vapor conduit and is condensed by contact with the heat exchanger. Because this causes the vapor pressure in the vessel to drop, the electrolyte liquid flows from the vessel containing the heat exchanger into the other vessel, rises in increasing measure along the electrodes therein and thus increases the transmission of heat from the electrodes to the electrolyte. As soon as the thermostat arranged in the medium to be heated by the heat exchanger indicates that the desired temperature has been reached, which takes place very rapidly because the supply of heat to the heat exchanger is almost instantaneous, the stream of vapor is throttled through the valve in the vapor conduit in dependence upon the desired preselectable temperature.

To avoid heat circulations at the liquid side, that is, circulations between the vessel containing the heat exchanger and the vessel containing the electrodes, it is advantageous that the lowermost edge of the electrodes in their vessel is at the same level or at a higher level than the uppermost edge of the conduit through which the liquid electrolyte flows between the vessels.

It is further advantageous if the cooling and formation of condensate on the heat exchanger is aided by providing an additional heat exchanger which is immersed completely or in part in the liquid electrolyte. In this manner, the medium to be heated is subjected to heating at very high effectiveness and in a two-stage arrangement. It is preheated by the heat exchanger which is partly or completely immersed in the condensate and is then raised to the final desired temperature by the heat exchanger which is contacted exclusively by the vapor phase of the electrolyte.

A particularly compact arrangement with high transmissivity factors can be obtained in that the heat exchanger and the vessel containing the electrodes are both located in a single container of cylindrical configuration, and with the heat exchanger and the electrodes being arranged concentrically in upright position. Advantageous, the container is here constructed in cup-shape with the electrodes being arranged concentrically therewith and the heat-exchanger being U-shaped.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a somewhat diagrammatic vertical section illustrating a first embodiment of the invention;

FIG. 2 is a further embodiment of the invention, in a view similar to FIG. 1; and

FIG. 3 is a view similar to FIG. 2 illustrating an additional embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Discussing firstly the embodiment illustrated in FIG. 1 it will be seen that there is provided a container **1** having two communicating vessels or chambers **1'**, **1''**. In the vessel **1''** is located the heat exchanger **2**, and the vessels **1'** and **1''** together constitute a closed system, being connected by one conduit **3** at the vapor side and by another conduit **4** at the liquid side of the electrolyte. The electrolyte is identified with reference numeral **5** and it will be seen that each of the vessels **1'**, **1''** contains at the bottom a quantity of liquid electrolyte and above it a quantity of electrolyte in vapor phase. In the vessel **1'** are also located the electrodes **6** whose lower edge **6'** is located at the same level as or higher than the uppermost edge **4'** of the conduit **4**, in order to prevent the circulation of liquid.

A valve **7** is interposed in the conduit **3** and may either be coupled with a thermostat **8** located in the outlet **2'** of the heat exchanger **2** where the latter discharges liquid which is heated, or with a pressostat **9** which is connected with the interior of the vessels.

Reference numeral **2''** designates the inlet of the heat exchanger **2** at which medium to be heated enters the latter.

It will be appreciated that if the electrical circuit with which the electrodes **6** are connected is completed, either by a manual switch or by a switch **10** operated by a timer, then the electrodes will supply full heat because in this case they are surrounded by the non-heated electrolyte **5** over their entire height to the level A. As the temperature of the electolyte rises, the vapor pressure in the vessel **1'** increases when the valve **7** is closed. The increasing vapor pressure in the vessel **1'** causes the electrolyte **5** to be pushed back into the vessel **1''** via the conduit **4** and, for instance, to be raised in the vessel **1''** to the level B. As this takes place, the level of electrolyte surrounding the electrodes **6** drops, and the amount of heat supplied by the electrodes decreases correspondingly. Equilibrium condition is reached when the vapor pressure produced in the vessel **1'** by the residual heating effect produced by the electrodes **6** as the level of the electrolyte **5** around them decreases corresponds to the static counterpressure of the liquid electrolyte in the vessel **1''**, which is derived from the difference of the height of the liquid electrolyte in the two vessels **1'**, **1''**. If, in this condition, the valve **11** is opened and heated medium is withdrawn from the outlet **2'** of the heat exchanger **2**, then the thermostat **8** opens the valve **7** in the conduit **3**, so that the heated vapor in the vessel **1'** expands as it flows into the vessel **1''** where it contacts the heat exchanger **2** to become condensed as it yields up heat to the same. Thus, it yields its heat of condensation at appropriate pressure to the medium in the heat exchanger **2** at high heat transmission values. At the same time the vapor pressure which has previously existed in the vessel **1'** decreases, and via conduit **4** a quantity of liquid electrolyte necessary to reestablish equilibrium will flow from the vessel **1'** back into the vessel **1**, rising about the electrodes **6.** The thermostat **8,** which has been preadjusted to a desired temperature for the medium in the outlet **2'**, so regulates the valve **7** that the heat content of the vapor which still flows through the conduit

3 to the heat exchanger 2 will be just sufficient in order to heat the medium in the heat exchanger 2 to the desired temperature. Because the vapor pressure in the vessel 1' is a direct function of the corresponding vapor temperature, the described regulation can also be effected by a pressostat 9 which is associated with the container 1.

FIG. 2 shows an embodiment corresponding to that of FIG. 1, and like reference numerals have been used to designate like components. In addition, however, the embodiment in FIG. 2 utilizes the condensate 5' which drips off the heat exchanger 2 for the purpose of prewarming the medium to be heated, to thereby increasing the total effectiveness of the system. This is achieved by having in this embodiment a second heat exchanger 2''' which advantageously is so constructed that it will be immersed over its entire height in the hot boundary layer C of the condensate 5' which is to be cooled, and the medium to be heated is passed first through the heat exchanger 2''' and only subsequently through the heat exchanger 2.

The embodiment in FIG. 3, finally, shows the heat exchanger 2 arranged in the container 1. The container 1 is here of cylindrical configuration and, as in the previous embodiments, has the vessels or chambers 1' and 1'', the chamber 1'' being located inside the chamber 1'. Reference numeral 3 again identifies the vapor-phase conduit which is to be opened or closed by the valve 7. The liquid phase conduit 4, however, is replaced by openings 4'' which are provided in the wall 2IV of the vessel 1''. The valve 7 is to be opened or closed, as in the preceding embodiments, by the thermostat 8 which is associated with the outlet 2' of the heat exchanger 2, or by a pressostat 9 associated with the container 1. It will be seen that the chambers 1' and 1'' are here of cup-shaped configuration whereas the heat-exchanger 2 is of U-shaped configuration. The electrodes 6, which are in upright position, are concentrically arranged with the chambers 1' and 1''.

Of course, various changes may be made in the form, the size and the manner of flow regulation, depending upon the particular requirements of a given application. For instance, the embodiments in FIGS. 1 and 3 could be utilized as water heaters for household use, or again as large-dimension systems for the heating of swimming pools or the like. If a more flexible regulation of the system operation is desired, additional vessels, each provided with a heat exchanger 2, could be associated with the vessel 1' in FIG. 1, and they could be charged with vapor cushions for storage purposes during nighttime when the cost of electrical current is usually less than during the daytime.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of constructions differing from the types described above.

While the invention has been illustrated and described as embodied in an arrangement for producing heat, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. An arrangement for producing heat, comprising two closed vessels each of which contains a quantity of electrolyte in liquid phase and a quantity of electrolyte in vapor phase; at least one heat exchanger in one of said vessels arranged to have admitted therein a medium to be heated, at least part of said one heat exchanger being located in the electrolyte vapor of said one vessel; electrodes in the other of said vessels and being at least in part located in the liquid electrolyte of said other vessel, said electrodes being adapted to be connected with a source of electrical energy for vaporizing the liquid electrolyte in said other vessel; a first flow connection between said vessels for vaporized electrolyte to flow from said other vessel to said one vessel; a second flow connection between said vessels for liquid electrolyte to flow between said vessels; and valve means interposed in at least said first flow connection for regulating the flow of electrolyte in either phase between said vessels, said valve means having an open position for permitting vaporized electrolyte to flow from said other vessel to said one vessel and a closed position for preventing the flow of vaporized electrolyte from said other vessel to said one vessel, and means for actuating said valve means to said open position so as to permit the vaporized electrolyte to flow into said one vessel and contact said part of said one heat exchanger to thereby heat the medium in said one heat exchanger.

2. An arrangement as defined in claim 1, wherein said vessels are two connected chambers of a container.

3. An arrangement as defined in claim 1, wherein said vessels are two discrete containers and said flow connections are conduits.

4. An arrangement as defined in claim 1, said one heat exchanger defining a flow path for the medium to be heated; and said actuating means comprising a pressostat responsive to the vapor pressure of the electrolyte in said other vessel, said pressostat being coupled with said valve means for opening and closing said valve means in dependence upon said vapor pressure.

5. An arrangement as defined in claim 1, wherein said electrodes have lower edges which are located on a level at least equal with that of an upper edge of said second flow connection.

6. An arrangement as defined in claim 1, wherein the vaporized electrolyte from said other vessel condenses in said one vessel upon contacting said part of said one heat exchanger; and further comprising another heat exchanger in said one vessel and defining with said one heat exchanger a flow path for the medium to be heated, said other heat exchanger being located upstream of said one heat exchanger, and said other heat exchanger being arranged so as to be at least partially submerged in the condensed electrolyte to thereby preheat the medium to be heated and cool the condensed electrolyte.

7. An arrangement as defined in claim 1, wherein said vessels are two chambers of a single container; and

wherein said container is of cylindrical configuration.

8. An arrangement as defined in claim **7**, wherein said electrodes are arranged upright and concentrically in said container.

9. An arrangement as defined in claim **7**, wherein said chambers are of substantially cup-shaped configuration.

10. An arrangement as defined in claim **7**, wherein one of said chambers is located interiorly of the other of said chambers, said chambers being substantially concentrically arranged.

11. An arrangement as defined in claim **10**, wherein said one heat exchanger is of substantially U-shaped configuration and said chambers are of substantially cup-shaped configuration.

12. An arrangement for producing heat, comprising two closed vessels each of which contains a quantity of electrolyte in liquid phase and a quantity of electrolyte in vapor phase; a heat exchanger in one of said vessels defining a flow path for a fluid to be heated, at least part of said heat exchanger being located in the electrolyte vapor of said one vessel; electrodes in the other of said vessels and being at least in part located in the liquid electrolyte of said other vessel, said electrodes being adapted to be connected with a source of electrical energy for vaporizing the liquid electrolyte in said other vessel; a first flow connection between said vessels for vaporized electrolyte to flow from said other vessel to said one vessel; a second flow connection between said vessels for liquid electrolyte to flow between said vessels; valve means interposed in at least said first flow connection for regulating the flow of electrolyte in either phase between said vessels, said valve means having an open position for permitting vaporized electrolyte to flow from said other vessel to said one vessel and a closed position for preventing the flow of vaporized electrolyte from said other vessel to said one vessel; and thermostat means coupled with said valve means for operating said valve means between said open and closed positions in dependence upon the temperature of the fluid flowing through said heat exchanger, said thermostat means being effective for operating said valve means to said open position when the fluid flowing through said heat exchanger is to be heated and when said electrodes have vaporized a quantity of the liquid electrolyte in said other vessel so as to permit the vaporized electrolyte to flow into said one vessel and contact said part of said heat exchanger to thereby heat the fluid flowing through said heat exchanger.

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