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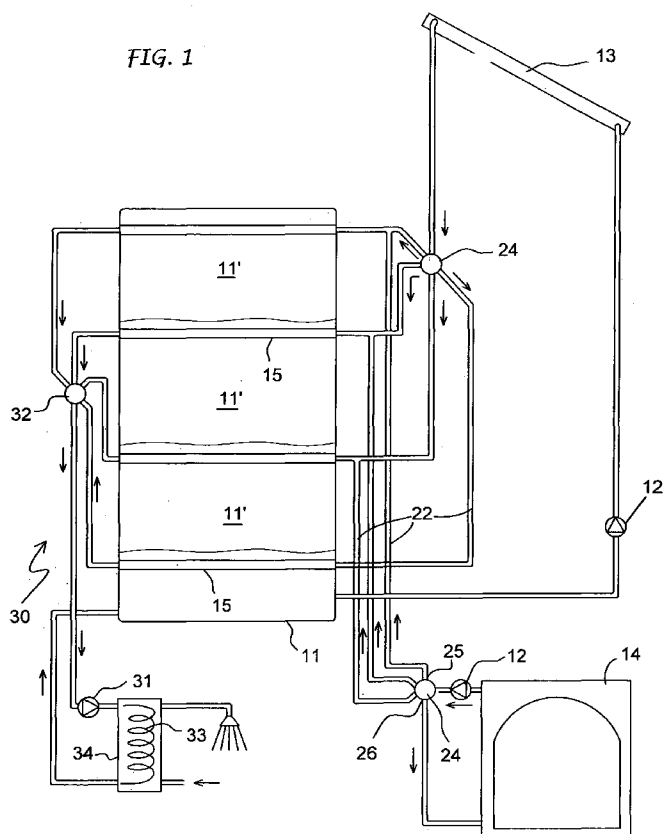
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(54) Title: STRATIFICATION TYPE HEAT ACCUMULATION SYSTEM

FIG. 1



(57) Abstract: The invention is intended for a closed-circuit heat accumulation system comprising a substantially cylindrical tank arranged vertically, annular channels arranged at various levels on the inner surface of the tank in line with the layers of water to be accumulated and in relation to the temperature of the water available from time to time, water supply and return pipes within the circuit connected from the outside to said tank at the level of each of said annular channels, self-regulating valve means to control the supply and return in the tank, through said pipes and said annular channels, of the water at different temperatures for its stratification, and means for programming the operation of said valve means according to the temperature of the circulating water.

“STRATIFICATION TYPE HEAT ACCUMULATION SYSTEM”

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Field of the Invention

The present invention generally relates to the field of liquid accumulators with heat energy content and concerns in particular an innovative system of accumulation in a tank of a heat conveying liquid, normally water, in
5 superimposed layers depending on the temperature of arrival of the liquid itself.

State of the Art

A hot liquid, normally water, coming from any heating source, whether solar, fuel fired, or from water-cooled appliances, perhaps at different
10 temperatures, can be accumulated in layers in a tank for the temporary storage of heat energy. Accumulation is in closed cycle and the stored heat energy can then be used, by means of a possible heat exchanger, for several other uses, such as the production of domestic hot water, hot water for local floor heating or by means of radiators, etc.

15 In this respect heat accumulation systems have already been proposed and used in which the water at different temperatures is collected in superimposed layers starting with the coldest at the bottom up to the hottest at the top, with the possibility of then taking from the system the hottest water or that at the desired layer level for the contemplated use.

20 Such accumulation is based on the physical principle whereby the specific weight of the water varies together with the variation of the temperature, so that in a mass of water the coldest is at the bottom while the hottest rises and occupies the upper layers. Correspondingly the temperature of the water collected in a tank will vary in the sense of increasing from the bottom upwards

as long as, obviously, care is taken not to cause any mixing and, consequently, to mix the water in the various layers.

The documents DE 2 703 460, WO 80/01714, FR 2 565 333, EP 0 683 362, EP 1 010 961 describe stratification heat accumulation systems that well
5 indicate the state of the art and which are currently known.

Nevertheless, in these known systems of accumulation, the water is conveyed and collected in the storage tank through a column, substantially cylindrical, built in the tank itself and to which are connected at various levels both the water inlet pipes and the outlet pipes with a relatively complicated
10 network of channels that is difficult and costly to make. What is more, at least in EP 0 683 362, to calm down the inflow and outflow of the water and prevent currents and/or vortices that could cause the mixing of the various layers of water, the column is configured to define a concentric inner chamber and outer chamber, where the first chamber communicates with the second through
15 numerous openings, and the second chamber communicates with the inside of the tank through another series of radial openings, with the result that the system is even more complex.

Object and Summary of the Invention

Starting with what has been said, the object of the present invention is to
20 present upgrading solutions of a constructive and functional nature to the stratification heat accumulation systems to overcome the drawbacks of known technology and with the intention of providing an efficient accumulation system, that is simpler and cheaper to make, with possible easy access for maintenance and that can be more precisely controlled through a control unit.

25 This object is achieved, according to the invention, with a closed-circuit

heat accumulation system comprising a substantially cylindrical tank arranged vertically, annular channels arranged at various levels on the inner surface of the tank corresponding to the layers of water to be accumulated and in relation to the temperatures of the water available from time to time, water supply and
5 return pipes forming part of the circuit connected from outside to said tank at the level of each of said annular channels, self-regulating valve means for controlling the supply and return in the tank, through said pipes and said annular channels, of the water at different temperatures for its stratification, and means for programming the operation of said valve means according to the
10 temperature of the circulating water.

The annular channels can be at least in number equal to the layers of water in the tank and made in at least two different ways with large openings turned towards the centre of the tank. In any case, their location on the cylindrical inner wall of the tank is such as to allow a high volume of inflowing
15 and outflowing water, at low speed and therefore without any vortical movement which could cause the mixing of the water layers. What is more, their manufacture *in primis*, and their fastening and any access inside the tank are very simple and easy, and do not affect the actual storage capacity of the tank.

20 Furthermore and advantageously, the self-regulating valve devices can consist of multiway ball valves, for example of the type described in another patent application of the same applicant, and include at least a first valve to which the water supply pipes can be connected at the various tank levels and at least a second valve to which the water return pipes can be connected from
25 the various tank levels. What is more, the same pipes, connected to a single

self-regulating multiway valve could also be used alternately in one direction for the supply and in the opposite direction for the return of water from the tank.

Brief Description of Drawings

Further details of the invention will become evident from the rest of the description made with reference to the attached drawings, which are merely
5 approximate and not limiting, in which:

the Fig. 1 shows a schematic view of the system with transparent view of accumulation tank;

the Fig. 2 shows an enlarged view of a detail of the accumulation tank to
10 highlight two types of inner annular channels.

Detailed Description of the Invention

In the example shown, the system comprises a container or tank 11 for the layer accumulation 11' of hot water at different temperatures, which can be produced or come, by means of at least one pump 12 or with natural circulation
15 systems, from different heat sources operating at variable temperature, such as a solar panel 13, a boiler 14 and also a water-cooled appliance.

The accumulation tank 11, which will be insulated towards the outside or made of a heat-insulating material, is substantially cylindrical and arranged vertically. At the top, it can be opened for operation at atmospheric pressure or
20 closed for operation under pressure, according to need.

Inside the accumulation tank 11 are annular channels 15 arranged at various levels, in a number equal at least to the layers of water 11' at different temperature to be defined in the tank, the layers of water being three or more depending on the storage capacity and height of the tank and on the
25 temperatures of the available hot-water sources. Such annular channels 15 are

fixed, for example by welding, to the cylindrical inner surface of the tank, and each of them can be made starting with a tubular element 16, with round or not round section, bent in a round shape and having cracks or side openings 17, as large as possible, turned towards the centre of the tank –Fig. 2.

5 But more preferably, each annular channel 15 will be formed starting with two metal-plate round elements 18 each having a first wing 19 that fastens onto the inner surface of the tank and a second wing 20, angled with respect to the first and which extends towards the inside of the tank. The two initial elements are opposite and associated so that between them they delimit an
10 annular continuous duct and so their second wings 20 converge to define a slit or opening 21 such as to place in communication said duct with the inside of the tank- Fig. 2. Said slit 21 can be without interruption, or interrupted, for example, at the inlet and outlet parts of the liquid in the tank.

To the tank 11, at the level of the inner annular channels 15, a number of
15 first pipes 22 are fastened for supplying water in the tank at different temperatures and each second pipes 23 for the return of the water from the tank.

Each pipe 22, 23 is in communication with a respective annular channel and the water flows towards and from the tank are controlled by means of valve
20 units. Preferably and as shown in Fig. 1, each valve unit can consist of a multiway self-adjusting ball valve with bi-directional use. The supply pipes 22 can be connected, directly or through a manifold, to an equal number of outlets 25 of a first multiway ball valve 24 having an inlet 26 connected to any hot water source 13, 14 of the aforementioned type. Similarly, the return pipes 23
25 are connected, these too directly or by means of a manifold, to an equal

number of inlets of another multiway ball valve having in turn an outlet connected to the same hot water source, to close the hydraulic circuit.

Each of said ball valves can be controlled by means of a servo-motor prepared and controlled according to a preset principle to cause a rotation of the respective ball shutter and place in communication from time to time and selectively, in the first valve the inlet way 26 with at least one outlet way 25 of the water towards the tank and, in the second valve one or the other of the inlet ways with the outlet way of the water towards the source 13 or 14, in answer to a signal provided from outside. This signal can be a temperature signal read with at least a special probe upstream and/or downstream of each valve or at least of the valve connected to the supply pipes.

It should be noticed in any case, as has already been said above, that the circulation of the water from the heating source to and from the accumulation tank can be completed with just one series of pipes connected to each single annular channel inside the tank and connected to a single multiway valve. In this case, the pipes will be used in one direction for supplying water to the tank and in the opposite direction for the return of the water from the tank, and the valve will be controlled consequently.

Finally, to the tank will be connected a circuit 30 with a pump 31 for taking water from the accumulation tank 11 at the level of the upper layer or at any other level and with the aid of a multiway valve 32 also of the aforementioned type for using the thermal content of the water for heating, through a possible heat exchanger 33 and a possible auxiliary tank 34, of another liquid, normally water, to be used as domestic water or heat conveying fluid in local heating plants.

"STRATIFICATION TYPE HEAT ACCUMULATION SYSTEM"

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C L A I M S

1. Closed circuit stratification accumulation system for a liquid, in particular water, at different temperatures, coming from one or more solar or
5 fuel heating sources or from water-cooling systems, comprising
- a substantially cylindrical tank, vertically arranged,
 - annular channels arranged at various levels on the inner surface of the tank in line with the layers of water to be accumulated,
 - water supply and return pipes as part of the closed circuit connected to
10 said tank from outside and in communication with each of said annular channels,
 - at least one self-regulating valve unit to control, through said pipes and said annular channels, the supply and return of water at different temperatures for its stratification in the tank,
 - 15 - means for controlling the operation of at least said valve unit in response at least to the temperature of the water circulating from time to time.
2. Accumulation system according to claim 1, wherein said tank is heat insulated towards the outside and open at the top.
3. Accumulation system according to claim 1, wherein said tank is heat
20 insulated towards the outside and closed for its operation under pressure.
4. Accumulation system according to claims 1 and 2 or 3, wherein each annular channel consists of a round-shaped tubular element with side slits or openings turned towards the centre of the tank.
5. Accumulation system according to claims 1 and 2 or 3, wherein each

annular channel consists of two round elements each having a first wing that fastens onto the inner surface of the tank and a second wing, angled with respect to the first and which extends towards the inside of the tank, and wherein said two elements are opposite and associated to delimit between
5 them a continuous annular duct and to define with their second wings a slit or opening such as to place in communication said duct with the inside of the tank.

6. Accumulation system according to claim 1, wherein said slit between said two opposite round elements is without interruption or interrupted in some of its parts.

10 7. System according to any of the previous claims, wherein to the tank, at the level of the inner annular channels, first pipes are fitted for supplying the tank with water at different temperatures and second pipes for the return of the water from the tank, where each pipe is in communication with a respective annular channel and the water flows towards and from the tank are controlled
15 by means of at least one valve unit.

8. Accumulation system according to claim 7, wherein each valve unit consists of a self-regulating multiway ball valve that can be used bi-directionally and where the supply pipes are connected, directly or by means of a manifold, to an equal number of outlets of a first multiway ball valve having an inlet
20 connected to the hot water source, and the return pipes are connected, directly or by means of a manifold, to an equal number of inlets of a second multiway ball valve having in turn an outlet connected to the hot water source.

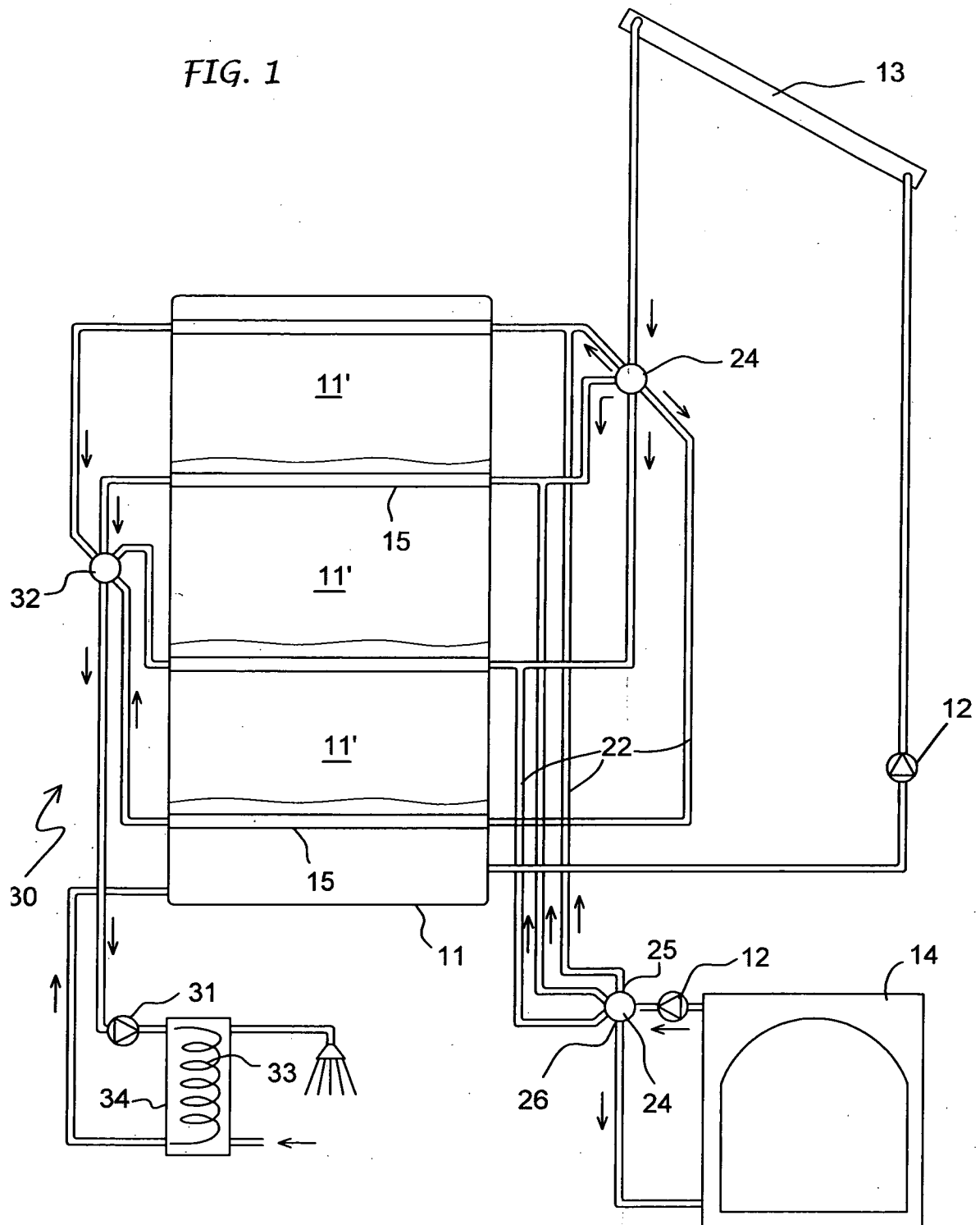
9. Accumulation system according to claim 7, wherein each multiway ball valve is controlled by means of a servo-motor prepared and controlled
25 according to preset programs and according to a signal indicative of a physical

quantity relating to the circulating water.

10. Accumulation system according to claim 9, wherein each multiway ball valve is operated according to a temperature signal read with at least a specific probe upstream and/or downstream of each valve or at least the valve
5 connected to the supply pipes.

11. System according to any of the claims from 1 to 6, wherein the tank, at the level of the inner annular channels, is provided with pipes both for a supply and a return of the water at different temperatures in the tank itself, and wherein said pipes are in communication with at least one source of hot water
10 through at least one self-regulating multiway ball valve that can be used bi-directionally.

FIG. 1



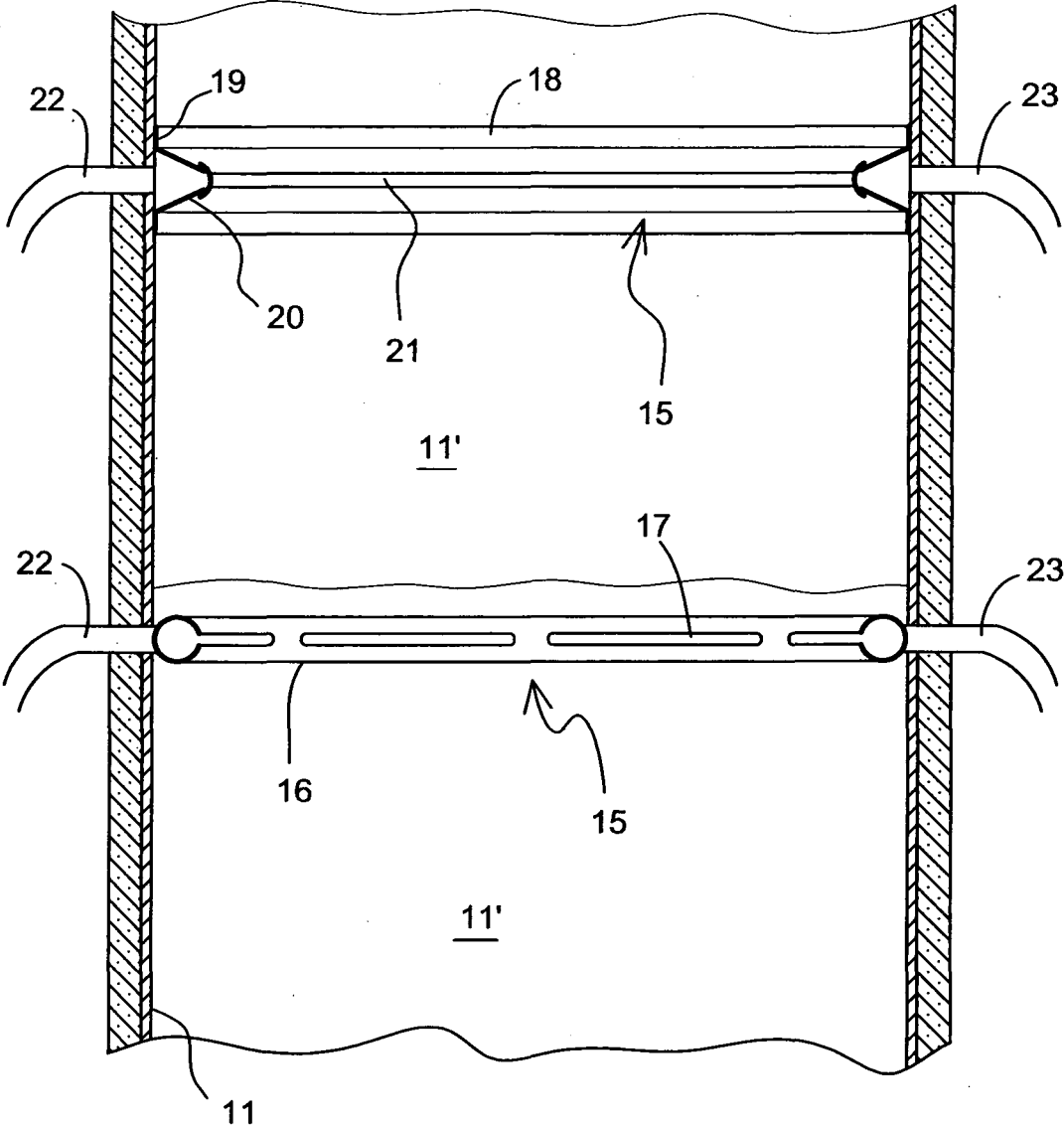


FIG. 2