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(71) Applicant: **Tol Group S.R.L.**
24043 Caravaggio (BG) (IT)

(72) Inventors:
- **BETTONAGLI, Daniele deceased (IT)**
- **SESSANTINI, Cristian 24049 VERDELLO (BG) (IT)**
- **BELLINI, Massimiliano 25080 MONIGA DEL GARDA (BS) (IT)**

(74) Representative: **Mittler, Andrea et al**
MITTLER & C. s.r.l.
Viale Lombardia, 20
20131 Milano (IT)

(54) BOILER WITH PLATES IN A ZIGZAG WAY FOR PRODUCING AND ACCUMULATING HOT SANITARY WATER

(57) A boiler (1) for the production of hot sanitary water comprising a storage tank (2) of the sanitary water coming from a water supply system. The boiler (1) internally comprises a heat exchanger (8) with watertight plates arranged in a zigzag way to perform the heat exchange between a heat transfer fluid coming from a heating circuit connected to a heat pump, or other, and the sanitary water stored in said storage tank (2). (Fig. 1).

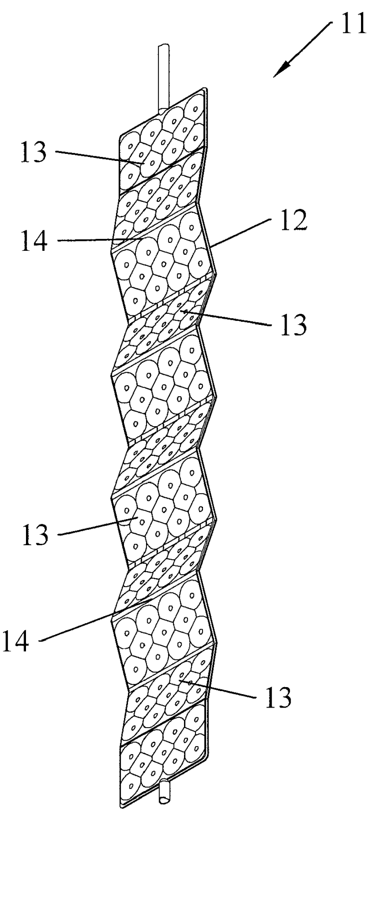

FIG.1

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Description

[0001] The present invention relates to a boiler with zigzag plates for producing and accumulating hot sanitary water.

[0002] Two systems are normally used for producing hot sanitary water: instant systems and storage systems. Sanitary water is the water intended for human consumption, such as treated or non-treated water used for drinking, for preparing food and beverages and for other domestic uses, independently from the origin and from the supply system, which may be a water network or tanks.

[0003] Instant systems are designed and dimensioned to respond to hot water demands by a direct, i.e. instant, production. Storage systems, instead, are designed and dimensioned to respond to hot water demands with a direct production and with the help of a preheated water reserve. With respect to the instant system, the storage system makes it possible to use much less powerful generators, in addition to a more continuous and regular system operation, and thus with better thermal efficiency.

[0004] Typically, a storage system comprises a tank able to store the sanitary water with a heat exchanger inside able to achieve the flow of a heat transfer fluid, which has the task of transferring its thermal energy to the sanitary water in order to heat it. An example of heat exchanger present inside a storage system may be the one illustrated in patent KR-1496361B1, i.e. a serpentine heat exchanger comprising a single exchanger pipe shaped according to a plurality of mutually stacked loops.

[0005] The problem of the known storage systems is that, because of a similar heat exchanger (which may appear also with more than one serpentine), considerably large tanks which are difficult to arrange on the wall are required to obtain a large exchange surface.

[0006] Another problem is represented by the limited dispensing time of the sanitary water.

[0007] WO-98/10233, FR-2391444, EP-1350560 and EP-1527816 show heat exchangers comprising a plurality of exchanging plates.

[0008] Italian patent application 102015000069891 by the present applicant discloses a boiler comprising a plurality of rectangular shape exchanging plates.

[0009] BE-456987 discloses a heat exchanger between fluids counterflowing between plates with a zigzag development. Each plate is full and the fluids pass between the plates arranged in parallel.

[0010] DE-102009026420 discloses a device for heating drinking water which flows through a spiral line in a container full of water.

[0011] The drinking water line is housed in a duct which is open on the top in which the hot water taken from the upper part of the containers counterflows.

[0012] Disadvantageously, the exchanged heat is very limited and exchanging plates are not shown.

[0013] It is the object of the present invention to make a storage boiler for the production of hot sanitary water which solves the aforesaid problems, whereby improving the efficiency of the exchanging plates and reducing both energy consumption and the volume occupied by the exchanging plates in the tank.

[0014] It is a further purpose of the present invention to provide sanitary water unlimitedly both with direct production and with the help of a preheated water reserve, in the full respect of the standard UNI EN-13203-1/2/3.

[0015] According to the invention, such object is achieved by a boiler as disclosed in claim 1.

[0016] Advantageously, a zigzag development is provided, substantially along a broken line, on the length of the plate, which allows to slow down both the internal flow (technical water) and the external flow (sanitary water), thus extending the heat exchange time between the two fluids themselves.

[0017] The surface of the exchanging plates is advantageously increased by 3,7 %, the dimension being the same.

[0018] These and other features of the present invention will be more apparent from the following detailed description of a practical embodiment thereof, shown by way of non-limitative example in the accompanying drawings, in which:

Figure 1 shows a perspective view of a zigzag plate;
Figure 2 shows a side view of the plate of figure 1;
Figure 3 shows a top plan view of the plate of figure 1;
Figure 4 shows a side view of a boiler with a plurality of plates, each of which is shown in figures 1-3;
Figure 5 shows a front view of the boiler of Figure 4.
Figures 4-5 show a boiler 1 for the production of sanitary hot water according to the invention.

[0019] Sanitary water is the water intended for human consumption, such as treated or non-treated water for drinking, for preparing food and beverages and for other domestic uses, independently from the origin and from the supply system which may be a water network or tanks.

[0020] The boiler 1 comprises a storage tank 2 for storing the sanitary water to be heated coming from a water supply system, for example; the sanitary water is introduced into the tank 2 by an inlet duct 3 communicating with the water network and is supplied hot by an outlet duct 4 connected to sanitary waterworks.

[0021] In particular, the tank 2 is substantially cylindrical and comprises an upper base 5 and a lower base 6 of substantially circular shape, and a side surface 7. It is worth noting that the tank 2 may have another shape, i.e. with elliptical cross section.

[0022] In an embodiment, the tank 2 may be a stainless steel tank with capacity of 150 liters, with cylinder having a height of 2140 mm, and each of the upper and lower bases 5, 6 having a diameter of 311,5 mm. The overall dimension of the tank 2 is thus 311,5 x 311,5 x 2140 mm.

[0023] As shown in Fig. 4, the inlet duct 3 of the sanitary water from the water network is positioned in a lower part of the side surface 7 of the tank 2 and comprises a tube

20 provided with a plurality of holes 21, said tube 20 being able to inject inlet sanitary water through said holes 21 inside the tank 2. The hot sanitary water is instead taken from an outlet duct 4 located in the central part of the side surface 7 of the tank 2; the outlet duct 4 comprises a tube 19 with a first curved stretch and a second vertical linear stretch for drawing hot sanitary water from the top of the tank 2. As mentioned, the sanitary water is sent to the sanitary waterworks by the outlet duct 4.

[0024] Inside the storage tank 2 there is a heat exchanger 8 able to exchange thermal energy between a heat transfer fluid which flows inside the heat exchanger 8 and the sanitary water contained in the tank 2; for example, the heat transfer fluid may consist of water, being named "technical water". In this case, it is a heat exchanger 8 of the water-water type, with the technical water which represents the fluid at a higher temperature with the task of transmitting the heat to the sanitary water.

[0025] The technical water is at a temperature of about +55°C and comes from a heating circuit which may be connected to a heat pump, to a thermal solar system, to a system which extracts energy from biomasses or heat generators fed with gas or other fuel. Although the boiler 1 according to the present invention is designed to operate with each of the aforesaid systems, it is optimized for coupling to heat pumps because, as will be shown below, the large exchange surface offered by the particular heat exchanger 8 used means that the temperature of the technical water returned to the heating circuit will not high, and therefore such to preserve the heat pump itself.

[0026] Indeed, as known, a heat pump substantially comprises four elements, which are an evaporator, a compressor, a condenser and an expansion valve. A refrigerating fluid with an extremely low boiling point circulates through a closed circuit which crosses the aforesaid elements. The environmental energy supplied by a geothermal circuit causes the evaporation of such refrigerating fluid which, after having been compressed (with consequent superheating to high temperature) transmits thermal energy to the heating circuit in which the technical water flows. This occurs cyclically because the pressure of the refrigerating fluid which can absorb the environmental energy is reduced after the step of condensing due to the heat transmission to the technical water.

[0027] If the technical water does not release sufficient heat during the heat exchange with the sanitary water, the heat pump may be damaged because the temperature of the returning technical water will be excessively high. By virtue of the large exchange surface offered by the particular heat exchanger 8 described below, the returning technical water will release sufficient thermal energy to have an optimal temperature for the correct operation of the heat pump.

[0028] The heat exchanger 8 is a fixed heat exchanger made of stainless steel of the type with watertight plates having a high heat exchange surface and low loss of load on technical water side. Said heat exchanger 8 (Fig. 4) comprises an upper distribution manifold 9, able to inject the delivery technical water coming from the heating circuit, and thus from the heat pump, and a lower distribution manifold 10 able to let out the returning technical water through the heating circuit towards the heat pump. As mentioned, both the upper and lower manifolds 9, 10 are made of stainless steel and in the case in the example, have a diameter of 1 inch.

[0029] The heat exchanger 8 comprises a plurality of exchanging plates 11 (also made of stainless steel) connected between said upper and lower distribution manifolds 9, 10.

[0030] Each exchanging plate 11 (Figs. 1-3), in turn, comprises an inner chamber 12, able to make the technical water flow inside; each inner chamber 12 receives technical water coming from the upper manifold 9 of the heat exchanger 8 and leads it to the lower manifold 10.

[0031] As clearly shown in figures 1-2, each exchanging plate 11 comprises a plurality of portions 13 which follow one another in series according to a broken line in a zigzag way, between the two manifolds 9, 10 in the direction of the length of the exchanging plate 11. Edges 14 between consecutive portions 13 are clearly visible.

[0032] Each portion 13 is substantially rectangular.

[0033] So, a particular zigzag development is created on the length of the plate 11 which makes it possible to slow down both the internal flow (technical water) and the external flow (sanitary water), thus extending the heat exchange time between the two fluids themselves.

[0034] In the examined embodiment, the heat exchanger 8 comprises four exchanging plates 11 (Fig. 2), each with a long side (zigzag-shaped) of 1645 mm and a short side 247 mm and the inner chamber 12 which can be made by stamping or inflating operation of the appropriately shaped surfaces, conferring the shape in figure 1, to obtain the maximum exchange efficiency.

[0035] As shown in figures 4-5, the heat exchanger 8 is centrally positioned inside the tank 2, with vertically oriented exchanging plates 11 starting from the upper distribution manifold 9, which is located in an upper part of the storage tank 2, up to the lower distribution manifold 10, which is located in the lower part of the tank 2.

[0036] On the other hand, the injection tube 20 of the inlet duct 4 is positioned so that the pairs of holes 21 are staggered with respect to the exchanging plates 11 of the heat exchanger 8; in other words, except for the first and last pair of holes 21, each of the remaining pairs of holes 21 is positioned so as to be located between two exchanging plates 11, so as to optimize the heat exchange between technical water and sanitary water.

[0037] The technical water is introduced in the inner chambers 12 of each exchanger plate 11 through the upper distribution manifold 9 to better exploit the production of hot sanitary water with instant taking effect. In this manner, indeed, the sanitary water present in the upper part of the tank 2, which is the one which is drawn first through the tube 19 at the time of use, will be the one which will be heated better and first by the technical water because it is let into the heat exchanger 8 at its maximum temperature (+55°C).

[0038] As mentioned, the heating circuit is connected to the boiler 1 by the upper and lower distribution manifolds 9, 10 of the heat exchanger 8 to convey the technical water which will heat the sanitary water present inside the tank 2 from the inner chambers 12 of the exchanging plates 11; for this purpose, the tank 2 comprises a first and a second section 15, 16, the first arranged centrally on the upper base 5 and the second inferiorly arranged on the side surface 7 of the tank 2, respectively the inlet up and the outlet down, coupled respectively to said upper and lower manifolds 9, 10.

[0039] The boiler 1 further comprises a magnesium anode so that the inner surfaces of the tank 2 can be subjected to cathodic protection, i.e. electrochemical protection from metal corrosion. As well known, cathodic protection is an electrochemical technique for protecting from corrosion metallic structures exposed to an electrolytic environment which may be aggressive towards the metal.

[0040] Two wells 18 for temperature sensors are also provided: one positioned at 2/3 of the height of the tank 2 to adjust the normal lighting of the heat pump; the second positioned at 1/3 of the height of the tank 2 to anticipate the lighting of the heat pump in case of high demand of hot sanitary water.

[0041] The insulation has an average thickness of 50 mm and guarantees a high thermal insulation with coefficient of conductivity of 0,023W/mK.

[0042] During operation, the delivery technical water at +55°C, coming from the heating circuit connected to the heat pump, is introduced from the top by the upper distribution manifold 9 in the exchanging plates 11 crossing the inner chambers 12.

[0043] On the other hand, the sanitary water entering into the tank 2 (which is at about +10°C) is introduced in counterflow with respect to the movement of the technical water, and this occurs by the tube 20 of the inlet duct 3, which is positioned on the lower part of the tank 2. By virtue of the staggered arrangement of the holes 21 with respect to the exchanging plates 11, the sanitary water is injected between one plate and the other, so that the thermal exchange between technical water and stored sanitary water is increased.

[0044] The high exchange surface offered by the exchanging plates 11 means that the returning technical water releases sufficient thermal energy to have an optimal temperature for the correct operation of the heat pump, whereby preventing it from being damaged.

[0045] The hot sanitary water (at a temperature of about +50°C) is drawn from the upper part of the tank 2 by the tube 19 of the outlet duct 4 so as to have a nearly instant heating effect upon drawing (variables: sanitary water arrival temperature, external air temperature, etc.), because, as mentioned, the technical water arrives from the upper manifold 9 to the heat pump at its maximum temperature.

[0046] Some technical data related to the boiler 1 according to the embodiment shown above are provided below:

- the warm-up time, i.e. the time for heating the entire amount of water stored in the tank 2 (150 liters in this case), from a temperature of about +10°C to a temperature of about +50°C and the technical water to a temperature of +55°C, is equal to 50 minutes with a with 8,0 kW of power heat pump; conversely, the warm-up time is about 35 minutes with a 14,0 kW power heat pump;
- the maximum power which can exchanged in kW is equal to 35 kW with the technical water at a temperature of +55°C, the sanitary water stored between +10°C and +45°C and continuous drawing of produced hot sanitary water;
- the technical water flow rate with 8,0 kW power heat pump is equal to 1,38 m^3/h;
- the technical water flow rate with 14,0 kW power heat pump is 2,40 m^3/h;
- the hot sanitary water which can be drawn during the first 10 minutes in 1/10' is equal to 370 liters between +10°C and +45°C, storage at +50°C and primary at +55°C and 8,0 kW power generator.

[0047] As mentioned, the boiler 1 according to the present invention for the production of hot sanitary water has very small dimensions and at the same time guarantees high efficiency, by virtue of the use of the particular heat exchanger 8 with zigzag watertight plates 11 and large heat exchange surface, thereby reducing energy consumption.

[0048] Advantageously, the adoption of zigzag exchanger plates 11 according to the present invention guarantees a larger heat exchange surface and a higher storage sanitary water volume, the space occupied by the tank 2 being equal.

Claims

1. Boiler (1) for the production of hot sanitary water comprising a storage tank (2) for accumulating the sanitary water coming from a water supply system, internally comprising a heat exchanger (8) with watertight plates able to carry out the heat exchange between a heat transfer fluid coming from a heating circuit which is connected to a heat pump, or other, and the sanitary water stored in said storage tank (2), said heat exchanger (8) comprising
   an upper distribution manifold (9) able to inject the delivery heat transfer fluid coming from the heating circuit,
   a lower distribution manifold (10) able to let out the return heat transfer fluid towards the heating circuit,
   a plurality of exchanging plates (11) connected between said upper and lower distribution manifolds

(9, 10), each exchanging plate (11) comprising an inner chamber (12) communicating with said upper and lower distribution manifolds (9, 10) and able to make the heat transfer fluid flowing inside for exchanging heat with the accumulated sanitary water, **characterized in that**
each exchanging plate (11) comprises a plurality of portions (13) which follow one another in series according to a broken line in a zigzag way, between the manifolds (9, 10) in the direction of the length of the exchanging plate (11).

2. Boiler (1) according to claim 1, **characterized in that** said storage tank (2) is provided with two wells (18) for temperature sensors, one positioned at 2/3 of the height of the tank (2) to adjust the normal ignition of the heat pump, the second positioned at 1/3 of the height of the tank (2) to anticipate the ignition of the heat pump in case of high demand of hot domestic water.

3. Boiler (1) according to claim 2, **characterized in that** an inlet duct (3) of the sanitary water from the water supply system is positioned in a lower part of the side surface (7) of the storage tank (2), while the heated sanitary water is drawn from the top of the storage tank (2) through an outlet duct (4) able to transport the sanitary water towards waterworks.

4. Boiler (1) according to claim 3, **characterized in that** said inlet duct (3) comprises a tube (20) provided with a plurality of holes (21) which are staggered with respect to the arrangement of the exchanging plates (11) of the heat exchanger (8), said tube (20) being able to inject through said holes (21) the sanitary water between the exchanging plates (11) inside the storage tank (2), and **in that** said outlet duct (4) comprises a tube (19) with a first curved portion and a second linear vertical portion for the suction of the sanitary hot water from the top of the storage tank (2).

5. Boiler (1) according to any one of the preceding claims, **characterized in that** said heat exchanger (8) is centrally positioned inside the storage tank (2), with vertically oriented exchanging plates (11) starting from the upper distribution manifold (9), which is located in a upper part of the storage tank (2), up to a lower distribution manifold (10), which is located in the lower part of the storage tank (2).

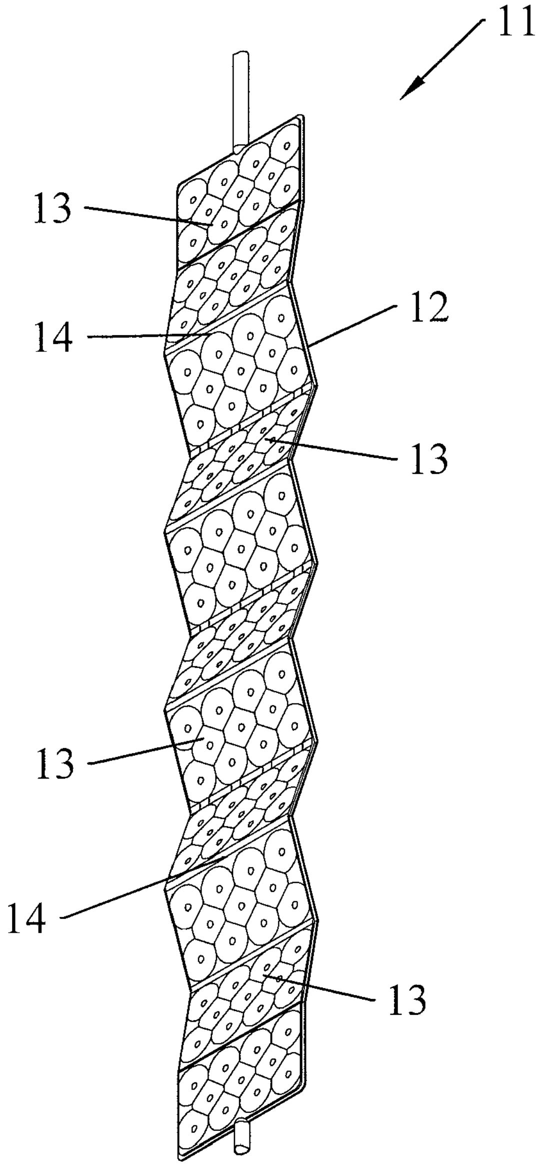

FIG.1

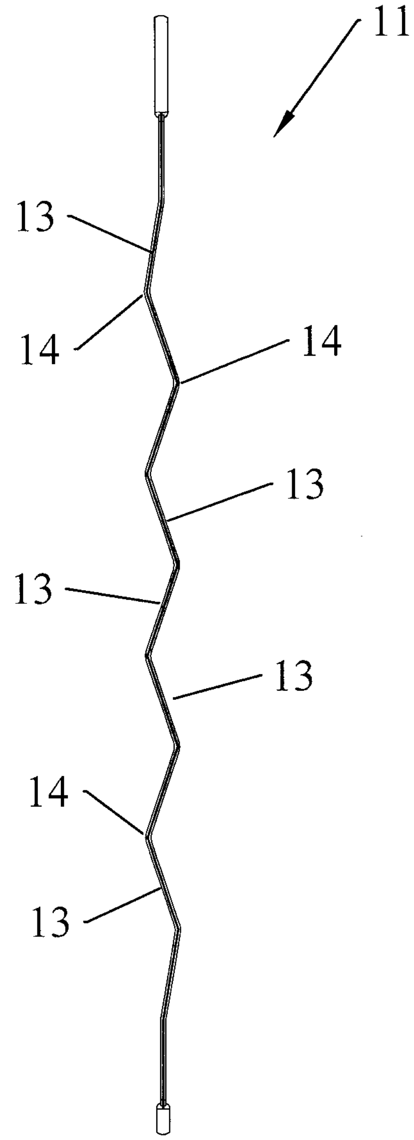

FIG.2

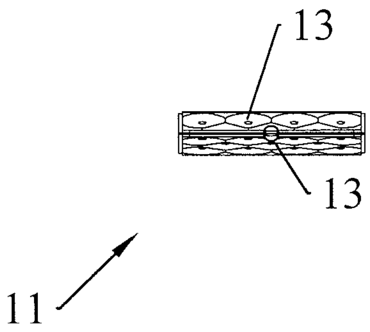

FIG.3

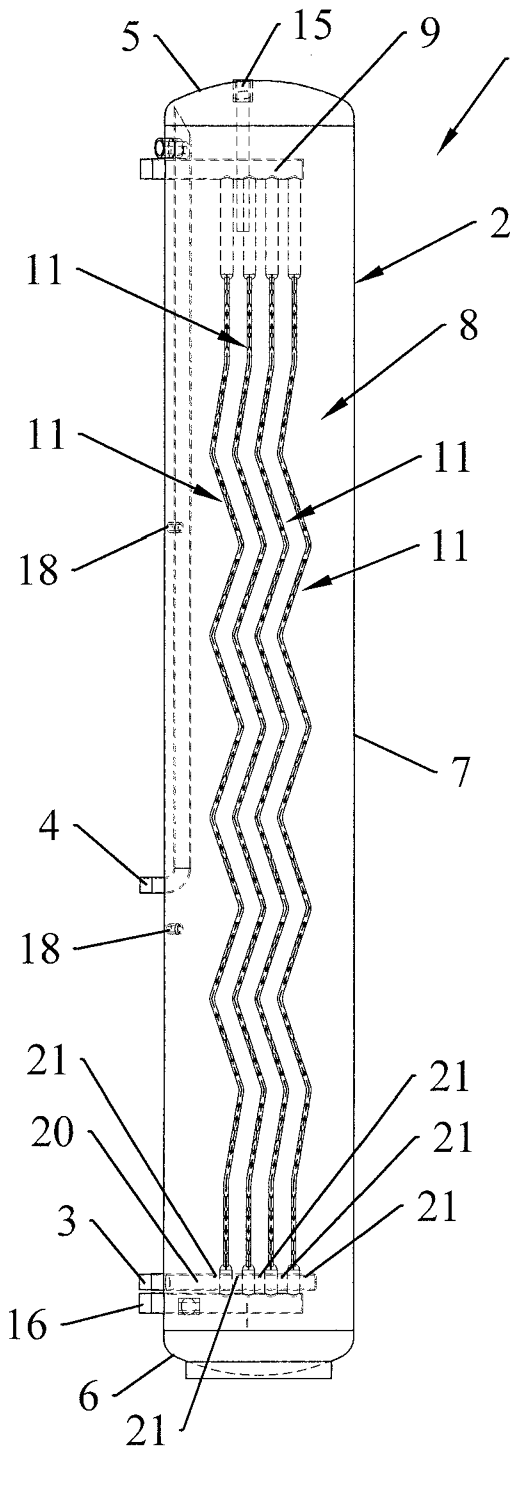

FIG.4

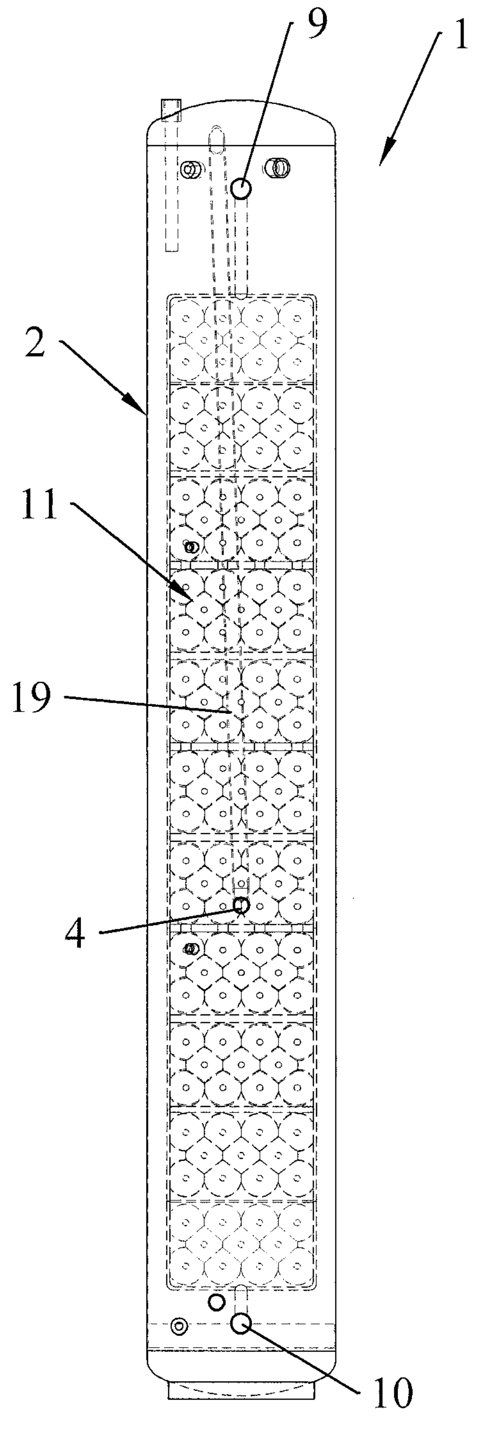

FIG.5

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EUROPEAN SEARCH REPORT

Application Number
EP 17 20 4285

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

F24H
F28F
F24D

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	4 May 2018	Riesen, Jörg

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