



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
28.07.2010 Bulletin 2010/30

(51) Int Cl.:
F24H 1/00 (2006.01) F22B 5/00 (2006.01)

(21) Application number: **08779204.0**

(86) International application number:
PCT/RU2008/000379

(22) Date of filing: **18.06.2008**

(87) International publication number:
WO 2009/008768 (15.01.2009 Gazette 2009/03)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

(71) Applicant: **Vorobiev, Leonid Jurievich**
Novosibirsk 630090 (RU)

(72) Inventor: **VOROBIEV, Juriy Fedorovich**
Novosibirsk 630090 (RU)

(30) Priority: **09.07.2007 RU 2007125918**

(74) Representative: **Sloboshanin, Sergej et al**
V. Föner, Ebbinghaus, Finck, Hano
Mariahilfplatz 3
81541 München (DE)

(54) **METHOD FOR HEATING LIQUID HEAT CARRIER AND A DEVICE FOR CARRYING OUT SAID METHOD**

(57) The proposed heating method includes supplying a liquid heat carrier to a heating area by means of turning it about the cylindrical surface of a heater in such a way as to form an axially symmetric swirl flow, the trajectory of each heat carrier particle being tangent to the surface of the heater the temperature of which is higher than the critical thermal point of the heat carrier. The heating device contains a heat exchanger having a cylindrical body, tangentially positioned pipes for supplying the cold

heat carrier and pipes for discharging the hot heat carrier. The heater having a cylindrical surface is coaxially arranged in the cylindrical body. The heating device contains an expansion tank, binding pipes and heat exchangers. The temperature of the heater is controlled by means of thermocouples. An electric heat source (a resistance helix) is located in the heater. The heating device has a high efficiency of heat transfer from the heater to the heat carrier due to the double phase transition: water-steam-water.

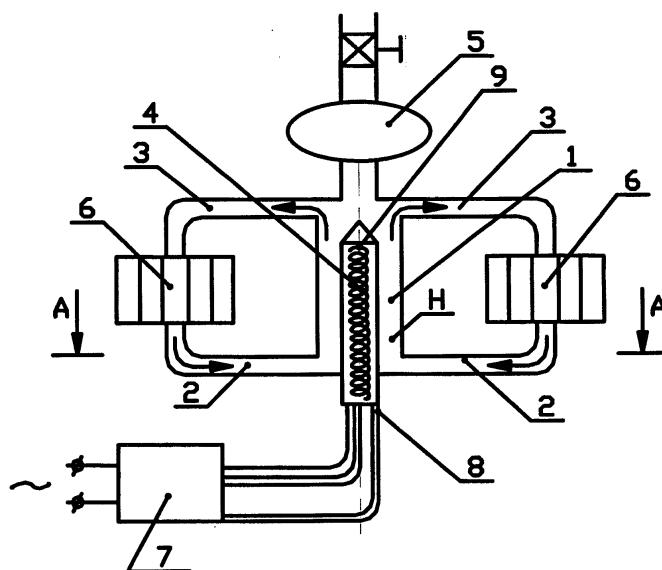


FIG. 1

Description

Field of the invention

[0001] The invention relates to heat power engineering, and more particularly to hot steam generation for industrial and individual needs, as well to construction of heating systems.

Discussion of prior art

[0002] A method of evaporation of liquid in the channel by means of heating it over the steam saturation point is known (see U.S. Patent No. 3326640, issued in 1967). The disadvantages of the method described therein are a lack of reliability and high materials consumption caused by the need to increase liquid pressure.

[0003] A method of evaporation of liquid by heating it in a channel above the steam saturation point, decreasing the pressure in the liquid and maintaining the temperature of the channel walls below the limit of superheat of the evaporated liquid is known, where the heat output of the channel increases by means of imposing current collecting electric potential on the channel walls (see Russian Patent No. 2128804, published on April 10, 1999). The disadvantage of this method is inefficiency of the evaporation process and complexity of commercial application.

[0004] A method of steam generation is known (see Russian Patent No. 2293913, published on February 20, 2007) where a boiler is filled with water up to a required level, and electric voltage is applied to the water by means of electrodes positioned in the water. The electric voltage is applied to the water by using high voltage pulses, and water jets that appear upon electric voltage application are dispersed structure by flowing water jets through a splitter, which is a system that hinders water jets. The efficiency of heat output from the heater to the heat carrier in said method is also low.

[0005] A method of steam generation described in SU 419687, published on March 15, 1974, is known. An operating environment heated up to the temperature lower than its saturation point under current pressure is supplied to an inlet chamber, where the environment is then swirled. At the starting point, the speed of the environment increases and the pressure decreases. The environment moving towards a diaphragm the swirl range decreases in speed, and the environment pressure becomes equal to saturation pressure at this temperature. Steam bubbles affected by buoyancy forces collect in the center and are delivered to a consumer. The disadvantage of this method is also a lack of efficiency of heat transfer from the heater to the heat carrier.

[0006] A direct-flow water heater, described in SU 663982, published on May 25, 1979 is known, which contains a body with a central combustor enclosed in a water jacket and a peripheral ring-shaped catalyst chamber. The disadvantage of such water heater is poor distribu-

tion of gases coming out of the catalyst chamber and low efficiency of the device.

[0007] A direct-flow surface water heater, described in SU 787812, published on December 20, 1980 is known, which contains a body, a burner device connected to the combustor, which is enclosed in a water jacket with a ring-shaped catalyst chamber located around the water jacket and connected to the combustor with its bottom side, and to a pipe for discharge of exhaust gases with its foreside, by means of a ring-shaped demister above which a ring-shaped diaphragm with valves is arranged. This device also has an inefficient transfer from the heater to the heat carrier.

[0008] A method of liquid heat carrier heating and a device for carrying out this method are known (see Russian Patent No. 2178125, published on January 10, 2002). The liquid heat carrier heating method described therein consists of supplying a liquid heat carrier to a heating area in a heating device body from a heat source, heating the heat carrier and discharging the heated heat carrier from the heating area. The liquid heat carrier is supplied from above to the heating area on the spinning shell ring, thus forming a thin-film liquid sheet of the heat carrier. The heated heat carrier is then discharged on the underside of the spinning shell ring, and in the body of a heating device hot exhaust products are organized to force the flow around the shell ring from the heat source, on the inside and outside surfaces of the shell ring with the combustion products being drawn off of the body of a heating device.

[0009] In this method and a device for carrying out the method, the spinning of a shell ring causes forming of condensed flow of liquid heat carrier on the walls of the shell ring, and the direct heating is made by means of infrared radiation and hot fuel combustion products from the heat source, while the rate of interior pressure in the heat carrier, which is effected by centrifugal force is chosen depending on the rate of the ring shell spin, so as to ensure the heating and the discharge of the heat carrier with a temperature above its boiling point under air pressure. The disadvantage of this method and the device for carrying out the method is low efficiency of heat transfer from the heater to the heat carrier.

[0010] Hence, there is a need to develop new methods for heating liquid heat carriers and devices for carrying out these methods with a high efficiency heat transfer from a heater to a heat carrier.

Disclosure of embodiments of the invention

[0011] The objective of this invention is to create a method to increase the efficiency of heat transfer from a heater to a heat carrier, to increase the reliability of the device for carrying out this method, to simplify its design and at the same time to increase its productive capacity. Other achieved objectives and advantages of this invention will be shown below when briefly describing the drawings figures in preferred embodiments.

[0012] The method of heating a liquid heat carrier includes supplying a liquid heat carrier to a heating area in a heating device body from a heat source, heating the heat carrier and discharging the heated heat carrier from the heating area. In order to increase the efficiency of heat transfer from the heater to the heat carrier the supplying of a liquid heat carrier to the heating area is made by means of turning it about a cylindrical surface of the heater, thus forming an axially symmetric swirl flow, the trajectory of each heat carrier particle being tangent to the surface of the heater whose temperature is higher than the critical temperature of the heat carrier.

[0013] Heating the heat carrier in accordance with claimed invention is done using a double phase transition, which comprises a first transition from liquid to steam and a second transition from steam to liquid, i.e. evaporation and condensation in one free range of a heated liquid molecule (particle).

[0014] In order to turn the heat carrier, it is preferentially supplied on the underside of the heating device through at least two pipes tangentially positioned and forming the force couple. The heat source is preferred to be electric heating or natural gas burning.

[0015] To organize an ascending path of flow it is preferred to observe the formula:

$$(m_T T_T)/\text{sec} \leq (m_n T_n)/\text{sec},$$

where m_T is the heat carrier weight;

T_T is the heat carrier temperature;

m_n is the heater weight;

T_n is the heater temperature.

[0016] The objective is fulfilled by means of a heating device that switches a heater with a heating source, a heat exchanger with pipes for supplying the cold heat carrier and for discharging the hot heat carrier. The heater having a cylindrical surface is coaxially arranged in the heat exchanger that has a cylindrical body, in order to supply the heat carrier on the underside of the body at least two pipes are arranged tangentially positioned to form an axially symmetric swirl flow, and at the top of the cylindrical body a discharge of the hot heat carrier is arranged.

[0017] The heating device preferably includes an expansion tank, binding pipes and a heat exchanger. For supplying the hot heat carrier it is preferred to arrange at least two pipes at the top of the cylindrical body.

[0018] In the described method, the temperature of the heater surface is higher than the critical thermal point of the heat carrier. The heater surface that has a temperature over the critical thermal point of the heat carrier (water) is immediately surrounded by a steam sheet (steam jacket), and heat transfer slows down considerably. In case of using water as a heat carrier, the critical thermal point of water is 374,15 °C. Keeping in mind the high speed of steam molecules free range (up to 500 m/sec)

and extremely short free range, this method suggests to organize the heat carrier flow in such a way as to make liquid water molecules turn to steam when touching the cylindrical surface of the heater, and having their motion path immediately changed, joining the organized flow of liquid heat carrier (water). The energy of vaporization is given up to the heat carrier during condensation (double phase transition), and the following molecules of the liquid heat carrier (water) and of the resulting (water) steam may follow the organized trajectory of flow.

[0019] The heating device has high efficiency of heat transfer from the heater to the heat carrier by means of double phase transition: water-steam-water (specific heat of water is 4,19 J/g*K at 20°C, specific heat of evaporation is 2255 J/g).

Brief description of the attached drawings

[0020]

Fig. 1 displays the main view of the heating device; Fig. 2 displays a A-A sectional view of the device of Fig. 1.

[0021] The heating device includes a heat exchanger having a cylindrical body 1, tangentially positioned pipes for supplying the cold heat carrier 2, and pipes for discharging the hot heat carrier 3. The heater 4 having a cylindrical surface is coaxially arranged in the cylindrical body 1. The heating device includes an expansion tank 5, binding pipes and heat receivers 6. The device can be supplied with an electric power distribution box and an automatic control system 7. The temperature of the heater 4 is controlled by means of thermocouples 8 arranged in the heater 4. An electric heat source (a helical resistive element 9) is located inside the heater 4.

[0022] The system being filled with the heat carrier the heater 4 is heated over the critical temperature. Due to its physical properties the heated liquid flashes to the expansion tank 5 and the cold heat carrier is supplied to the heating area due to the flow continuity by means of forming an axisymmetric (axially symmetric) swirl flow, the trajectory of each heat carrier particle being tangent to the surface of the heater 4 the temperature of which is higher than the critical thermal point of the heat carrier. An axially symmetric swirl flow arises because the supply of the cold heat carrier is done through at least two tangential pipes, and due to this the heat carrier swirls in the device body. Depending on the power of the installation, more than two tangential pipes for supplying the cold heat carrier may be used or a guiding device may be implemented. Any known device for heat carrier swirling can be used as a guiding device.

[0023] When touching the surface of the heater, the heat carrier is quickly heated and it evaporates. Once it gets into the swirl flow of the heat carrier, the heat carrier condenses inside the flow, giving up its steam condensing energy to the heater. Once that happens, the heat

carrier is heated and the heat carrier flows. The discharge of the hot heat carrier is carried out through the discharge pipes 3 in order to maintain the coaxially organized heat carrier flow in regard to the heater 4. Any known heat source that is used for these purposes can be used for the heater 4.

[0024] The heating device operates as follows:

[0025] The heat carrier (water) is poured in the heat exchanger 1 through the expansion tank 5 or a special feed line (not shown in Fig. 1). The temperature of the heater 4 is raised in any known way (using electric heating or fuel combustion heat). The density of the heated heat carrier decreases. The heat carrier having a form of cylinder H around the heater 4 starts rotary motion under condition of the continuity of flow that makes room for supplying the cold water through the tangential pipes 2. The heated heat carrier discharges through the discharge pipes 3 to the receiver 6. In the receivers 6 the heat carrier flow is cooled and the heat carrier returns to the heat carrier supplying pipes 2 of the device.

The preferred embodiment

[0026] The preferred embodiment is shown in Fig. 1 and Fig. 2. To swirl the heat carrier, it is supplied on the underside of the heating device through the two pipes 2 tangentially arranged and forming the force couple. The electric heat can be used as a heat source. The heater also includes an automatic control system 7. To discharge the hot heat carrier, two pipes 3 are arranged at the top of the cylindrical body.

[0027] To organize an ascending path of flow the following formula is observed:

$$(m_T T_T)/\text{sec} \leq (m_n T_n)/\text{sec},$$

where m_T is the heat carrier weight;

T_T is the heat carrier temperature;

m_n is the heater weight;

T_n is the heater temperature.

[0028] When using the proposed heating device for room heating, a pump is not needed, because the heater 4 can rise the water temperature up to the critical point ($T = 374,15^\circ\text{C}$) and further, up to the heater temperature.

[0029] Claimed solution results in the increase of efficiency of heat transfer from the heater to the heat carrier, the increase of reliability of the device and the simplification of its construction.

Industrial applicability

[0030] The device described herein can be used in, e.g., heat power engineering and can be used in different liquid heating systems, particularly water heating systems.

Claims

1. A method of heating a liquid heat carrier, the method comprising:

supplying the liquid heat carrier to a heating area in a heating device body from a heat source; heating the heat carrier and discharging the heated heat carrier from the heating area; **characterized in that** in order to increase the efficiency of heat transfer from the heater to the heat carrier, the supply of the liquid heat carrier to the heating area is implemented by swirling the liquid heat carrier about a cylindrical surface of the heater, thereby forming an axially symmetrical swirl flow, wherein a trajectory of each heat carrier particle is substantially tangential to the surface of the heater; the heater has a temperature higher than a critical temperature of the heat carrier.

2. The method of claim 1, **characterized in that** for swirling the heat carrier it is supplied on an underside of the heating device through at least two pipes, the two pipes being tangentially arranged and forming a force couple.

3. The method of claim 1, **characterized in that** electrical heating, gas combustion is used as a heat source.

4. The method of any of claims 1, 2, 3, **characterized in that** to organize an ascending path of flow the following formula is observed:

$$(m_T T_T)/\text{sec} \leq (m_n T_n)/\text{sec},$$

where m_T is the heat carrier mass;

T_T is the heat carrier temperature;

m_n is the heater mass;

T_n is the heater temperature.

5. A heating device comprising:

a heater with a heat source;

a heat exchanger with pipes for supplying cold heat carrier and for discharging hot heat carrier;

characterized in that the heater with a cylindrical surface is arranged coaxially in the heat exchanger having a cylindrical body;

for supplying the cold heat carrier on the underside of the cylindrical body are arranged at least two pipes positioned tangentially to form an axially symmetrical swirl flow or a directing apparatus with elements for swirling the water flow;

and

a discharge of the hot liquid heat carrier is arranged on the top of the cylindrical body.

6. The heating device of claim 5, **characterized in that** it further comprises an expansion tank, binding pipes and a heat receiver. 5
7. The heating device of claims 5 or 6, **characterized in that** at least two pipes are arranged at the top of the cylindrical body for hot liquid heat carrier discharge. 10

15

20

25

30

35

40

45

50

55

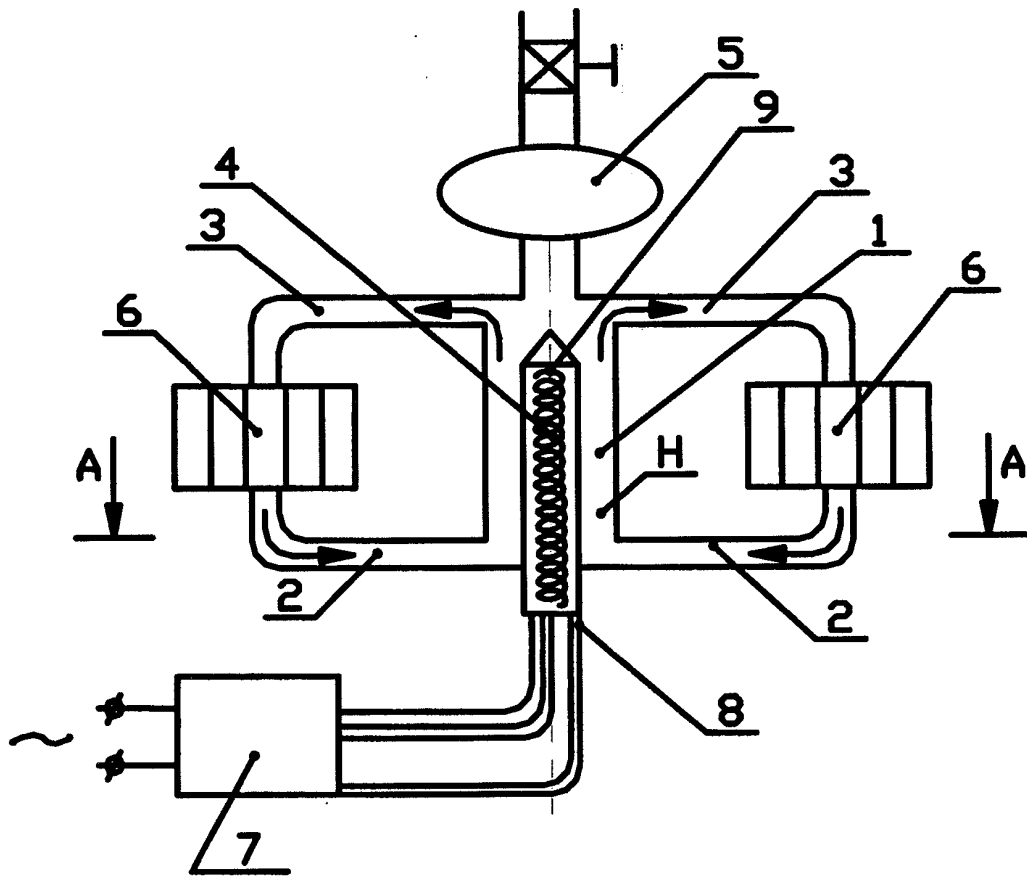


FIG. 1

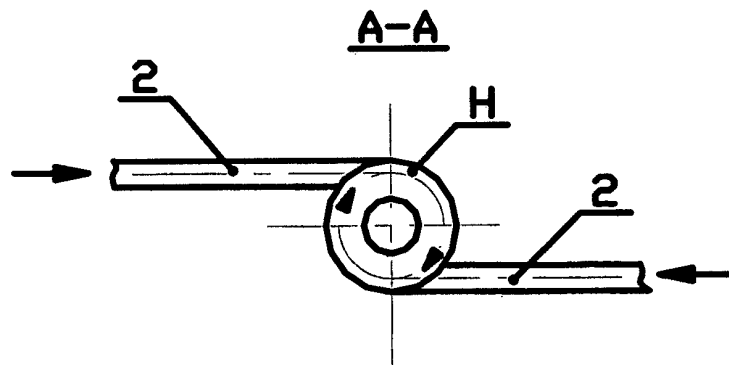


FIG. 2

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 3326640 A [0002]
- US 1967 A [0002]
- RU 2128804 [0003]
- RU 2293913 [0004]
- SU 419687 [0005]
- SU 663982 [0006]
- SU 787812 [0007]
- RU 2178125 [0008]