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(54) Title: THICK FILM HEATING DEVICE

(57) Abstract: A thick film heating device (1), a beverage dispensing device (10), and a method for heating water are provided. The thick film heating device (1) is suited for being installed into the beverage dispensing device (10) and comprises two concentric tubes (2, 3) arranged one inside the other to form a water flow path (4) in between, wherein a thick film heater (7) is provided to a surface of at least one of the concentric tubes (2, 3). The device further comprises patterning means (5) for forming a channel pattern within the water flow path (4), and pressurizing means (6) for pressurizing water flowing into the water flow path (4) to a water pressure of at least 8 bar.

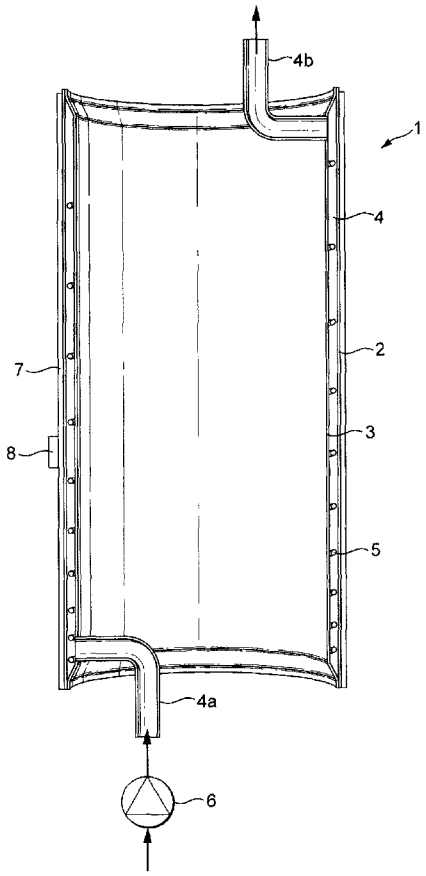

FIG. 1

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THICK FILM HEATING DEVICE

Field of the invention

The present invention relates to a thick film heating device for a beverage dispensing device, and to a beverage dispensing device including the thick film heating device. The present invention relates also to a method for heating water with the thick film heating device. In particular, the present invention proposes a thick film heating device with simplified design, in order to make its use in beverage dispensing devices commercially feasible.

Background of the invention

Thick film heating devices for heating water or other liquids are generally known from the state of the art. In particular, thick film heating devices for use in beverage dispensers are documented, for example, in the international patent application WO 2004/006742.

However, although the use of thick film technology for heating devices in beverage dispensers is documented in the state of the art, there exists up to date no beverage dispenser on the market, which actually uses internally a thick film heating device to heat water or another liquid for producing a beverage. This is mainly due to the high production costs and the high process control costs of the state of the art thick film heating devices.

Apart from high costs, another reason why there is up to date no commercial implementation of the thick film technology into a beverage dispenser is that the state of the art thick film heating devices rely on the use of a small section water pathway. However, scale deposition induced within the water pathway presents potential risk of blockage or congestion after a certain amount of time.

The present invention aims to improve the state of the art, in particular in respect to the above-mentioned disadvantages. Therefore, the present invention has the object to provide a thick film heating device, which can be implemented into a beverage dispensing device, and is of reduced cost. A specific object of the present invention is to provide a thick film heating device that can be produced cheaper and can be controlled less costly. Further, an object of the present invention is to provide a thick film heating device having reduced weight, in order to improve the heating speed and performance thereof.

Summary of the invention

The present invention solves the above-mentioned objects by the independent claims, which describe a thick film heating device, a beverage dispensing device, and a method for heating water, respectively. The dependent claims develop further advantages of the present invention.

In particular, the present invention is directed to a thick film heating device for a beverage dispensing device, comprising

:

- two concentric tubes arranged one inside the other to form a water flow path in between, wherein a thick film heater is provided to a surface of at least one of the concentric tubes,
- patterning means for forming a channel pattern within the water flow path, and
- pressurizing means for pressurizing water flowing into the water flow path.

The thick film heating device is also suitable for other liquids than water, which are to be heated. For example, the thick film heating device can be used to heat milk, milk-based liquids, coffee, tea, soup and the like.

The inner concentric tube, which is arranged within the outer concentric tube, is preferably hollow, in order to reduce the weight of the thick film heating device. Reducing the weight of the thick film heating device increases the heating speed and performance of the device. Further, the costs of producing the thick film heating device are reduced.

The formation of a channel pattern within the water flow path, e.g. by structuring one or more narrow water channels, which presents a further restriction for the water or liquid, has the effect that the water speed is increased. The same effect can be achieved by minimizing the distance between the two concentric tubes, which is particularly possible due to the reduced risk of blocking the water flow path by scale described above. The increased water speed leads to an increase of the heat transfer coefficient of the water or liquid, so that the heat transfer from the thick film heater is enhanced. As a further consequence, the length of the concentric tubes can be reduced as well, if desired.

Preferably, the means for forming the channels is a spiral coil disposed within the water flow path. The spiral coil (i.e. a spring) has a low weight, so that the overall weight of the thick film heating device is reduced, in particular, compared to a cylinder insert with engraved helicoidal grooves, which is known from the state of the art. The form of the spiral coil can be easily changed to another form in the manufacturing if necessary. The spiral coil provides a channel pattern that spirals around the inner concentric tube. The water flow path is thus narrowed so as to increase the heat transfer as explained above. Further, because the water flows along the spiraling channel pattern, which follows the spiraling of the coil, the effective length of the water flow path is increased. Thus, the interaction of the water with the thick film heater is increased as well.

Preferably, the pressurizing means is a pump located upstream of the water flow path. The pump can, for example, be an internal pump of a beverage dispensing device, into which the thick film device is installed. The pump then needs to be controlled accordingly.

Because the water is pressurized, its evaporation temperature can be increased, e.g. to at least 160°C. If another liquid or fluid is used, then the pressure should be adapted

accordingly in order to reach the desired evaporation temperature of the liquid, e.g. of 160°C or more. Thus, the water or other liquid can be heated to high temperatures without any evaporation taking place inside the water flow path. Thereby, the deposition of scale is minimized, and thus also the risk of blocking the water flow path is reduced. The thick film beverage device can be operated for a longer time period before it requires descaling, or even makes descaling unnecessary. Preferably pressurizing means pressurizes water flowing into the water flow path at a water pressure of at least 8 bar.

Preferably, the concentric tubes are laser welded. On one hand, the concentric tubes are to be built as thin as possible, in order to reduce the weight of the thick film heating device as far as possible. On the other hand, the concentric tubes need to withstand water pressures of e.g. at least 8 bar. Laser welded concentric tubes can withstand such high water pressures. Further, the production process of such laser welded concentric tubes is convenient, and can be controlled very well and precisely.

Preferably, the thick film heating device further comprises at least one water temperature sensor for measuring temperature in the water flow path. The temperature sensor can be a positive or negative temperature coefficient resistance. It is preferably placed on the surface of the thick film heater and estimates the temperature of the water in the water flow path on the other side of the cylinder. It is preferably a positive temperature coefficient resistance (PTC resistance). The at least one temperature sensor is generally distanced from the heating resistance of the thick film heater, preferably by at least 7 mm.

Preferably the thick film heating device comprises control means for controlling heating of the thick film heater based on the temperature measured by the at least one temperature sensor for measuring temperature in the water flow path. The control of the heating is usually implemented by controlling the power of the heating resistance. According to the preferred embodiment the control means can be configured to adjust the power of the heating resistance so that the temperature in the water flow path heater is about 160°C. This temperature is specifically adapted to water pressurized to 8 bar or more, which has an evaporation temperature of about 170°C or more. Thus, there is no chance that the water evaporates inside the water flow path, and consequently deposition of scale into the water flow path is consequently reduced.

A plurality of temperature sensors can be distributed on the surface of the thick film heater, for example, in different distances to the heating resistance of the thick film heater, in order to obtain various temperature readings. Thereby, the absolute temperature and/or the homogeneity of the temperature along the length of the thick film heating device can be monitored.

Preferably the thick film heating device comprises further comprises at least one overheating temperature sensor placed close to the heating resistance of the thick film

heater. This second kind of temperature sensors is used to protect the thick film heater against overheating. Preferably, the at least one overheating temperature sensor is placed very closely to the heating resistance of the thick film heater. It provides a real time measure of the temperature. The overheating temperature sensor can be a positive temperature coefficient resistance or a negative temperature coefficient resistance. It is preferably a positive temperature coefficient resistance

The present invention is further directed to a beverage dispensing device comprising a thick film heating device according to the above description.

The beverage dispensing device of the present invention can be constructed cheaper, lighter and more compact than the state of the art dispensers, due to the above-described advantages of the thick film heating device. The simple design of the thick film heating device further allows controlling it with a simpler algorithm. Thus, further cost savings can be achieved by cutting the complexity and thus price of a control unit of the beverage dispensing device.

Preferably, the beverage dispensing device comprises a water supply and a beverage preparation chamber for receiving heated water from the thick film heating device and configured to prepare a beverage with the heated water either from a substance to be extracted or by mixing the heated water with a powder.

The present invention is further directed to a method for heating water with a thick film heating device such as described hereabove comprising the steps of :

- pressurizing water to a pressure of at least 8 bar,
- providing the pressurized water to the water flow path,
- controlling the temperature of the thick film heater, preferably so that the water temperature on the water flow path is controlled to a limit of about 160°C.

The method of the present invention has the same advantages that have been described above in relation to the thick film heating device and the beverage dispensing device, respectively.

Brief description of the drawings

The present invention will now be described in more detail with reference to the attached drawings :

- Fig. 1 shows a thick film heating device according to the present invention.
- Fig. 2 shows a thick film heating device according to the present invention.
- Fig. 3 shows an example of patterning means for forming a channel pattern in the water flow path of the thick film heating device.

- Fig. 4 shows a part of a thick film heating device according to the present invention.
- Fig. 5 shows the surface of the thick film heating device according to the invention.
- Fig. 6 shows a beverage dispensing device according to the present invention.

Detailed description of the drawings

Fig. 1 shows a thick film heating device 1 according to the present invention. The thick film heating device 1 is composed of two concentric tubes 2, 3, which are arranged one inside the other. In Fig. 1 the concentric tube 3 has a smaller diameter than the concentric tube 2, and is thus arranged inside the concentric tube 2. The space between the two concentric tubes 2, 3 defines a water flow path 4 for water or for another liquid to be used with the thick film heating device 1. The other liquid can, for example, be milk, coffee, tea, soup. Yet water is preferred. The thick film heating device 1 comprises an inlet 4a for the introduction of water or the other liquid into the water flow path 4. Likewise, the thick film heating device 1 comprises an outlet 4b for outputting water or the other liquid from the water flow path 4. Although water can be introduced in whatever sense inside the device, it is usually preferred that the two concentric tubes 2, 3 are vertically oriented and that the inlet 4a is placed at the bottom so that water can raise in the device 1.

Both concentric tubes 2, 3 are preferably hollow, i.e. also the inner concentric tube 3 is hollow, to reduce weight. The outer concentric tube 2 can preferably have a diameter of about 6 - 100 mm, and a length of about 30 - 300 mm. The thickness of each concentric tube 2, 3 is preferably about 0,5 - 4 mm. The distance between the two concentric tubes 2, 3, which defines the width of the water flow path 4, is preferably about 1 - 10 mm, more preferably about 2 - 5 mm.

In order to be able to resist pressures of up to 8 bar, the concentric tubes 2, 3 are both preferably manufactured by laser welding. The laser welded concentric tubes 2, 3 have the further advantage that the production process is fast and convenient.

On a surface of at least one of the concentric tubes 2, 3, a thick film heater 7 is provided. The thick film heater 7 comprises at least a thick film, which is provided onto a surface of at least one or each of the concentric tubes 2, 3. The thick film heater 7 comprises further means to provide an electric current through the thick film, e.g. terminals, wires connecting the thick film, or the like. The thick film acts as a resistance and generates heat when an electric current is forced through it.

The thick film is usually coated onto an exterior surface of at least one of the concentric tubes 2, 3 and not inside the water flow path 4. It provides heat via the surface of the concentric tubes 2, 3. Therefore, the concentric tubes 2, 3 are preferably made of a heat conducting material, e.g. metal. In case both concentric tube surfaces are provided with a thick film, the two thick films can, for example, be connected electrically in parallel. When the

thick film heater 7 is operated to produce heat, water or another liquid flowing through the water flow path 4 is heated up.

Inside the water flow path 4, the thick film heating device 1 comprises patterning means 5 for forming a channel pattern. The channel pattern is formed to further narrow the effective water flow path for the water or other liquid, in order to increase the speed thereof inside the water flow path 4. The increase of the speed increases the transfer coefficient of the water or other liquid, and thus enhances the heat transfer from the thick film heater 7 to the water or the liquid.

As shown in the **figs. 2 and 3**, the patterning means 5 for forming the channel pattern can be a spiral coil (i.e. a spring), which is disposed within the water flow path 4. The spiral coil 5 provides barriers 5b for the water or liquid within the flow path 4, so that the water flow (indicated by dotted arrows) will only take place between the free sections 5a of the spiral coil 5. That means the water flow will follow the shape of the coil 5 and will spiral around the inner concentric tube 3 inside the flow path 4. The spiral coil 5 has preferably a thickness that matches the distance between the inner concentric tube 2 and the outer concentric tube 3, i.e. it matches the width of the water flow path 4. The spiral coil 5 can be built specifically light in weight, so that the weight of the whole thick film heating device 1 can be reduced. The shape of the spiral coil 5 (e.g. its length and/or the lengthwise distance 5c between its elements 5b) can be easily changed and adapted during the manufacturing process of the thick film heating device 1, if necessary.

The thick film heating device 1 is further equipped with pressurizing means 6 for pressurizing the water or the other liquid, before it flows via the inlet 4a into the water flow path 4. The pressurizing means 6 is usually a pump. If water is introduced into the water flow path 4, the pressure is preferably increased to at least 8 bar. This pressure raises the evaporating temperature of water to at least about 170°C. The thick film heating device 1 is preferably also controlled such that the surface area of the thick film heater 7 reaches at most about 160°C. This means, that the water or liquid, which is provided into the water flow path 4, cannot evaporate inside the water flow path 4. Thus, deposit of scale is minimized in the water flow path 4, and the risk of congestion thereof is reduced.

If another liquid than water is used with the thick film heating device 1, the pressure is preferably adapted such that the evaporating point of the liquid or fluid is not reached as well. However, most used liquids will show behavior very similar to the behavior of water.

The control of the heating can be carried out by control means, for example a microprocessor, for controlling the power of the heating resistance of the thick film heater. The control is essentially based on the measure of the surface temperature of the thick film heater 7, which comprises at least one temperature sensor 8, preferably a plurality of further temperature sensors. The temperature sensor 8 is preferably placed on the thick film support

of the thick film heater 7 but at a distance of the heating resistance in order to reflect the temperature of water inside the flow path and not of the heating resistance itself. The temperature sensors 8 are used to sense temperatures of the surfaces of the concentric tubes 2, 3 and indirectly of the water within the water flow path 4, in order to allow the control mans to control the heating of the thick film heater 7 more precisely. The temperature sensors 8 are preferably distanced from the heating resistance of the thick film heater 7 by at least about 7 - 15 mm. Depending on the measured temperature the control means increases or decreases the power to the thick film heater in order to increase or decrease heating. The temperature sensor is preferably a positive temperature coefficient resistance (PTC). Also a negative temperature coefficient resistance (NTC) could be used.

According to the preferred embodiment the temperatures sensor 8 also enables the control means of the thick film heater 7 to avoid that temperature increases above 160°C at any position along the water flow path 4.

The presence of several temperature sensors can feed back further indication about homogeneity of the temperature along the length of the thick film heating device 1 to the control means.

The thick film heating device also comprises an overheating temperature sensor 9 that can be a PTC or NTC resistance that has mainly the function of preventing an overheating of the thick film heater 7. Such a sensor can detect an important increase of temperature due for example to the absence of water inside the device and the necessity to stop the heating.

The heating means of the thick film heater 7 can be composed of individual several heating resistances, which are preferably connected in series and can be controlled individually by the control means. For example, a first resistance of the thick film heater 7 can generate a first temperature, and a second resistance or further resistance can generate a second of further temperature. The temperature of water along each resistance can be measured by a temperature sensor and the overheating temperature of each resistance can be measured by a overheating temperature sensor. Thus, a precise control of the heating along the length of the thick film heating device 1 is possible. Further, a temperature gradient experienced by the water or other liquid flowing through the water flow path 4 may be established.

Figure 4 shows in more detail, how the concentric tubes 2, 3 form the water flow path 4 in between, and how the inlet 4a can transfer water or another liquid into the water flow path 4.

Figure 5 is a view of the external surface of the thick film heating device 1 on which a thick film heater 7 is applied. The thick film heater 7 comprises a layer 21 on the surface of which three heating resistances 22, 23, 24 are printed. Apart from said heating resistances 22, 23, 24 four PTC resistances are also printed on the layer 21 : three of these PTC

resistances 25, 26, 27 are overheating temperature sensors whereas the fourth one 8 is a water flow temperature sensor. Each of the three overheating PTC resistances 25, 26, 27 is placed next to one heating resistance 22, 23, 24 to which it is dedicated to control any overheating, for example at a distance d of about 1 mm. The PTC resistance 8 for measuring the temperature of the water flow circulating in the cylinder 2 is placed at a greater distance from the heating resistances so as not to be influenced by the direct heating of the said resistances. It is placed at a distance D from the heating resistance, this distance is of at least 7 mm. Then the temperature at this place of the layer surface corresponds to the temperature of the external tube 2 in which water circulates and implicitly corresponds to the water temperature in the flow path.

The different resistances are connected through wires 28 to power source and to the control means.

Figure 6 shows a beverage dispensing device 10 according to the present invention, which is equipped with a thick film heating device 1 as described above. The beverage dispensing device 10 further comprises a water supply 11, for example a water tank or a pre-heating boiler or even a supply to tap water. Further, the beverage dispensing device 10 comprises a pump 6, which is able to pump and pressurize water from the water supply 11 and provide the water to the thick film heating device 1.

The beverage dispensing device 10 also comprises a control unit 14, for example a microprocessor or the like, which is configured to control the operation of the pump 6 and the powder 15 of the thick film heater 7. Therefore, it may receive feedback from the at least one temperature sensor 8. The control unit 14 may further control a beverage preparation chamber 13 of the beverage dispensing device 10. Water, which has been heated by the thick film heating device 1, can be provided to the beverage preparation chamber 13 via the outlet 4b. The beverage preparation chamber 13 is preferably configured to prepare beverages under control of the control unit 14 by using the heated water to either extract a beverage from a substance to be extracted, or by mixing the heated water with a powder or other soluble beverage ingredient. The beverage preparation chamber 13 is further configured to dispense the beverage, for example into a receptacle in a dispensing area 17. The beverage preparation chamber 13 may further comprise frothing means for frothing the produced beverage, e.g. a whipper.

Due to the simplified design of the thick film heating device 1, the control unit 14 of the beverage dispensing device 10 can use a simpler algorithm when it controls the heating of the water or the other liquid with the thick film heating device 1. Therefore, the control unit 14 can be designed simpler and cheaper than in common beverage dispensers.

In summary, the present invention presents a thick film heating device 1, a beverage dispensing device 10 including such a thick film heating device 1, and a method for heating

water or another liquid. The thick film heating device 1 is designed simpler, cheaper and with less weight than a thick film heating device known from the state of the art.

Further, by controlling the water pressure (or the pressure of another liquid) provided to the thick film heating device 1, and by controlling the heating of the thick film heater 7, deposition of scale inside the water flow path 4 is minimized. Therefore, the risk of potential blocking of the water flow path 4 is reduced. This allows furthermore using a narrower water flow path 4 as in the state of the art.

Further, the water flow path 4 may be structured into even narrower channels, in order to increase the overall speed with which the water or liquid flows through the water flow path 4. Therefore, the heat transfer from the thick film heater 7 to the water or liquid is enhanced. In particular by creating a turbulent flow of the water, e.g. by the coil spring 5 forcing the water in a spiral around the inner concentric tube 3, a particularly good heat transfer is achieved.

CLAIMS

1. Thick film heating device (1) for a beverage dispensing device (10), comprising :
- two concentric tubes (2, 3) arranged one inside the other to form a water flow path (4) in between, wherein a thick film heater (7) is provided to a surface of at least one of the concentric tubes (2, 3),
- patterning means (5) for forming a channel pattern within the water flow path (4), and
- pressurizing means (6) for pressurizing water flowing into the water flow path (4).

2. Thick film heating device (1) according to claim 1, wherein the patterning means is a spiral coil (5) disposed within the water flow path (4).

3 Thick film heating device (1) according to any one of the claims 1 or 2, wherein the pressurizing means is a pump (6) located upstream of the water flow path (4).

4. Thick film heating device (1) according to one of the claims 1 to 3, wherein the concentric tubes (2, 3) are laser welded.

5. Thick film heating device (1) according to any one of the claims 1 to 4, further comprising a water temperature sensor (8) for measuring temperature in the water flow path.

6. Thick film heating device (1) according to claim 5, wherein the temperature sensor (8) is a positive temperature coefficient resistance positioned on the surface of thick film heater (7).

7. Thick film heating device (1) according to claim 6 wherein the at least one temperature sensor (8) is distanced from the heating resistance of the thick film heater (7), preferably by at least 7 mm.

8. Thick film heating device (1) according to any one of claims 5 to 7, further comprising control means (14) for controlling heating of the thick film heater (7) based on the temperature measured by a temperature sensor (8) for measuring temperature in the water flow path.

9. Thick film heating device (1) according to any one of the precedent claims, further comprising an overheating temperature sensor (25, 26, 27) placed close to the heating resistance (22, 23, 24) of the thick film heater.

10. Thick film heating device (1) according to claim 9, wherein the overheating temperature sensor is a positive temperature coefficient resistance positioned on the surface of the thick film heater (7) and next to the heating resistance of the thick film heater.

11. Beverage dispending device (10) comprising a thick film heating device (1) according to any one of the claims 1 to 10.

12. Beverage dispensing device (10) according to claim 11 comprising :
- a water supply (11),
- a beverage preparation chamber (13) for receiving heated water from the thick film heating device (1) and configured to prepare a beverage with the heated water either from a substance to be extracted or by mixing the heated water with a powder.

13. Method for heating water with a thick film heating device (1) according to any one of the claims 1 to 10 comprising the steps of :
- pressurizing water to a pressure of at least 8 bar,
- providing the pressurized water to the water flow path (4),
- controlling the temperature of the thick film heater (7).

14. Method for heating water according to claim 13, wherein the water temperature on the water flow path of the thick film heater (7) is controlled to a limit of about 160°C.

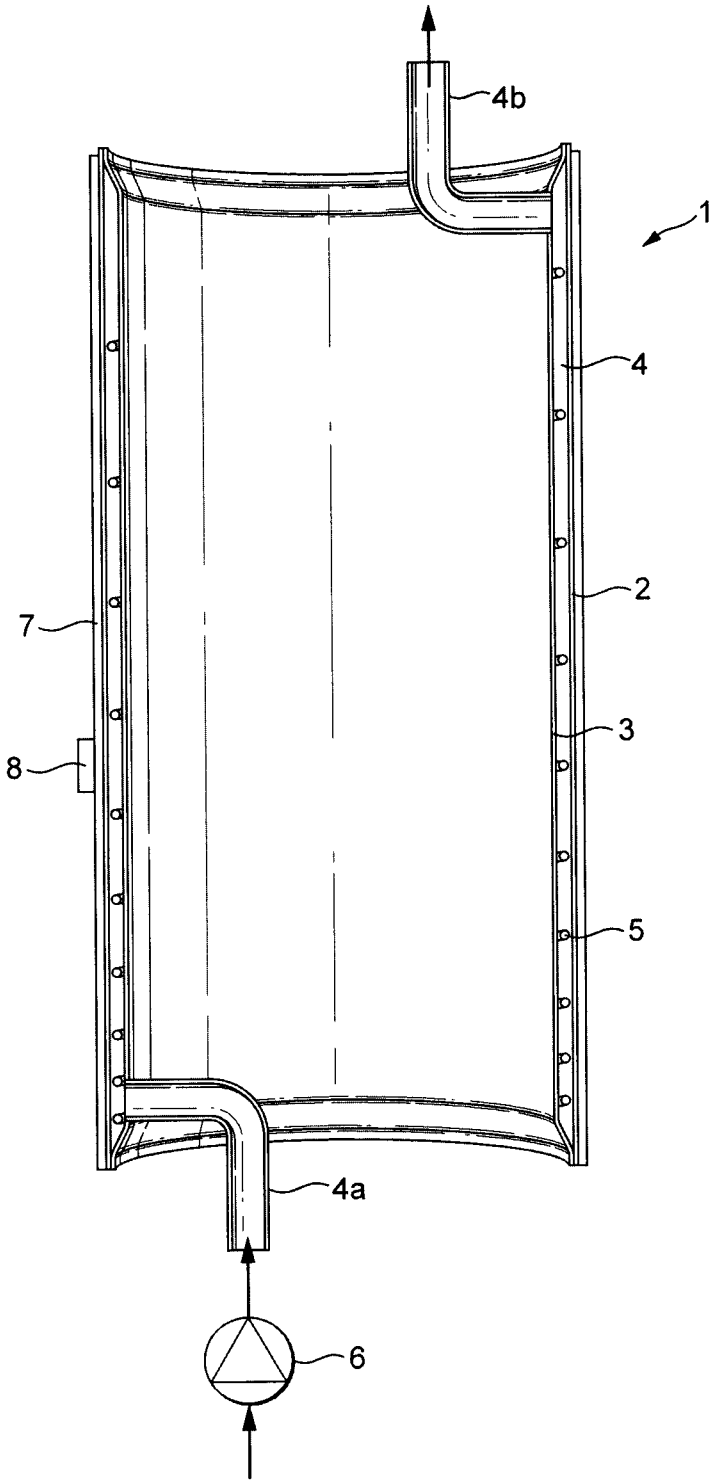

FIG. 1

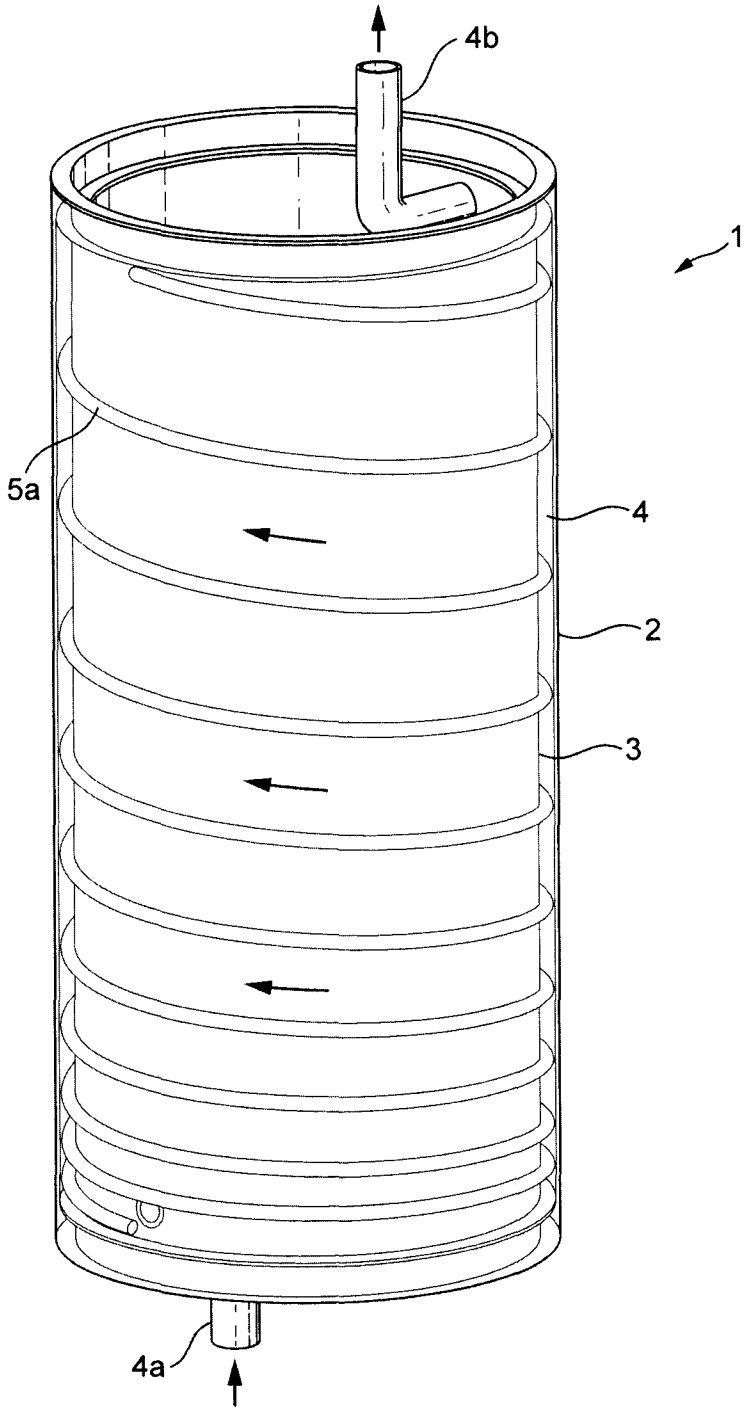

FIG. 2

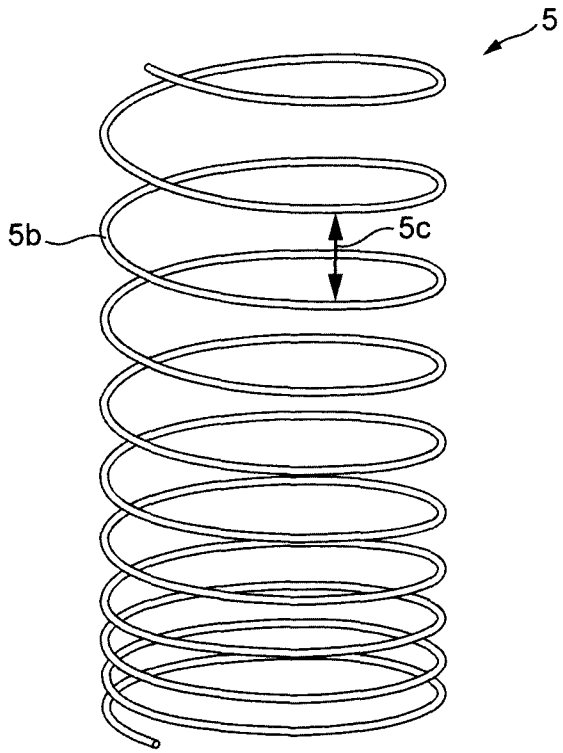

FIG. 3

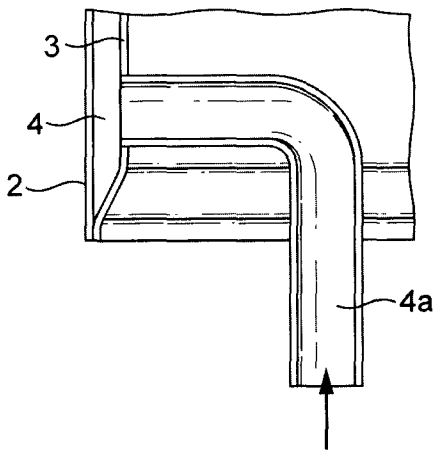

FIG. 4

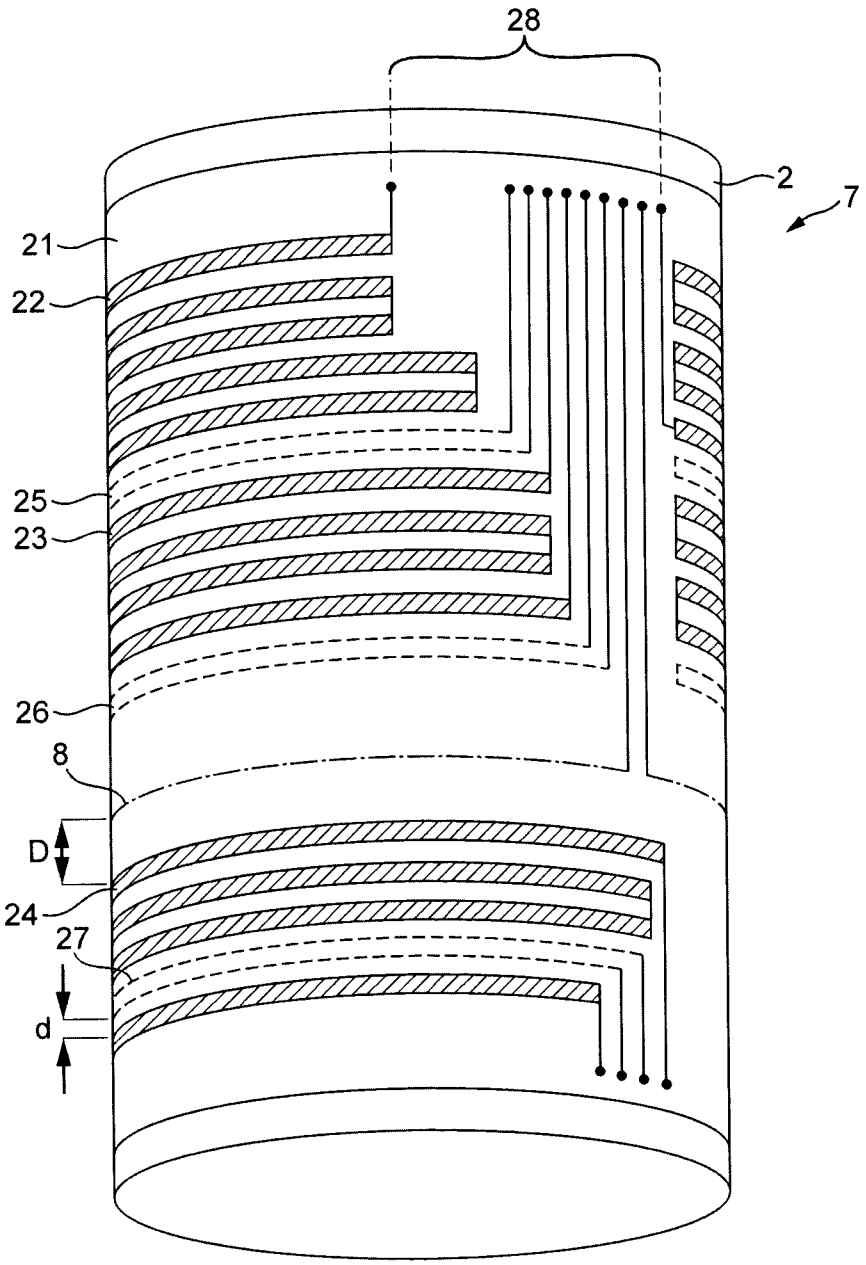

FIG. 5

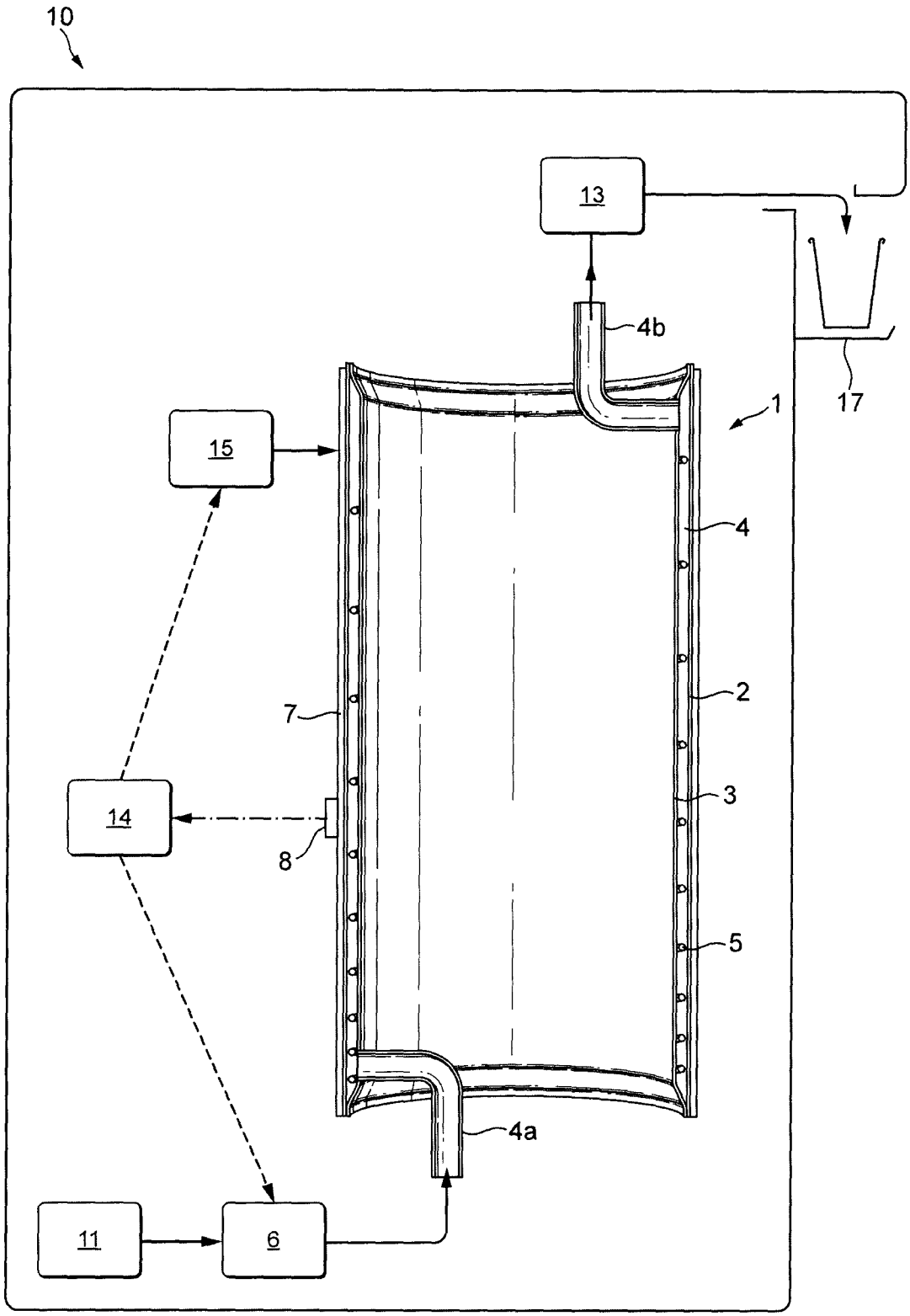

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2013/078344

A. CLASSIFICATION OF SUBJECT MATTER

A47J 31/54 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: A47J 31/54

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, WPI,EPODOC: thick 2d film+, conduct+, resist+, tube?, pipe?, duct?, sens+, detect+, overheat+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/0041705 A1 (BLECKMANN GMBH & CO., KG) 24 February 2011 (24.02.2011)	1-11,13-14
Y	description, paragraphs [0019]-[0082], figures 1-8, and claims 1-24	12
Y	CN 1424886 A (NESTEC S.A.) 18 June 2003 (18.06.2003) description, page 5, paragraph 2 and figure 3	12
X	CN 1668235 A (NESTEC S.A.) 14 September 2005 (14.09.2005) the whole document	1-11,13-14
Y		12
X	CN 1788527 A (SEB S.A.) 14 June 2006 (14.06.2006) the whole document	1-10

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search	Date of mailing of the international search report
04 March 2014 (04.03.2014)	**03 Apr. 2014 (03.04.2014)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer WANG, Hui Telephone No. (86-10)62413528

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