



(11) **EP 2 354 703 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
10.08.2011 Bulletin 2011/32

(51) Int Cl.:
F24H 1/43 (2006.01) **F24H 1/44 (2006.01)**
F24H 1/52 (2006.01)

(21) Application number: **11152168.8**

(22) Date of filing: **26.01.2011**

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

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(30) Priority: **26.01.2010 NL 2004147**

(54) **Heat exchanger**

(57) The invention relates to a heat exchanger for transferring heat from a heat source to a fluid flowing in a first channel, comprising an inner wall made of heat conducting material, surrounding the heat source, being thermally connected with the heat source and having the shape of a surface of revolution, a outer wall concentric to the inner wall, wherein the distance between both walls is substantially constant and a first conduit comprising the first channel, extending between both walls and being in thermal contact with the inner wall. Preferably said tube has been deformed by subjecting the inner side of the tube to a pressure sufficiently high to cause such a permanent deforming of the tube that it is clamped between the inner and outer walls.

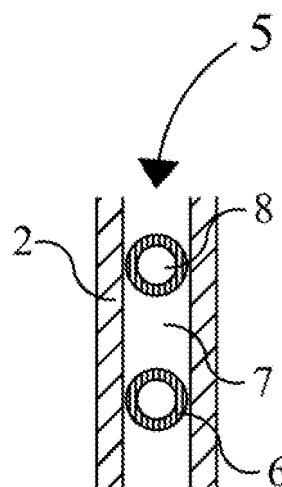


FIG. 2

Description

[0001] The invention relates to a heat exchanger for transferring heat from a heat source to a fluid flowing in a first channel. Such a heat exchanger finds application in for instance domestic boilers for central heating.

[0002] Often these heaters comprise a casting surrounding the heat source, being thermally connected with the heat source and having the shape of a surface of revolution, wherein a channel for conducting the fluid to be heated is casted into said body.

[0003] The costs of such a construction are substantial as casting is an expensive process. The aim of the present invention is to provide such a heat exchanger of which the production costs are lower. Another aim of the invention is to provide such a heat exchanger having an improved efficiency.

[0004] This aim is reached by a heat exchanger for transferring heat from a heat source to a fluid flowing in a first channel, comprising an inner wall made of heat conducting material, surrounding the heat source, being thermally connected with the heat source and having the shape of a surface of revolution, a outer wall concentric to the inner wall, wherein the distance between both walls is substantially constant, both walls enclose an open space and wherein a first conduit comprising the first channel, extends in the open space and the first conduit is in thermal contact with the inner wall.

[0005] In the heat exchanger according to the invention there is no need to cast in any conduits, so that the production costs thereof are lower. It should however be noted that the inner wall itself may be provided by a casting, although it may also be formed by an extruded element. It is noted that the intimate contact between the heat source and the fluid flowing in the conduits leads to an improved efficiency.

[0006] Although shapes like frusto-conical shapes may be used, it is advantageous if the inner and the outer wall are both substantially cylindrical and that the first conduit extends helically in the open space between the inner and the outer wall. Apart from the ease of locating the helical conduit between the two walls, there is the advantage that the length of the cylindrical heat exchanger is in principle unlimited. Of course there are practical limitations, but the length of the heat exchanger may be adapted to its power, allowing to produce heat exchangers of different powers with the same diameter, leading to simplification of the production facilities.

[0007] According to a preferred embodiment the first conduit is adjacent to the inner and outer walls and the pitch of the winding of the first conduit is larger than the outer size of the first conduit in axial direction of the heat exchanger to enclose a second helical channel between the windings of the first conduit. This feature provides a second channel which may be operated independently of the first channel without providing a second conduit, leading to substantial savings. Nevertheless two different fluids may be heated independently by the same heat

exchanger. An application thereof resides in the so called 'combi-boiler' which is adapted to heat both water for central heating and tap water. According to the prior art such a heat exchanger is provided of a casting in which two different channels are incorporated. It is also possible to locate the first conduit adjacent to the inner wall with a smaller pitch.

[0008] It is however also possible to provide a bifilarly wound second conduit extending within the open space between the inner and outer walls and that the second channel extends through the second conduit. This provides the same functionality as the preceding embodiment but at the cost of an extra conduit. There may however be reasons making this embodiment imperative, like the need to heat two separate tap water channels, as tap water may only be contacted by copper in heating appliances. Further the provision of two separate conduits allows the creation of two extra channels enclosed by the conduits if some geometrical conditions are met, resulting in four independent channels, albeit at the cost of complicated headers.

[0009] Although varying means of connection between the conduits and the inner and outer walls are possible, like soldering, brazing or welding, it is advantageous when the at least one conduit is formed by a tube and that the tube has been clamped between the inner and outer walls as clamping does not require access between the inner and the outer walls to execute an operation.

[0010] The clamping is preferably executed by deforming said tube by subjecting the inner of the tube to a pressure sufficiently high to cause such a permanent deforming that the tube is clamped between the inner and outer walls. Again this is an advantageous process of fixing the tube in its required, hardly accessible location.

[0011] In an alternative embodiment after the at least one tube has been wound around the inner wall, the outer wall has been expanded and has been positioned surrounding the inner wall and the wound tube and subsequently the outer wall has been let cool down to make it shrink around the inner wall and the tube. This embodiment has the advantage of allowing an easy positioning of the tube or tubes around the inner wall, for instance through winding. Positioning of the outer wall is easy when it is expanded as caused by heat, while the cooling down causes the clamping connection. Although not mentioned before the winding of the tubes against the inner side of the outer wall, the cooling of the inner wall and subsequent warming up thereof is not excluded.

[0012] Preferably the wall of said tube comprises an inner layer and an outer layer surrounding the inner layer, wherein the inner layer is made of a material compatible with the preparation of drinking water, like copper or stainless steel and the outer layer is made from another material compatible with the material of the walls of the heat exchanger. Expressed otherwise the tube comprises two concentric tubes, of which the inner tube is made of material compatible with the preparation of drinking water and the outer tube is made of a material compatible with

the walls of the heat exchanger. The compatibility of the materials of the outer layer of the tube and the walls of the heat exchanger is meant to understood a selection of materials which avoid corrosion or other chemical interaction. It is for instance attractive to use tubes of which the outer layer is made of the same material as the inner wall, such as of aluminium.

[0013] To increase the contact surface between the tube and the inner wall, it is preferred that the tubes have a substantial oval cross section. This substantial oval cross section may be used with any material, while the material may be chosen independent from the shape of the cross section of the tube. Of course the tube may comprise two layers as explained above.

[0014] Yet another embodiment provides the feature that the inner wall is formed by an extruded work piece having a flat outer surface and a finned inner surface of which the fins extend in the axial direction. This configuration allows manufacturing through extrusion which is advantageous, especially for large numbers.

[0015] To provide a better contact between the flue gasses in the heat exchanger, the fins are preferably interrupted. These interruptions make the flow of the flues gasses less laminar to improve the heat transfer between the flue gasses and the inner wall of the heat exchanger.

[0016] The construction of the heat exchanger is improved and simplified if at both ends of the heat exchanger a header closing of the open space between the inner wall and the outer wall has been located and that at least the conduit comprising the first channel is connected to both headers and that both headers comprise connection means for the second channel.

[0017] The advantages of the preceding features appear also in a heating boiler, adapted to heat central heating water and tap water, the boiler comprising a heat source, a central heating circuit and a tap water heating circuit, wherein the heating boiler comprises a heat exchanger as claimed in one of the preceding claims and that the first channel of the heat exchanger is connected to the tap water heating circuit and the second channel of the heat exchanger is connected to the central heating circuit.

[0018] The invention also relates to a method for producing a heat exchanger for transferring heat from a heat source to a fluid flowing in a first channel, comprising the steps of providing an inner wall made of heat conducting material, surrounding the heat source, being thermally connected with the heat source and having the shape of a surface of revolution, providing at least one helical first tube through which the first channel extends surrounding the inner wall and providing an outer wall, surrounding the inner wall and the tube wound around the inner wall, wherein one element of the set containing the inner wall, the tube or the outer wall is deformed to obtain a clamping connection between the inner wall and outer wall enclosing the tube.

[0019] According to a more specific embodiment said at least one tube is deformed to clamp it between both

walls by subjecting the inner volume of the tube to a pressure. According to an alternative embodiment the outer wall is expanded by heating it after the at least one tube has been wound around the inner wall, after which the outer wall is positioned surrounding the inner wall and the wound tube and letting the outer wall cool down to make it shrink around the inner wall and the tube.

[0020] Subsequently the present invention will be elucidated with the help of the following drawings, wherein:

Figure 1: depicts the half of a cross section of a heat exchanger according to the present invention;

Figure 2: depicts a diagram for elucidating the invention;

Figure 3: depicts a detailed view of a header, being a part of the heat exchanger depicted in figure 1;

Figure 4: depicts a detail of the header depicted in figure 3; and

Figure 5: a perspective view of an alternative embodiment of the header for the heat exchanger of the present invention.

[0021] The heat exchanger according to the invention is preferably though not exclusively adapted to be mounted in a boiler for a central heating installation for domestic use. The heat exchanger 1 depicted in figure 1 comprises a cylindrical inner wall 2, and which is provided at its inner side with fins 3 to increase the heat transfer surface between a heat source located surrounded by the inner wall 2, like a gas burner not depicted in the drawings. Preferably the inner wall is from cast material like cast aluminium. Concentric with the inner wall 2 and to the outer side thereof an outer wall 4 is provided. This outer wall may be made of steel sheet, although other materials may be used.

[0022] Between the inner 2 and the outer walls 4 a cylindrical gap 5 is located. According to the invention in the gap 5 a helical wound tube 6 has been provided. The tube 6 comprises walls with an inner layer of copper and an outer layer of aluminium. Other materials may be used. The tube 6 is clamped between the inner and outer walls 2, 4. The tube 6 has been fixed by the following process. Initially the tube 6 is helically wound on a mandrel to obtain its helical shape, although other methods to obtain a helical shape are not excluded. After removal from the mandrel the helical tube 6 is inserted into the gap between the inner and outer walls. It is noted that the tube 6 can easily be inserted into the gap 5 and be positioned to obtain its proper position. A first channel 8 extend through the tube 6. When the correct position between the inner 2 and the outer 4 walls have been reached one of the ends of the tube 6 is closed, for instance by applying a stopper, after which a substantial pressure through a fluid like a gas or a liquid is applied to the internal side of the tube, and indeed so much pressure that the tube expands. This is continued to a pressure wherein the expansion of the tube 6 is such that it is clamped between the inner 2 and outer walls 4. Care

must be taken that the deforming of the tube 6 is permanent so that the tube remains in shape when the pressure is taken away. Although in the preceding lines the use of a round tube is assumed, other cross sections are not excluded.

[0023] The winding of the tube 6 on the mandrel takes place such that the pitch of the winding is larger than the size of the tube in the axial direction of the helical winding. Expressed otherwise the pitch is such that there is space between adjacent turns of the winding so that enclosed between the inner and outer walls of the heat exchanger and adjacent turns of the tube 6 a second channel 7 is formed, which channel 7 also has a helical shape.

[0024] The second channel 7 can be used for conducting a second fluid circuit. This offers the possibility to provide a heat exchanger 1 with two independent channels 7, 8 through which fluid for heating may flow. When the heat exchanger is used as a domestic boiler, one of the channels 7, 8 can be used as a channel for heating tap water while the other channel 8, 7 can be used for heating central heating water. The tap water is then preferably conducted through the channel 8 extending through the copper tube 6.

[0025] For feeding and draining the fluids to and from the channel in the tube 5 and the channel 7 enclosed by the tube 5, the heat exchanger comprises a first header 10 located at the top of the walls 2, 4 and a second header 11 located at the bottom of the walls 2, 4.

[0026] The upper header 10 is depicted in figure 3 in more detail. The header 10 is composed of a flange shaped part 11 and a cylindrical part 12. The flange shaped part 11 is located on top of and in contact with the inner wall 2, and it comprises a skirt 13 extending in the downward direction, which extends adjacent to the inner wall 2. A groove 14 has been provided in the inner side of the skirt 13 and an O-ring has been located in the groove 13 to obtain a proper sealing. The cylindrical part 12 is located adjacent to the top of the outer wall 4. The top of the outer wall 4 is fold over to the outside to form a nose 16. At its lower side the cylindrical part comprises a nose 17. A U-shaped profile 20 extends around both noses 16, 17 and it connects the cylindrical part 12 of the header 10 to the outer wall 4. The U-shaped profile 20 is tensioned by a clamp not depicted in the drawings. At the lower side of the nose 17 of the cylindrical part 12 a groove 18 has been provided in which an O-ring 19 is located for sealing. The flange shaped part 11 and the cylindrical part 12 of the header 10 are mutually connected by a bolt connection. Also here a groove 21 and an O-ring 22 have been provided in the flange shaped part 11 to provide sealing.

[0027] The headers serve to provide connections between the channels 7, 8 and the conduits outside. Therefore the upper header 10 comprises an aperture 23 with a connection for an external conduit which connects said conduit to the inside 24 of the upper header 10. The tube 6 is guided to a connection piece integrated in the header 10, but which is not depicted in the drawing. A similar

construction is present in the lower header 11, which will be described with the help of figure 4. The lower header 11 comprises, just as the upper header 10 both a flange shaped part 31 and a cylindrical part 32. The construction thereof is substantially similar to that of the upper header 11. In the cylindrical part 32 of the lower header 11 a connection socket 33 has been provided which is connected with the tube 6. the socket 33 further leads to a connection for an external conduit. It will be clear that the lower header is further provided of a connection for the second channel 7 on a similar way as is present in the upper header 10.

[0028] Figure 5 depicts an alternative embodiment of the header according to the present invention. The header designated in it entirety by 40 comprises a sleeve 41 surrounding the outer wall 4. It is connected to the outer wall by brazing or another connecting method. Further the header comprises a top wall 42 connected to the inner wall 2 of the heat exchanger 1 and sealed thereto either through brazing. The sleeve 41 comprises a first extension 43 with an aperture 44. A connecting piece 45 is joined to the end of the tube 6 and the connecting piece 45 extends through the aperture 44. A swivel 46 is connected with both the connecting piece 45 and the rims of the aperture 44, for instance by a screw connection. Gaskets or sealing rings may be used as appropriate. Hence the inner space of the header 40 is closed off while the inner space of the tube 6, forming the channel 7 is connected to the environment. The swivel comprises a screw thread to allow connection with a tube for further transport of the fluid to be heated. Further the sleeve 41 comprises a second extension 47, provided with a second aperture 48 allowing access to the inner space of the sleeve 40 and hence to the second channel 8.

[0029] A header 40 of this kind is preferably connected to both sides of the heat exchanger 1. In this embodiment the header 40 is open in its middle, allowing access to the inner space of the heat exchanger 1. Hence a lid not depicted in the drawings with the required equipment for the burner can be inserted, allowing to use several kinds of burner. At the other side the lid to be inserted can also be provided with the required equipment.

[0030] It is noted that the headers are only described in so far as relating to the invention. It will be clear that there are other differences between the upper and lower headers in relation to the heat source, like a gas burner present within the cylindrical wall 4.

Claims

1. Heat exchanger for transferring heat from a heat source to a fluid flowing in a first channel, comprising an inner wall made of heat conducting material, surrounding the heat source, being thermally connected with the heat source and of which the outer surface has the shape of a surface of revolution, a outer wall concentric relative to the inner wall, wherein the dis-

tance between both walls is substantially constant and both walls enclose an open space, wherein a first conduit comprising the first channel extends in the open space and the first conduit is in thermal contact with the inner wall.

2. Heat exchanger as claimed in claim 1, **characterized in that** the inner and the outer wall are both substantially cylindrical and that the first conduit extends helically in the open space between the inner and the outer wall. 10
3. Heat exchanger as claimed in claim 1 or 2, **characterized in that** the first conduit is adjacent to the inner and outer walls and that the pitch of the winding of the first conduit is larger than the outer size of the first conduit in axial direction of the heat exchanger to enclose a second helical channel between the windings of the first conduit. 15
4. Heat exchanger as claimed in any of the preceding claims, **characterized in that** the at least one conduit is formed by a tube and that the at least one tube has been clamped between the inner and outer walls. 20
5. Heat exchanger as claimed in claim 4, **characterized in that** said at least one tube has been deformed by subjecting the inner side of the tube to a pressure sufficiently high to cause such a permanent deforming of the tube that the tube is clamped between the inner and outer walls. 25
6. Heat exchanger as claimed in claim 4, **characterized in that** after the at least one tube has been wound around the inner wall, the outer wall has been positioned surrounding the inner wall and the tube wound around the inner wall and subsequently the outer wall has been shrunk around the inner wall and the tube. 30
7. Heat exchanger as claimed in claim 4, 5 or 6, **characterized in that** said tube has a substantial oval cross section. 35
8. Heat exchanger as claimed in any of the preceding claims, **characterized in that** the wall of said tube comprises an inner layer and an outer layer surrounding the inner layer and that the inner layer is made of a material compatible with the preparation of drinking water, like copper or stainless steel and that the outer layer is made from another material compatible with the material of the inner or the outer walls of the heat exchanger. 40
9. Heat exchanger as claimed in any of the preceding claims, **characterized in that** the inner wall is formed by an extruded work piece having a flat outer 45

surface and a finned inner surface of which the fins extend in the axial direction.

10. Heat exchanger as claimed in claim 9, **characterized in that** the fins of the inner finned surface are interrupted. 5
11. Heat exchanger as claimed in any of the claims 3-10, **characterized in that** at both ends of the heat exchanger a header closing of the open space between the inner wall and the outer wall has been located and that at least the conduit comprising the first channel is connected to both headers and that both headers comprise connection means for the first and the second channel. 10
12. Heating boiler, adapted to heat central heating water and tap water, the boiler comprising a heat source, a central heating circuit and a tap water heating circuit, **characterized in that** the heating boiler comprises a heat exchanger as claimed in one of the claims 3-11 and that the first channel of the heat exchanger is connected to the tap water heating circuit and the second channel of the heat exchanger is connected to the central heating circuit. 15
13. Method for producing a heat exchanger for transferring heat from a heat source to a fluid flowing in a first channel, comprising the following steps: 20
 - providing an inner wall made of heat conducting material, surrounding the heat source, being thermally connected with the heat source and having the shape of a surface of revolution;
 - providing at least one helical first tube through which the first channel extends surrounding the inner wall;
 - providing an outer wall, surrounding the inner wall and the tube wound around the inner wall, **characterized in that** one element of the set containing the inner wall, the tube or the outer wall is deformed to obtain a clamping connection between the inner wall and outer wall enclosing the tube. 25
14. Method as claimed in claim 13, **characterized by** permanently deforming said at least one tube to clamp it between both walls by subjecting the inner volume of the tube to a pressure. 30
15. Method as claimed in claim 13, **characterized by** winding the at least one tube around the inner wall, positioning the outer wall surrounding the inner wall and the wound tube and make the outer wall shrink around the inner wall and the tube. 35

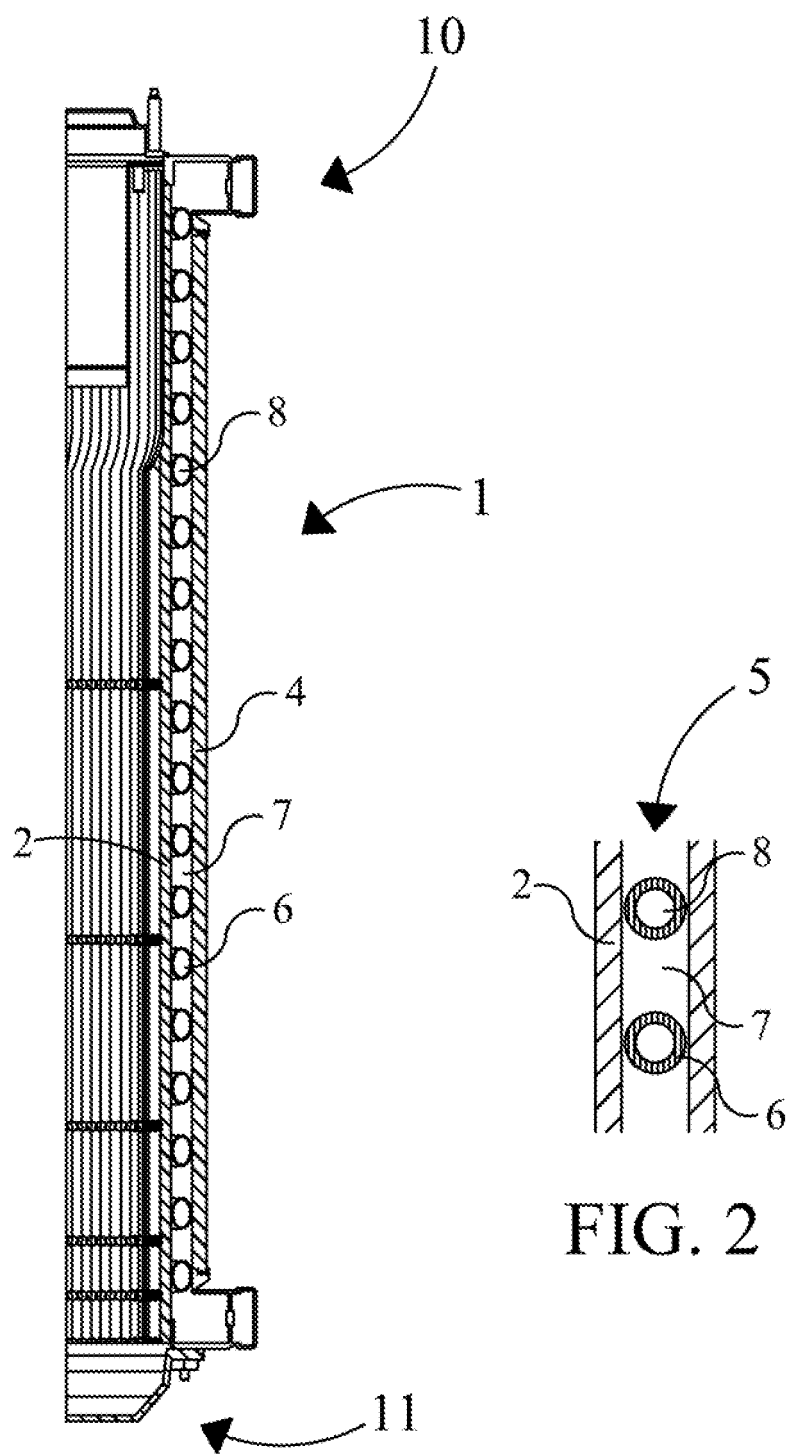


FIG. 1

FIG. 2

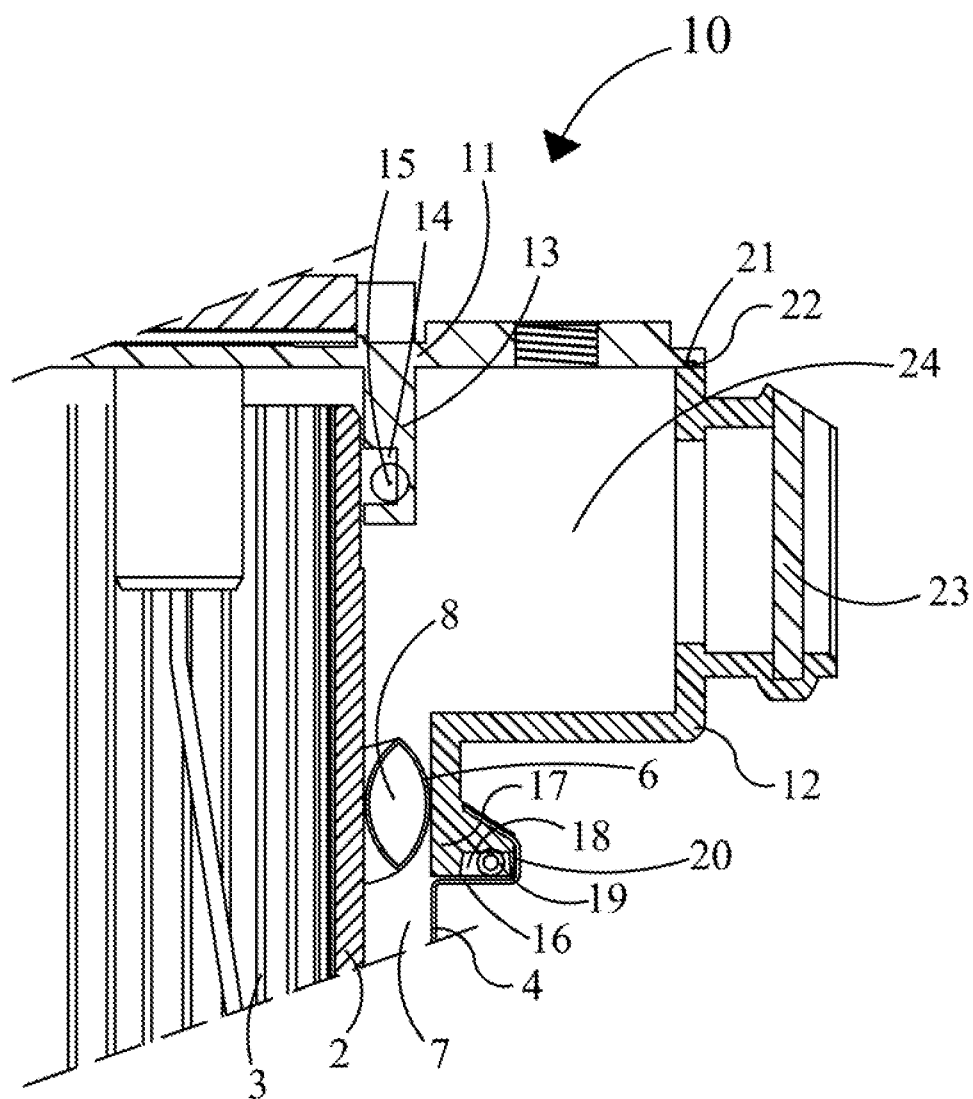


FIG. 3

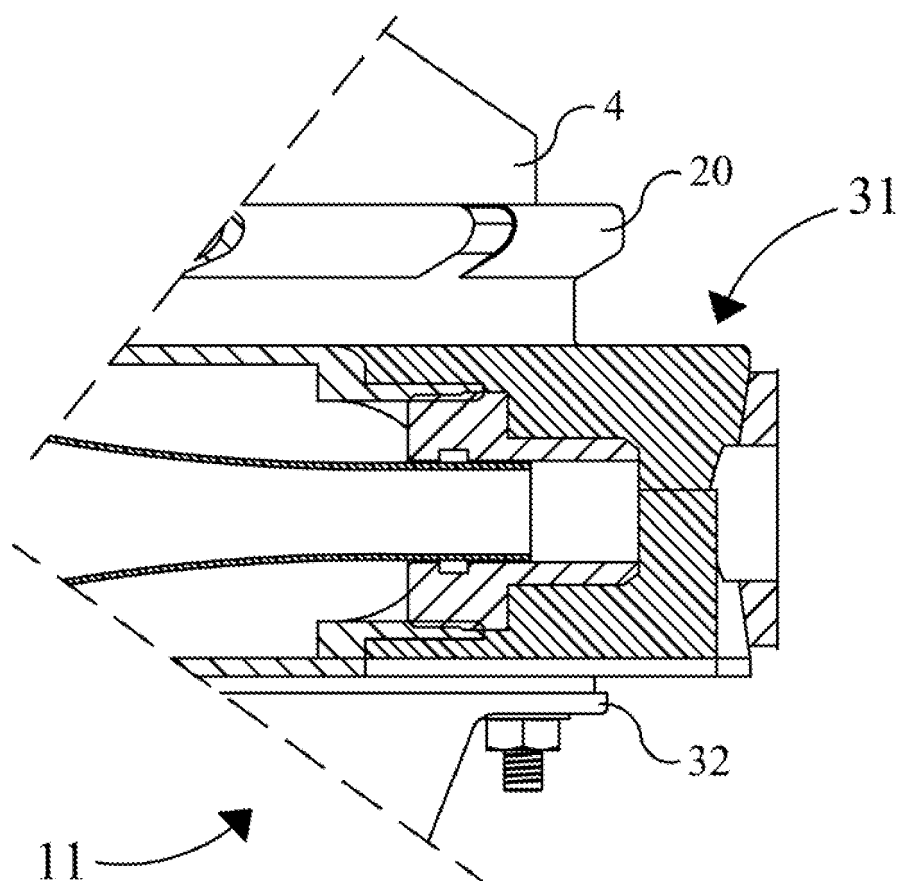


FIG. 4

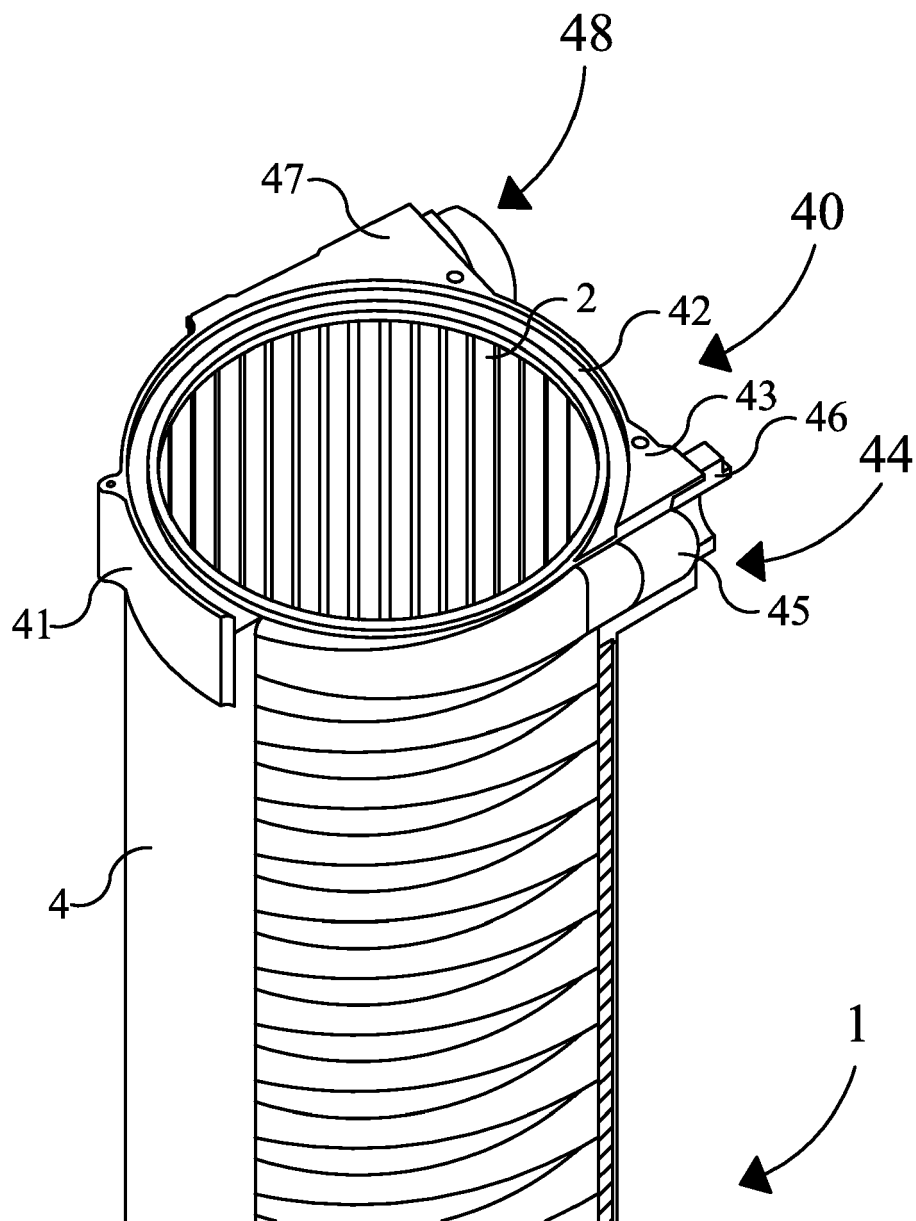


FIG. 5