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(54) **A regenerator for boilers and a boiler comprising said regenerator.**

(57) A regenerator (1) for recovering fumes generated in a combustion cell (4) of a domestic or industrial boiler (2). The regenerator (100) according to the invention comprises:

- a containment structure (10), located in which is a plurality of heat-exchange elements (5A, 5B), each of which defines at least one through cavity (8);
- a delivery channel (81) for conveying the fumes within said through cavities (8) of the heat-exchange elements (5A, 5B); and
- a first opening (17) and a second opening (18) provided on the containment structure, respectively for delivery and evacuation of water into/from said containment structure (10) in order to provide a bath of running water around said heat-exchange elements (5A, 5B).

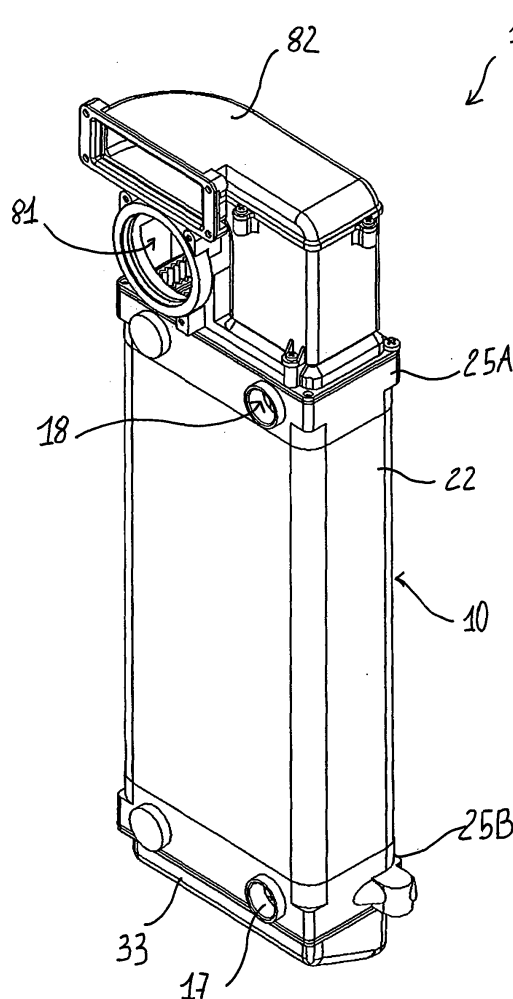


FIG. 1

Description

[0001] The present invention relates to a regenerator for domestic or industrial boilers and to a boiler comprising said regenerator.

[0002] As is known, regenerators are heat exchangers that are used for pre-heating the water that is to supply a boiler. Since they are heat exchangers they enable transfer of a certain quantity of thermal energy from one fluid that is a vector of heat to a colder one without there being the contact between the two fluids. In the specific case of regenerators, the vector fluid is constituted by the fumes of the boiler generated following upon combustion, whilst the colder fluid is constituted by water that is to flow into another heat exchanger, referred to as primary heat exchanger, which definitively heats the water before this is distributed to the water-using devices.

[0003] In greater detail, regenerators are usually made up of a plurality of tubes provided in a containment structure and internally traversed by the water coming from a mains or distribution network. The tubes are externally lapped by the hot fumes, which transfer part of their thermal content to the water, in this way increasing the temperature thereof. The heat exchange is obtained through the walls of the tubes, which for this reason are made of metal material.

[0004] Traditional regenerators are distinguished by a high thermal dispersion due to the fact that the hot fumes that lap the outer surface of the tubes heat also the surfaces of the containment structure, giving rise to a thermal irradiation around the latter. This aspect reduces the thermal efficiency of the regenerator in so far as part of the energy potentially usable for heating the water is instead dispersed in other directions.

[0005] Said drawback leads also to the need to confine the regenerator within a fluid-tight chamber of the boiler, designed also for containment of the combustion cell and of the primary heat exchanger. It should be noted that the design and construction of the fluid-tight chamber are markedly constrained by the presence of the regenerator.

[0006] On the basis of the above considerations, the primary task of what forms the subject of the present invention is to provide a regenerator for a domestic or industrial boiler that will enable the drawback referred to be overcome.

[0007] In the framework of this task, a purpose of the present invention is to provide a regenerator with low thermal dispersion.

[0008] Another purpose of the present invention is to provide a regenerator with high efficiency, high reliability, and that is easy to produce at competitive costs.

[0009] The above task, as well as the aforesaid and other purposes that will emerge more clearly from what follows, are achieved by means of a regenerator for recovering the heat of fumes of a domestic or industrial boiler comprising a containment structure, within which a plurality of heat-exchange elements are located, each provided with at least one through cavity. The regenerator

is characterized in that it comprises a delivery channel designed to convey the fumes within the through cavities of the heat-exchange elements and such as to be operatively connectable to a duct for the extraction of the fumes from the combustion cell of a boiler. The containment structure comprises a first opening and a second opening, respectively for delivery and evacuation of water that is to supply the boiler. Said openings have the purpose of providing together a bath of running water around the heat-exchange elements.

[0010] The presence of a bath of water defined through the containment structure affords the advantage of limiting any thermal dispersion in so far as it limits markedly the heating of the surfaces of the structure itself. This aspect also advantageously increases the global efficiency of the heat exchanger.

[0011] Further characteristics and advantages of the invention will emerge more clearly from the description of preferred, but non-exclusive, embodiments of the heat exchanger according to the invention, illustrated by way of non-limiting example in the annexed plate of drawings, in which:

- Figure 1 is a perspective view of an embodiment of a regenerator according to the invention;
- Figure 2 is a cross-sectional view according to a plane of longitudinal cross section of the regenerator of Figure 1;
- Figure 3 is a cross-sectional view according to a plane of transverse cross section of the regenerator of Figure 1;
- Figure 4, is an exploded view of the regenerator of Figure 1;
- Figure 5 is a perspective view of a boiler comprising the regenerator according to the invention;
- Figures 6 and 7 are internal views of the boiler of Figure 5;
- Figure 8 is a view of a first side of the boiler of Figure 6; and
- Figure 9 is a view of a second side of the boiler of Figure 6.

[0012] With reference to the figures referred to above, the regenerator 1 according to the invention comprises a plurality of heat-exchange elements 5A, 5B located within a containment structure 10. Each of these elements defines a through cavity 8 in the direction in which the element 8 itself develops. The regenerator 1 is characterized in that it comprises a delivery channel 81 for conveying the fumes generated in a combustion cell 4 of a boiler 2 within the through cavity 8 of the heat-exchange elements 5. As indicated more clearly hereinafter, in order to perform its function, the delivery channel 81 is operatively connectable to a duct 70, designed to enable extraction of said fumes from the combustion cell 4. The containment structure 10 of the regenerator 1 is provided with a first opening 17 and a second opening 18, respectively for delivery and evacuation of water, that is to be

heated by the boiler 2. The two openings 17 and 18 have the purpose of providing together a bath of running water around the heat-exchange elements 5A, 5B.

[0013] The fumes conveyed within the through cavities 8 of the heat-exchange elements 5A, 5B heat the bath of running water surrounding the elements themselves. This enables considerable limitation of the thermal dispersion by irradiation through the jacket 22 of the containment structure 10 in so far as the fluid that laps said surface is at a lower temperature than what is envisaged in known regenerators. Amongst the other advantages, the low thermal dispersion enables setting of the regenerator 1 on the outside of the fluid-tight chamber 3 of the boiler 2 according to modalities described in greater detail hereinafter.

[0014] Figure 1 illustrates a possible embodiment of the heat exchanger according to the present invention. The containment structure 10 is defined by a jacket 22 with longitudinal development and by a pair of flanges 25 provided at the opposite ends of the jacket 22. As emerges clearly from Figure 4, for example, the two flanges 25 have the purpose of positioning the heat-exchange elements 5 within the containment structure 10.

[0015] Figure 2 is a cross-sectional view of the regenerator of Figure 1 according to a plane of longitudinal cross section which shows a preferred embodiment of the invention, according to which the delivery channel 81 is operatively connected to a first series 5A of heat-exchange elements in a position corresponding to a first flange 25A of said plurality of flanges 25. A second series of heat-exchange elements 5B is operatively connected to said first series of heat-exchange elements 5A in a position corresponding to a second 25B of said plurality of flanges 25. In particular, according to a preferred embodiment of the invention, the two series of heat-exchange elements 5A, 5B are preferably arranged in a common direction, in which also the jacket 22 of the containment structure 10 develops.

[0016] As illustrated once again in Figure 2, the connection between the two series of heat-exchange elements 5A, 5B is preferably made through a chamber for return of the fumes 33, provided in a position corresponding to said second flange 25B and hermetically insulated from the bath of running water.

[0017] The technical solution just described basically defines a pre-set path for the fumes within the containment structure 10 that enables a reduction, given the same surface of heat exchange, of the overall dimensions of the regenerator 1.

[0018] With reference again to Figure 1, the first, delivery, opening 17 is defined on one side of the second flange 25B, whilst the second, evacuation, opening 18 is instead defined on one side of the first flange 25A for generating a bath of running water such as to lap the heat-exchange elements 5A, 5B throughout their length. It is to be understood that the function of the two openings 17 and 18 can be reversed, for example in the case where the regenerator 1 is installed in a position turned upside

down with respect to the one illustrated in Figure 1.

[0019] By virtue of this particular arrangement of the openings 17 and 18, heat exchange between the two fluids occurs in conditions of "countercurrent", when the fumes traverse the first series of elements 5A, and in conditions of "equicurrent" when the fumes return towards the first flange 25A within the second series of elements 5B. This obviously enables a high overall efficiency of the regenerator 1 to be obtained, which obviously also results in a better efficiency of the boiler interlocked to the regenerator itself.

[0020] Figure 3 is a cross-sectional view of the regenerator 1 of Figure 1 according to a transverse plane that in particular shows a possible embodiment of the heat-exchange elements 5A, 5B. In particular, they are constituted by tubes made of metal material or metal alloys with high thermal conduction, such as for example aluminium alloys. Said tubes are preferably defined by corrugated surfaces for increasing the useful surface of heat exchange between the two fluids.

[0021] It is to be considered in any case as falling within the framework of the inventive idea the possibility of using as heat-exchange elements tubes defined by surfaces different from the ones indicated or distinguished, for example, by ovalized or circular cross sections.

[0022] Figure 4 is an exploded view of the regenerator 1 according to the invention that shows in detail the elements constituting said regenerator. In particular, the regenerator 1 comprises an evacuation channel 82, which has the function of conveying the fumes towards a flue 97 (see Figure 6) when these exit from the cavities 8 of the heat-exchange elements 5A, 5B. In the solution illustrated the evacuation channel 82 is provided in a position corresponding to the first flange 25A in order to collect and convey the fumes that exit from the second series of heat-exchange elements 5B. This can be made of a single piece that can be operatively connected to the first flange 25A, but can also be made of a number of sectional parts that can be assembled together, as illustrated precisely in Figure 4. The shape of the evacuation channel 82 can obviously differ from the one illustrated, as its orientation can vary according to the different requirements of use.

[0023] Once again with reference to Figure 4, the regenerator 1 is provided with first sealing means 61 pre-arranged for providing the mechanical tightness between the first flange 25A and the duct for delivery 81 and duct for evacuation 82 of the fumes. Second sealing means 62 are instead pre-arranged for providing the mechanical tightness between the return chamber 33 and the second flange 25B of the regenerator 1.

[0024] Figures 5, 6 and 7 are perspective views of a boiler 2, characterized in that it comprises a regenerator 1 according to the present invention. The boiler 2 has a substantially prismatic structure with a vertical development, i.e., defined by four side walls, of which at least one provided with means 99 for control of operation of the boiler itself by a user. In greater detail, the boiler 2

comprises an outer casing 12, provided inside which is a fluid-tight chamber 3 in turn containing a combustion cell 4. A heat exchanger 55, referred to as "primary heat exchanger", is present inside the combustion cell 4 for the purpose of heating, with the products of combustion, the water for the water-using devices.

[0025] The regenerator 1 is advantageously located on the outside of the fluid-tight chamber 3 and operatively connected to the combustion cell 4 through a pipe 70 for extraction of the fumes. The containment structure 10 of the regenerator 1 is operatively connected, in a position corresponding to the second opening 18, to the primary heat exchanger 55 through a supply pipe 92, whilst the first delivery opening 17 is hydraulically connected to a water-distribution network, such as may be, for instance, the domestic network.

[0026] This arrangement of the regenerator 1 on the outside of the fluid-tight chamber 3 is possible by virtue of the low thermal dispersion that accompanies operation of the regenerator itself. The bath of water present in the containment structure 10 of the regenerator 1 limits in fact heating of the jacket 22 and hence the thermal dispersion through the latter.

[0027] Figures 8 and 9 are respectively a cross-sectional view and a side view of the boiler 2 that show in detail the arrangement of the regenerator 1 with respect to the fluid-tight chamber 3. The longitudinal development of the regenerator 1 enables positioning thereof along a wall of the fluid-tight chamber 3 so as to contain as much as possible also the space occupied by the outer casing 12 of the boiler 2.

[0028] In this connection the containment casing 12 can be advantageously provided in a first portion 12A that surrounds at least partially three sides of the fluid-tight chamber 3 and a second portion 12B that surrounds the regenerator 1 present up against a fourth side of the fluid-tight chamber 3. Amongst other advantages, said solution facilitates the operations of maintenance of the boiler 2 and in particular those of the regenerator 1. In fact, the maintenance of the latter does not require the operator to gain access to the fluid-tight chamber 3, but simply requires removal of the second portion 12B of the casing 12.

[0029] As may be appreciated from what has so far been said, it emerges that the present invention provides also a new method for preheating the water that is to supply the primary heat exchanger of a boiler. The method in particular comprises the steps of:

- providing, on the outside of the fluid-tight chamber 3 of the boiler 2, a plurality of heat-exchange elements 5 equipped with through cavities 8 in a bath of running water provided in a containment structure 10;
- extracting on the outside of the fluid-tight chamber 3 of the boiler 2 the fumes generated in the combustion cell 4 of the boiler itself;
- conveying the fumes extracted within the through

cavity 8 of the heat-exchange elements 5 in such a way as to heat the bath of running water;

- transferring the heated water to the primary heat exchanger 55 of the boiler 2.

[0030] The method just referred to hence differs from the ones traditionally used for the same purpose in so far as it provides a preheating of the water on the outside of the fluid-tight chamber 3 of the boiler 2 with the advantages already set forth above.

[0031] The method according to the invention then comprises also the creation of a pre-set path for said fumes within the elements 5A, 5B for the purpose of prolonging the duration of the heat exchange. Said path is obtained by connecting mutually the elements 5A, 5B preferably in such a way that the heat exchange between the fumes and the bath of running water occurs in part in conditions of equicurrent and in part in conditions of countercurrent.

[0032] According to a preferred embodiment of the invention, what has just been said is obtained by providing, in one and the same direction, a first series 5A and a second series 5B of heat-exchange elements within the bath of running water and by providing a return chamber between the two series of elements 5A, 5B so that the fumes at output from the first series of elements 5A are conveyed in the through cavities 8 of the second series of elements 5B.

[0033] The technical solutions adopted for the regenerator according to the invention hence enable the pre-set tasks and purposes to be fully achieved. In particular the regenerator 1 is distinguished by a high efficiency accompanied by a low thermal dispersion. Said characteristic enables the installation thereof on the outside of the boiler designed to be interlocked to the regenerator itself. In practice, the materials used, as well as the dimensions and the shapes involved, may be any whatsoever according to the requirements and the state of the art.

Claims

1. A regenerator (100) of fumes generated in a combustion cell (4) of a domestic or industrial boiler (2) comprising a containment structure (10), located in which is a plurality of heat-exchange elements (5A, 5B), each of which defines at least one through cavity (8), **characterized in that** it comprises a delivery channel (81) for conveying said fumes within said through cavities (8) of said heat-exchange elements (5A, 5B), said delivery channel (81) being operatively connectable to a duct for the extraction (70) of said fumes from said combustion cell (4), said containment structure (10) comprising a first opening (17) and a second opening (18), respectively for delivery and evacuation of water into/from said containment structure (10), said openings (17, 18) being provided

together so as to create a bath of running water around said heat-exchange elements (5A, 5B).

2. The regenerator (1) according to Claim 1, **characterized in that** said containment structure (10) comprises a jacket (22) with longitudinal development and a pair of flanges (25) provided at the opposite ends of said jacket (22), said flanges (25) positioning said heat-exchange elements (5A, 5B) at pre-set distances apart from one another. 10
3. The regenerator according to Claim 2, **characterized in that** said delivery channel (81) is operatively connected to a first series of heat-exchange elements (5A) in a position corresponding to a first flange (25A), said first series of elements (5A) being operatively connected to a second series of heat-exchange elements (5B) in a position corresponding to a second flange (25A). 15
4. The regenerator according to Claims 3, **characterized in that** said first series (5A) is operatively connected to said second series of heat-exchange elements (5B) through a return chamber (33) provided in a position corresponding to said second flange (25) and hermetically insulated from said bath of running water. 20
5. The regenerator (1), according to one or more of Claims 1 to 4, **characterized in that** said heat-exchange elements (5) are constituted by tubes made of a metal material. 25
6. The regenerator (1) according to Claim 5, **characterized in that** said tubes are defined by corrugated surfaces for increasing the useful surface of heat exchange. 30
7. The regenerator (1) according to one or more of Claims 1 to 6, **characterized in that** it comprises an evacuation channel (82) for conveying the fumes at output from said cavities (8) of said heat-exchange elements (5) towards a flue (97). 35
8. The regenerator (1) according to one or more of Claims 3 to 7, **characterized in that** said evacuation channel (82) is operatively connected to said second series of heat-exchange elements (5B) in a position corresponding to said first flange (25A). 40
9. The regenerator (1) according to Claim 7 or Claim 8, **characterized in that** it comprises first sealing means (61) for providing the mechanical tightness between said first flange (25A) and said delivery channel (81) and evacuation channel (82). 45
10. The regenerator (1) according to one or more of Claims 4 to 9, **characterized in that** it comprises 50

second sealing means (62) for providing the mechanical tightness between said second flange (25A) and said return chamber (33).

- 5 11. A boiler (2) for domestic or industrial use, comprising:
 - a combustion cell (4) in which products of combustion are generated;
 - a primary heat exchanger (55) set inside said combustion cell (4) for heating water through the products of combustion;
 - a fluid-tight chamber (3) containing said combustion cell (4); and
 - an outer casing (12) containing said fluid-tight chamber (3), 10

said boiler being **characterized in that** it comprises a regenerator (1) according to one or more of Claims 1 to 10 located on the outside of said fluid-tight chamber (3), said boiler (2) comprising an extraction pipe (70) for extraction of the fumes from said combustion cell (4), said extraction pipe (70) connecting said combustion cell (4) to said delivery channel (81) of said regenerator (1), said boiler (2) comprising a supply pipe (92) of said primary heat exchanger (55), said supply pipe (92) transferring heated water from said regenerator (1) to said primary heat exchanger. 15
12. The boiler (2) according to Claim 11, **characterized in that** said regenerator (1) is located up against an external wall of said fluid-tight chamber (3). 20
13. The boiler (2) according to Claim 11 or Claim 12, **characterized in that** said outer casing (12) comprises a first portion (12A) and a second portion (12B) connected in a removable way. 25
14. A method for preheating the water that supplies a primary heat exchanger (55) of a domestic or industrial boiler (2), said boiler comprising a combustion cell (4) present in which are said primary heat exchanger (55) and a fluid-tight chamber (3) containing said combustion cell (4), said method comprising the steps of: 30
 - providing, on the outside of said fluid-tight chamber (3), a plurality of heat-exchange elements (5A, 5B), provided with through cavities (8), in a bath of water defined through a containment structure (10);
 - extracting on the outside of said fluid-tight chamber (3) the fumes generated in said combustion cell (4) of said boiler (2);
 - conveying said fumes within said cavity (8) of said heat-exchange elements (5A, 5B) so that said fumes heat said bath of running water; and
 - transferring said heated water to said primary heat exchanger (55) of said boiler (2). 35

15. The method according to Claim 14, **characterized in that** a pre-set path for said fumes is determined within said bath of running water by connecting said heat-exchange elements (5A, 5B) together. 5
16. The method according to Claim 15, **characterized in that** said heat-exchange elements (5A, 5B) are connected together so that the heat exchange between said fumes and said bath of running water is carried out in part in conditions of equicurrent and in part in conditions of countercurrent. 10
17. The method according to Claim 16, **characterized in that** a first series of elements (5A) and a second series of heat-exchange elements (5B) are provided in one and the same direction within said baths of water and **in that** said series of elements (5A, 5B) it are operatively connected through a return chamber (33) so that the fumes coming out of said through cavities (8) of said first series of elements (5A) will be conveyed in said through cavities (8) of said second series of elements (5B). 15
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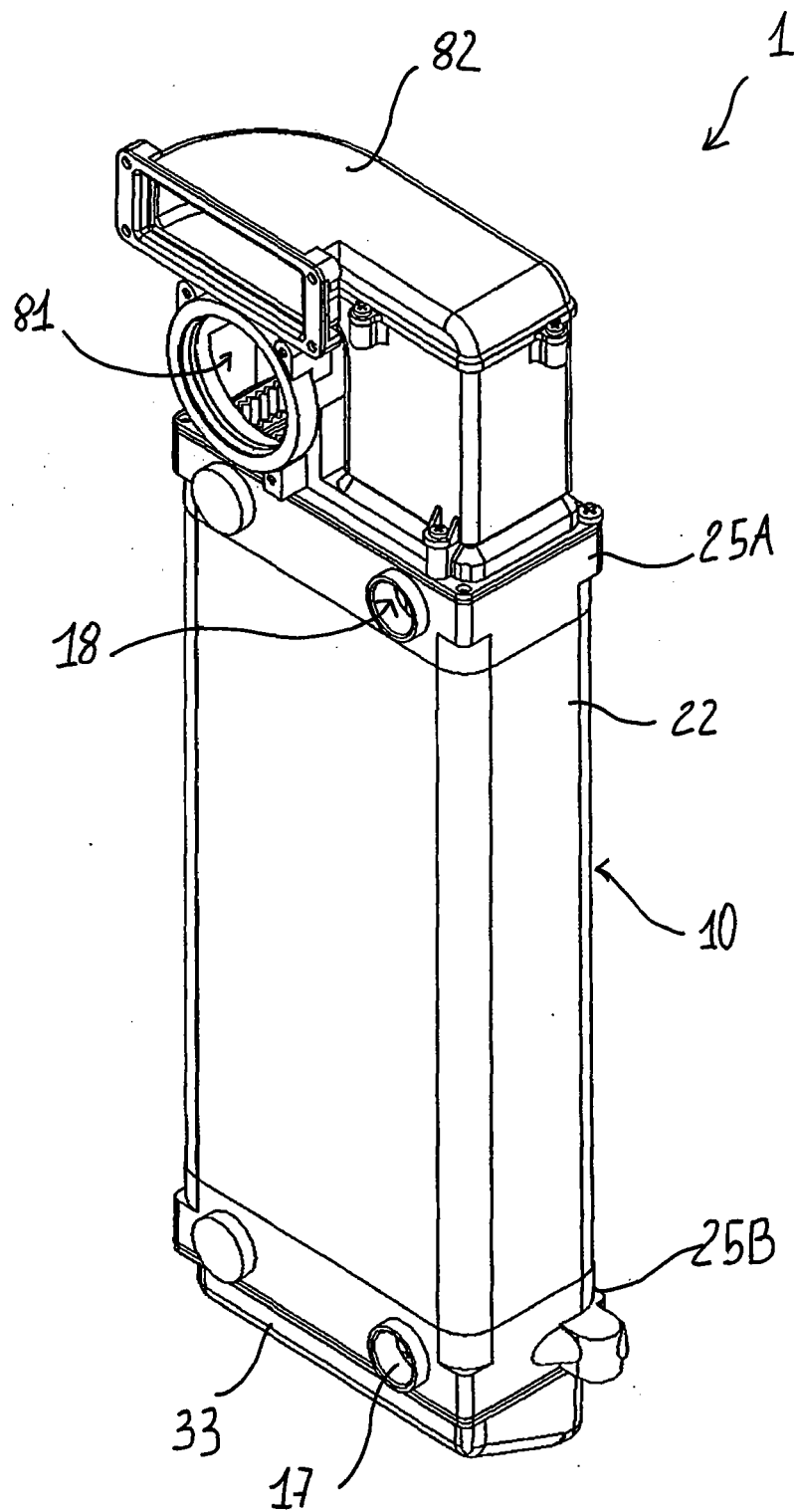


FIG. 1

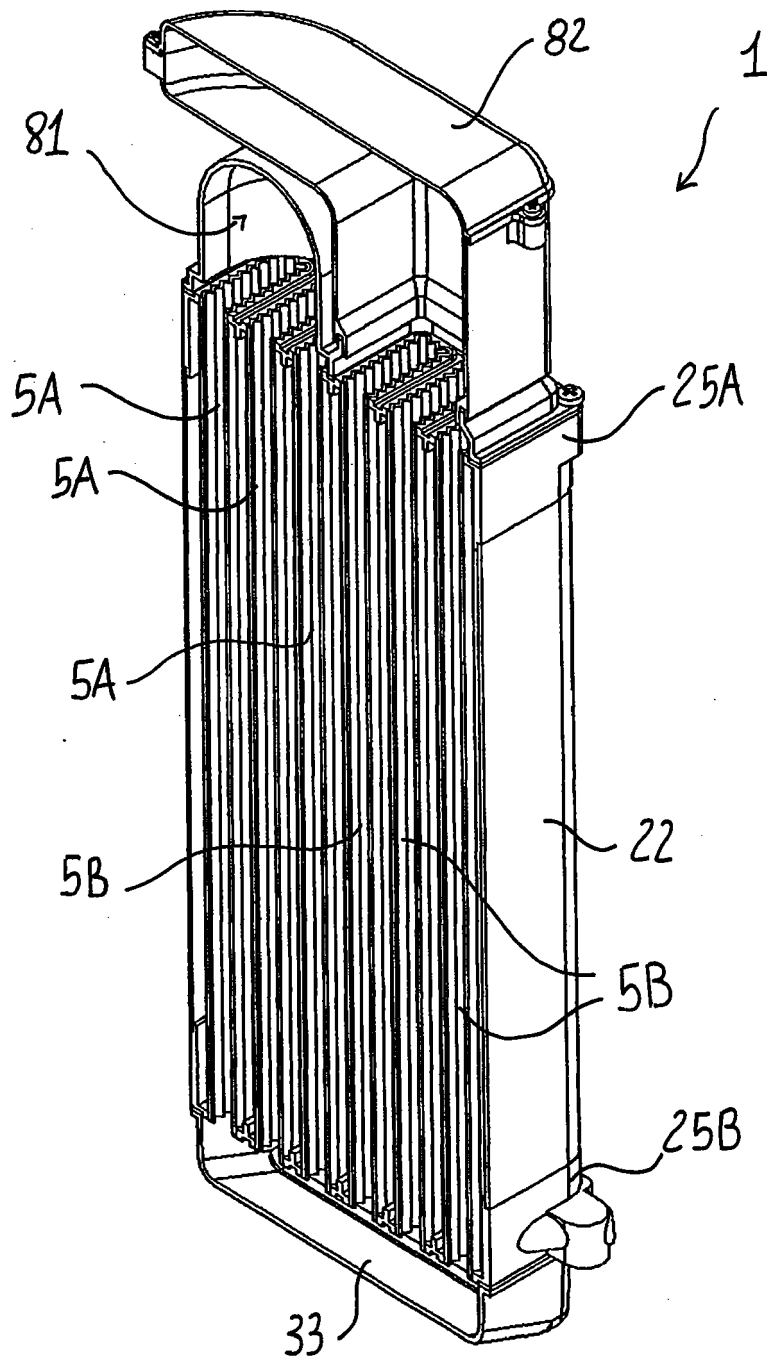


FIG. 2

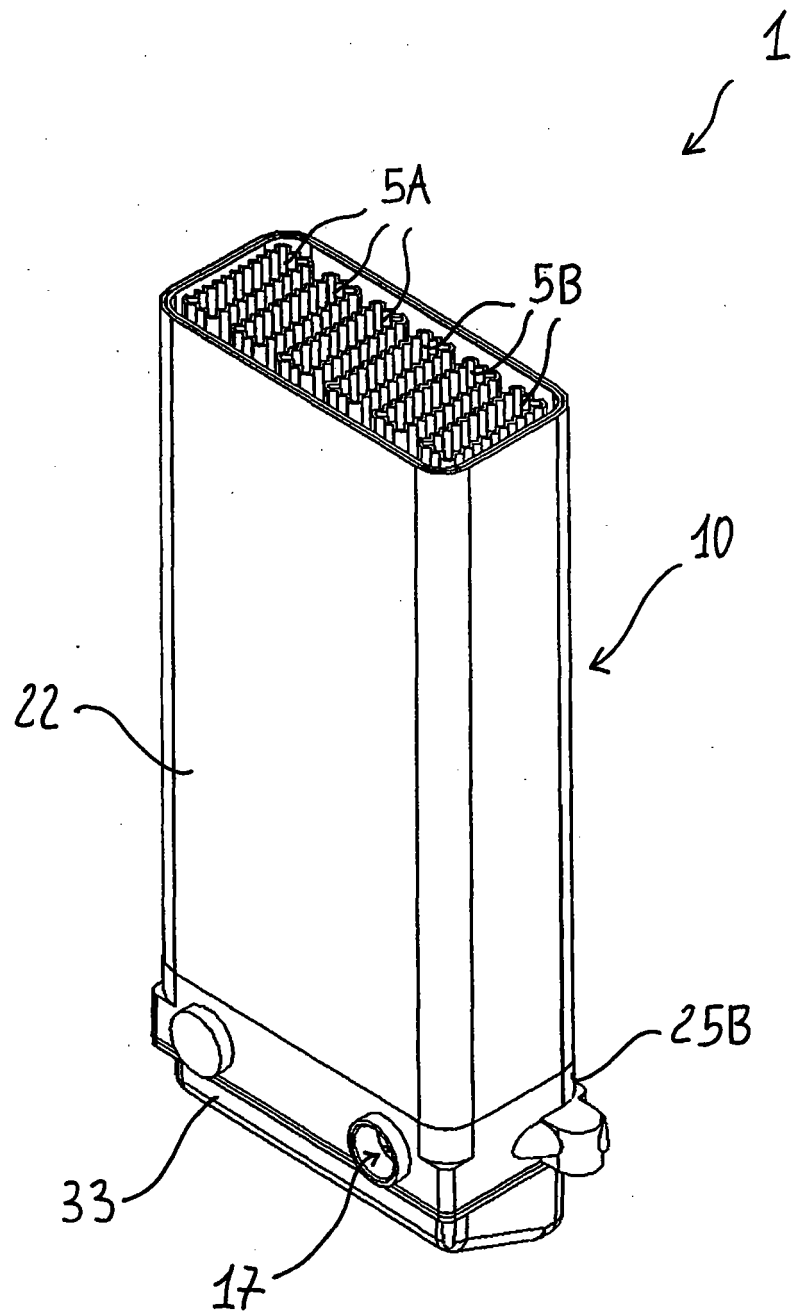


FIG. 3

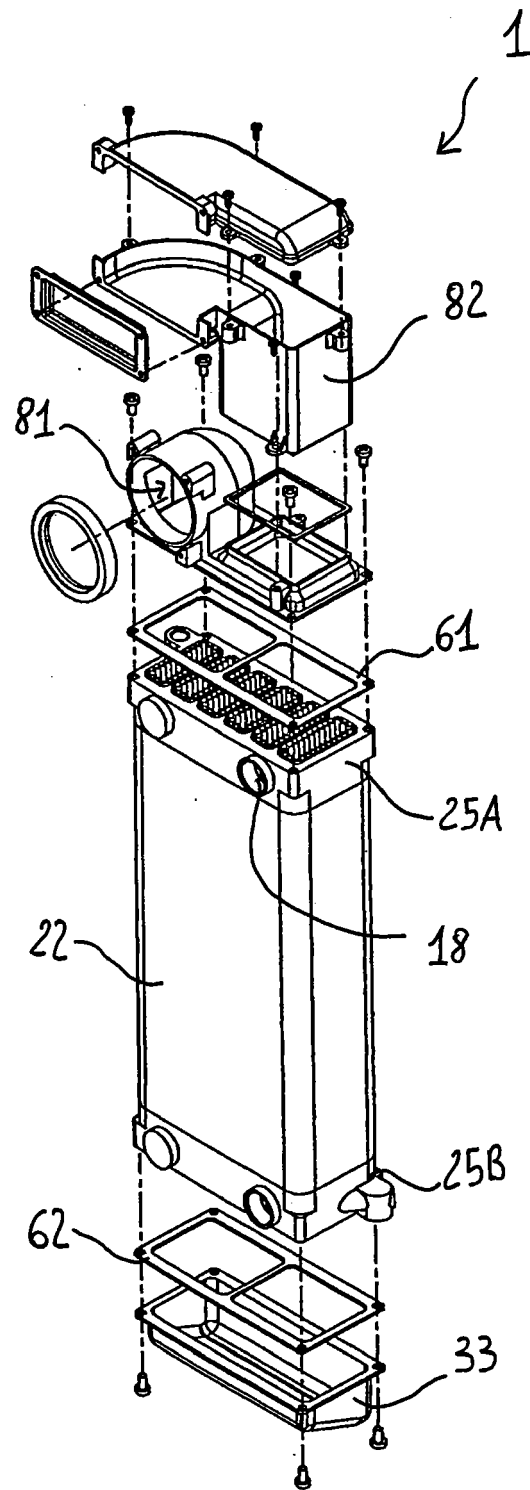


FIG. 4

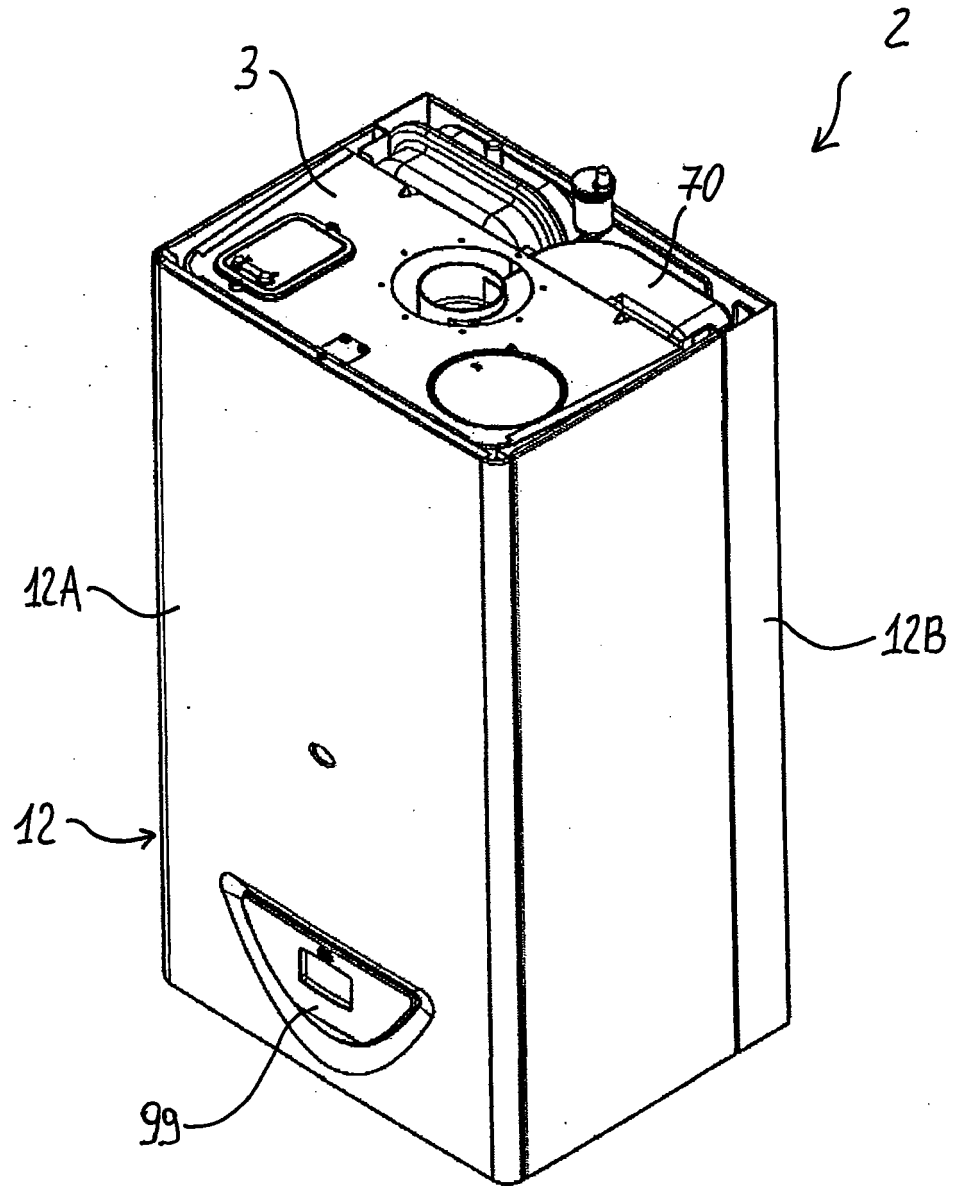


FIG. 5

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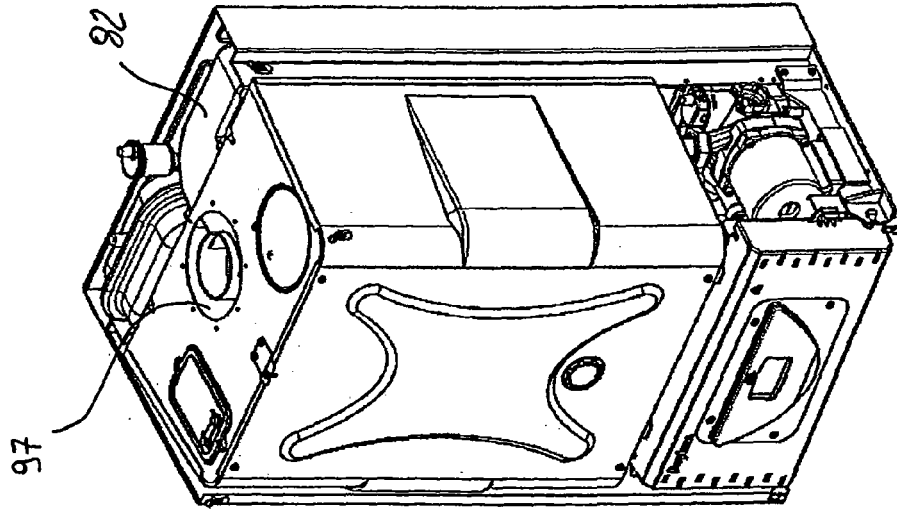


FIG. 7

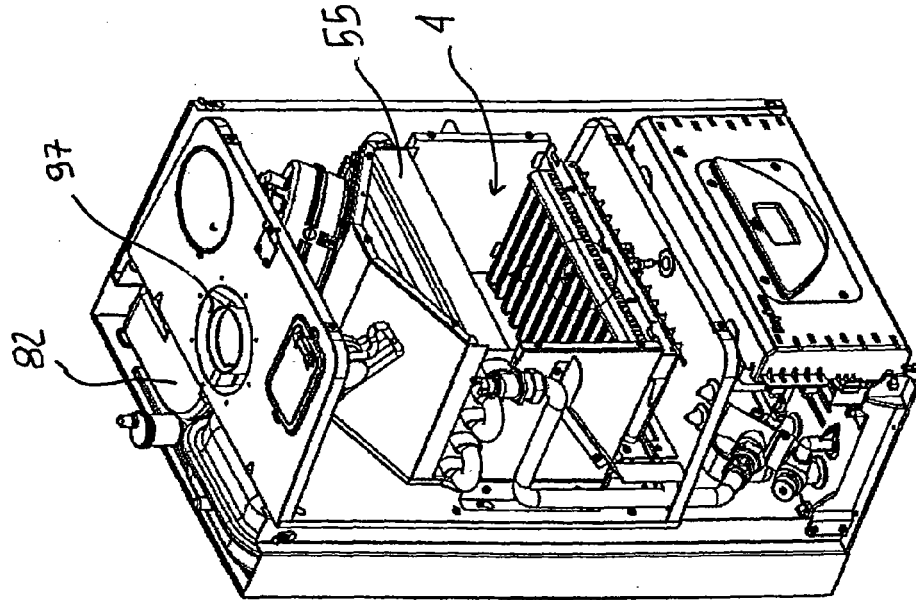


FIG. 6

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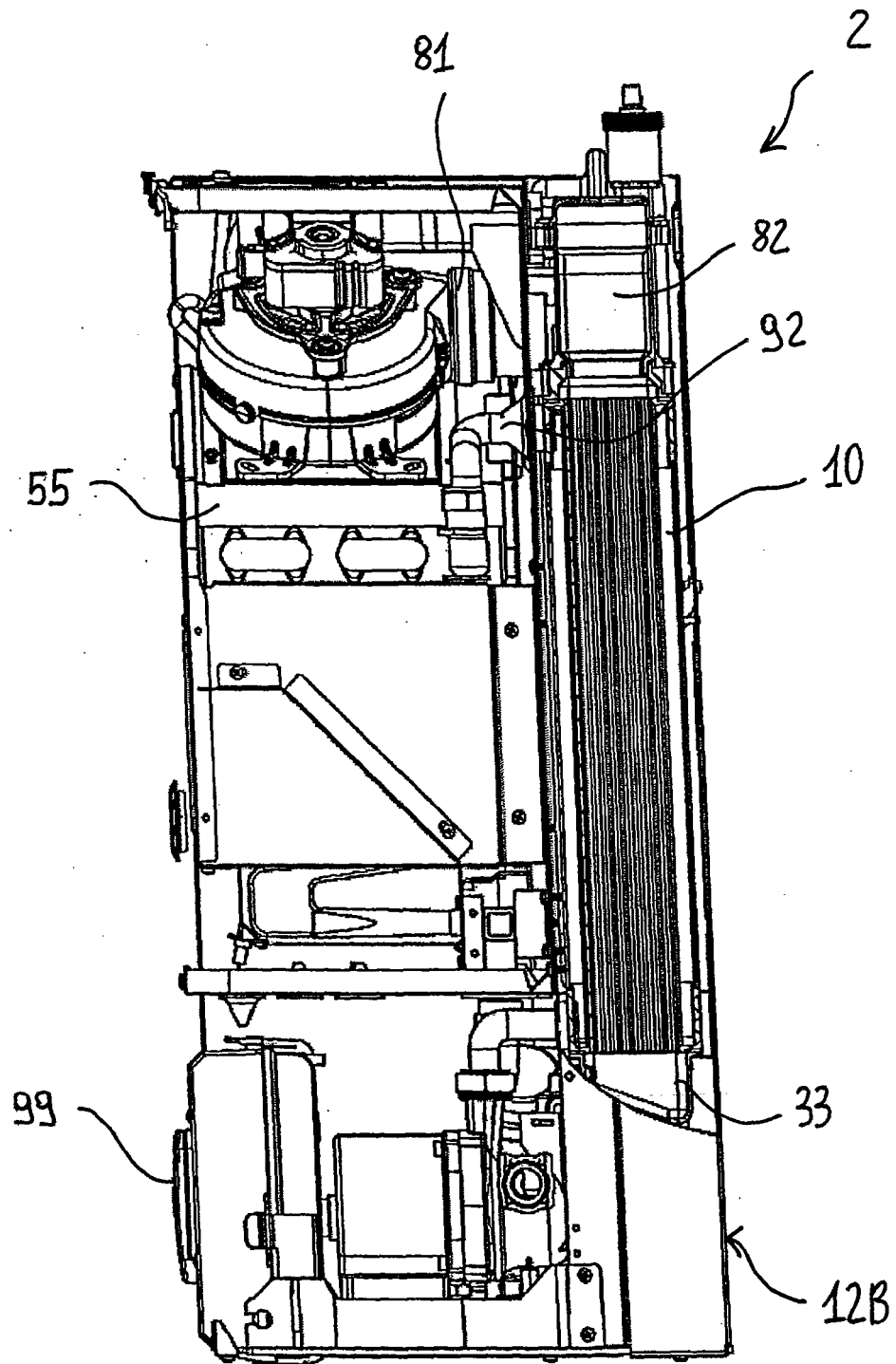


FIG. 8

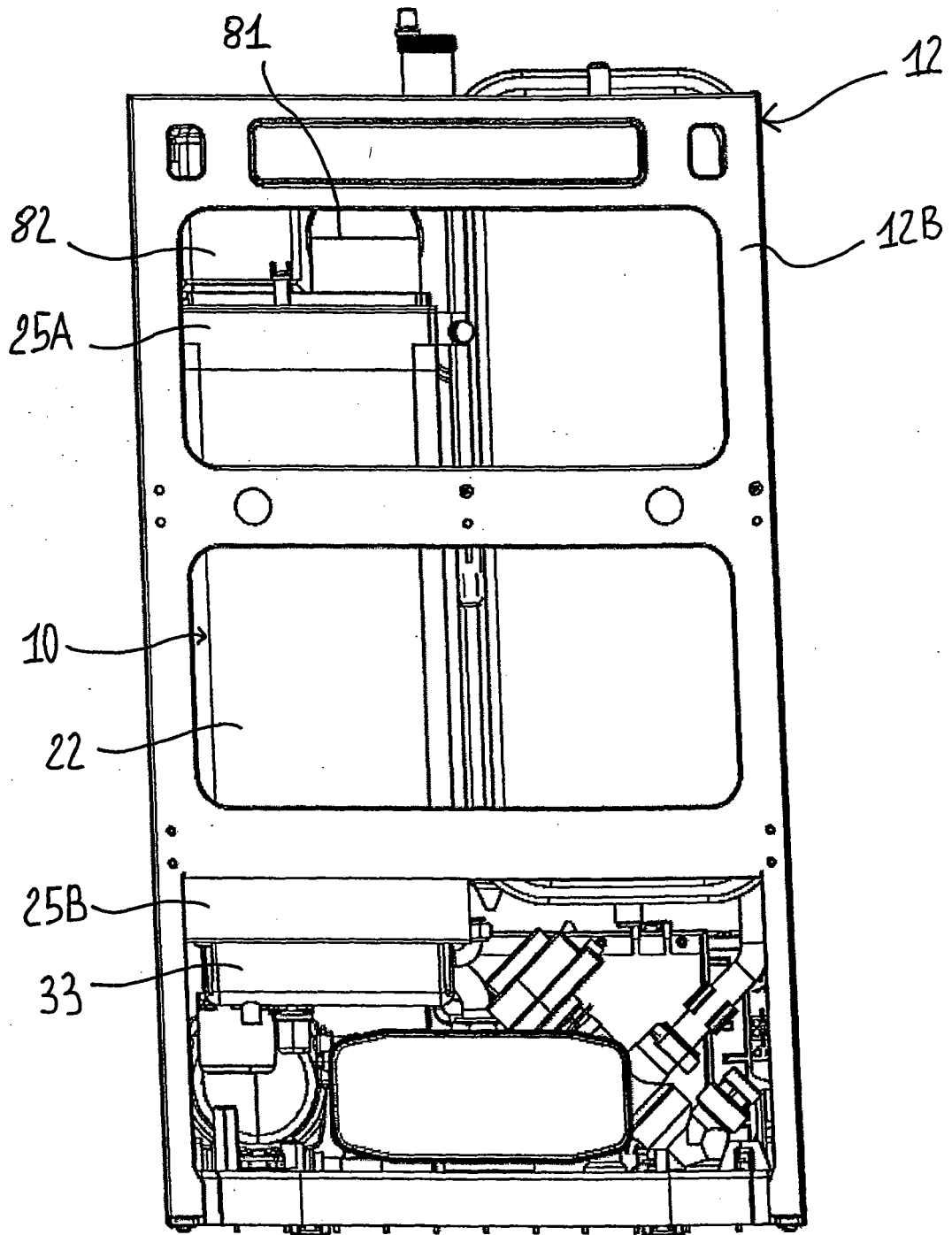


FIG. 9