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(54) **HEAT EXCHANGER FOR GAS COOKING OVEN**

WÄRMETAUSCHER FÜR GASBACKOFEN

ÉCHANGEUR DE CHALEUR POUR FOUR DE CUISSON À GAZ

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Description

TECHNICAL FIELD OF INVENTION

[0001] The present invention concerns a heat exchanger, in particular for a convection oven of domestic, professional or industrial type for cooking food, with gas or liquid fuel heating, hereinafter referred to concisely as gas oven.

BACKGROUND OF THE INVENTION

[0002] Convection ovens for the heat treatment of food normally comprise a box-like casing, defining a cooking chamber, in which can be arranged the food to be cooked or heated. The cooking chamber is provided in the front with an access opening selectively closable by a door hinged to the casing. Heating means and air circulation means, suitably connected to a command and control unit for their operation, are also provided to achieve a uniform heating of the air in the cooking chamber.

[0003] The air circulation means are typically made up of at least one fan, preferably bidirectional, driven by an electric motor and arranged in flow communication with the cooking chamber. On the other hand, for what concerns the heating means, there are essentially two types of food cooking ovens available on the market, known in fact as electric heating and gas burning ovens.

[0004] In electric ovens, the means for heating the atmosphere in the cooking chamber consist of electrical heating elements, that are generally positioned around the fan.

[0005] On the other hand, in gas ovens the heating means used are formed by a gas heating unit essentially comprising a burner, preferably of the pre-mixing type and generally housed in the lower part of the cooking chamber, and a heat exchanger typically formed by one or more tubes, variously arranged against the back wall of the cooking chamber or wound circumferentially around the fan, and adapted to be traversed by the exhaust gases generated by the burner to exchange heat with the atmosphere of the cooking chamber before being expelled at the ceiling of the chamber through a relative exhaust duct. An example of such prior art heat exchangers is disclosed in the document DE4125696.

[0006] One drawback that can be observed in these gas ovens lies in the fact that the thermal energy of the exhaust gases is used only partially for heating the cooking chamber, since the gases flow through the tubes at quite a high speed and the exchange surface of these tubes inside the cooking chamber is relatively small; consequently, the temperature of the gases at the exhaust opening is still rather high.

[0007] To remedy such drawback, it would therefore be advisable to increase the exchange surface of the tubes in the heat exchanger, for example by increasing their length inside the cooking chamber, thereby also increasing the efficiency of the heat transfer; in this manner,

however, the space required to house the heat exchanger is appreciably increased, with consequent problems of organizing the dimensions inside the structure of the oven.

[0008] It is also necessary to consider the fact that, unlike the electrical heating elements, for which the heat transfer is essentially constant along their whole length, in a heat exchanger the temperature of the exhaust gases that flow through it decreases progressively the farther they are from the burner, and consequently the heat available for the exchange with the atmosphere of the cooking chamber also decreases.

[0009] As a consequence, an increase in the length of the heat exchanger may entail unevenness in the distribution of the temperature inside the cooking chamber, which results in some cases in a non-homogeneous and therefore unacceptable cooking of the food.

[0010] Document JP2011-141098 A discloses an oven equipped with a heat exchanger formed by a pair of tube bundles that extend symmetrically around the fan. In particular, each tube bundle is formed by three delivery tube portions that penetrate into the cooking chamber of the oven from the upper wall of the same, and thus are crossed by the exhaust gases in a first direction, and a pair of return tubular portions, that extend farther outward than the delivery portions with respect to the fan and are connected to the latter through a return body positioned lower than the fan, and adapted to carry the exhaust gases toward adapted exhaust openings located at the top wall of the cooking chamber, and therefore being crossed in an opposite direction of flow.

[0011] However, the development of the heat exchanger described above is radial with respect to the fan, since the return tubular portions of the two tube bundles are arranged more outwardly with respect to the delivery portions; this entails an increase of the dimensions required for housing the heat exchanger, and further limits the choice of the dimensions of the fan to install in the oven.

[0012] In addition, as will be evident to an expert in the field, this configuration of the heat exchanger causes the air pushed radially by the fan of the oven to first cross the delivery tube portions and subsequently the return tubular portions, thus being not optimized from the point of view of heat exchange efficiency.

SUMMARY OF THE INVENTION

[0013] The main objective of the present invention is to remedy the shortcomings of the prior art by providing a heat exchanger for gas burning ovens that makes it possible to increase the efficiency of the heat exchange between the exhaust gases and the atmosphere of the cooking chamber and at the same time improves the uniformity of distribution of the temperatures inside the cooking chamber.

[0014] In the scope of the present objective, one purpose of the present invention is to propose a heat ex-

changer for gas burning ovens of small dimensions, such as to guarantee the compactness of the whole oven.

[0015] A further purpose of the present invention is to achieve a heat exchanger of rather compact size that can necessarily also be contained in the space provided in the cooking chamber of an electric oven, if said chamber allows it.

[0016] Another purpose of the present invention is to propose a heat exchanger for gas burning ovens that makes it possible to achieve a uniform temperature distribution inside the whole cooking chamber, eliminating the thermal gradient in particular along a vertical axis of reference, so as to achieve a homogeneous cooking of the food.

[0017] One not least important purpose of the present invention is to achieve a heat exchanger for gas burning ovens that accomplishes the above objective and purposes at competitive costs, so that its application is advantageous also from the economic point of view, and that can be obtained with the usual well-known plants, machines and equipment.

[0018] The above objective and purposes and others that will be more evident below, are achieved by a heat exchanger as defined in claim 1; further characteristics are defined in the subsequent dependent claims.

BRIEF DESCRIPTION OF THE FIGURES

[0019] Advantages and characteristics of the invention will be evident from the description which follows, given by way of example but without limitations, with reference to the enclosed figures, wherein:

- figure 1A illustrates, in a front view, a structure of a gas burning cooking oven in which is installed a heat exchanger according to the present invention;
- figure 1B illustrates the structure of the oven of figure 1A in a plan view;
- figure 1C illustrates, in a side view indicated by the arrow Z in figure 1A, the structure of the oven of the preceding figures;
- figure 2 illustrates, in a perspective view from the side W shown in figure 1A, a heat exchanger according to a first embodiment of the present invention;
- figure 3 illustrates, in a perspective view from the side W shown in figure 1A, a heat exchanger according to a second embodiment of the present invention;
- figure 4A illustrates, in a view in cross section along a vertical axis Y-Y shown in figure 1C, the heat exchanger of figure 3 when applied to an oven structure;
- figure 4B illustrates the heat exchanger of figure 3, shown in cross section along plane A-A of figure 4A;
- figure 4C illustrates the heat exchanger of figure 3, shown in cross section along the cutaway line C-C of figure 4B;
- figure 4D illustrates the heat exchanger of figure 3, shown in cross section along plane B-B of figure 4A;
- figure 4E illustrates the heat exchanger of figure 3, shown along the cutaway line D-D of figure 4D;
- figure 5A illustrates, in a cross-sectional view along a vertical axis Y-Y shown in figure 1C, a variant embodiment of a heat exchanger according to the present invention when applied to a gas burning oven structure;
- figure 5B illustrates the heat exchanger according to the variant embodiment of figure 5A, shown in cross section along plane A-A of the same;
- figure 5C illustrates the heat exchanger according to the variant embodiment of figure 5A, shown in cross section along the cutaway line C-C of figure 5B;
- figure 5D illustrates the heat exchanger according to the variant embodiment of figure 5A, shown in cross section along plane B-B of figure 5A;
- figure 5E illustrates the heat exchanger according to the variant embodiment of figure 5A, shown in cross section along the cutaway line D-D of figure 5D;
- figure 6A illustrates, in a cross-sectional view along a vertical axis Y-Y shown in figure 1C, a third embodiment of a heat exchanger according to the present invention when applied to a structure of a gas oven;
- figure 6B illustrates the heat exchanger of figure 6A, shown in cross section along plane A-A of the same;
- figure 6C illustrates the heat exchanger of figure 6A, shown in cross section along plane B-B of the same;
- figure 7A illustrates, in a cross-sectional view along a vertical axis Y-Y shown in figure 1C, a variant embodiment of a heat exchanger according to the present invention when applied to an oven structure;
- figure 7B illustrates the heat exchanger according to the variant embodiment of figure 7A, shown in cross section along plane A-A of the same;
- figure 7C illustrates the heat exchanger according to the variant embodiment of figure 7A, shown in cross section along the cutaway line C-C of figure 7B;
- figure 7D illustrates the heat exchanger according to the variant embodiment of figure 7A, shown in cross section along plane B-B of figure 7A;
- figure 7E illustrates the heat exchanger according to the variant embodiment of figure 7A, shown in cross section along the cutaway line D-D of figure 7D;
- figure 8A illustrates, in a front view, a structure of a gas burning oven in which is installed a heat exchanger according to a fourth embodiment of the present invention;
- figure 8B illustrates the oven structure of figure 8A according to a plan view;
- figure 8C illustrates, according to a side view shown by the arrow Z of figure 8A, the oven structure of the preceding figures;
- figure 9 illustrates, in a perspective view from side W shown in figure 8A, a heat exchanger according to the fourth embodiment of the present invention;
- figure 10 illustrates, in a perspective view, a heat exchanger according to a fifth embodiment of the

present invention, adapted to be used in a cooking oven equipped with three stacked fans;

- figure 11A is a front view of the heat exchanger of figure 10, and
- figures 11B, 11C and 11D are cross-sectional views seen respectively along planes A-A, B-B and C-C shown in figure 11A.

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

[0020] It is pointed out here that in the following description, the directional terms such as "above, below, vertical, horizontal, lower and upper", as well as any other similar term, should be interpreted with reference to a heat exchanger and to an oven structure when in use, as shown in the enclosed figures.

[0021] It also remains understood that advantageous characteristics that will be described with reference to one embodiment may be provided in other embodiments, even if they are not explicitly described or illustrated.

[0022] With reference to the enclosed figures 1A, 1B and 1C, a structure is described of a gas burning food cooking oven 1 equipped with a heat exchanger 10 according to the present invention. Said oven structure 1 comprises a box-like casing defining within it a cooking cavity or chamber 2 essentially of parallelepiped shape, formed essentially from a pair of lateral walls 2A, extending between a bottom wall 2B and a ceiling 2C; a back wall 2D closes the cooking chamber 2 at the back while in the front it is closed by a door 3 that is hinged to the holding casing and may be moved by means of a handle 3A.

[0023] In the front, the oven structure 1 comprises advantageously a control panel 8 provided with automatic or manual command and control means that allow the correct operation of the oven.

[0024] Inside said cooking chamber 2, near one of said lateral walls 2A and separated by a partition wall 4 that extends for all the height and almost all the width of the chamber 2 leaving open two vertical slits 4A for the passage of the oven atmosphere is provided a ventilation and heating chamber 50, within which is housed at least one fan 5, preferably with a horizontal axis X-X, adapted to circulate the air inside the cooking chamber 2 and driven by at least one coaxial electric motor (not shown), arranged externally to the cooking chamber 2.

[0025] To heat the atmosphere of the cooking chamber 2 a burner 6 is provided, advantageously of the pre-mixing type fueled, that is, with a controlled mixture of air and combustible gas, comprising a relative combustion chamber 6A, and a heat exchanger 10, extending preferably inside said heating and ventilation chamber 50 and adapted to put in fluid communication said combustion chamber 6A with an opening 7 for the exhaust gases.

[0026] In particular, said heat exchanger 10 preferably comprises two tube bundles 11, each formed by at least two tubular portions, that lead from the combustion cham-

ber 6A of said burner 6, extending in the ventilation and heating chamber 50 around the valve 5, to end at an exhaust manifold 14, common for both tube bundles 11, and connected to said vent 7.

[0027] Advantageously, the tubular portions of each of the tube bundles 11 are arranged in such a way as to lie on planes parallel to each other and preferably orthogonal to the axis X-X of rotation of the fan 5, and are connected to each other in series through at least one return element, preferably extending along an axis parallel to the axis of rotation X-X of the fan 5.

[0028] In particular, advantageously, the tubular portions of said tube bundles 11 are arranged in such a way that said heat exchanger extends in depth, that is, axially with respect to the axis of rotation X-X of the fan 5 to guarantee compactness for the heat exchanger itself and a maximum clustering around the fan, and therefore to increase the efficiency of the heat exchange, as will be explained later in greater detail.

[0029] According to the present invention, each tubular portion is adapted to be traversed by the exhaust gases generated by the burner 6 in an opposite direction of flow with respect to the portion lying on a plane adjacent to it.

[0030] As will be explained later in greater detail, said tubular portions can each be formed by a single tube or, as may be, by a pair or a plurality of tubes arranged parallel to each other, and may have a cross section preferably of circular, oval, or, as may be, any other suitable shape.

[0031] Furthermore, the cross-sectional dimensions of the tubes forming said tubular portions can remain essentially constant for the whole extension of the respective tube bundle 11.

[0032] Alternatively, advantageously, the dimensions of the tube cross sections forming said tubular portions can be variable along the entire extension of the respective tube bundle 11, and in particular preferably decrease progressively.

[0033] In fact, as the exhaust gases flow farther away from the burner they cool, their specific volume and thus their speed decreases; therefore, it is advantageous to suitably modulate the cross sections of the tubes, so as to increase as much as possible the heat transfer coefficients, while maintaining at the same time the flow resistance below a tolerance limit.

DETAILED DESCRIPTION OF A FIRST EMBODIMENT OF THE INVENTION

[0034] With reference to figure 2, a first embodiment of a heat exchanger 10 is disclosed in accordance with the present invention, extending between the combustion chamber 6A of said burner 6, arranged in particular in a lower region of the cooking chamber 2, and an exhaust manifold 14 connectable to said exhaust opening 7 formed on the ceiling 2C of said cooking chamber 2, as shown in figures 1A and 1C.

[0035] In this first embodiment, the two tube bundles

11 extend around the fan 5 in a manner symmetrical to a diametrical axis of the same, and in particular, advantageously, a vertical axis Y-Y passing through the center of the fan 5. Each of the two tube bundles 11 forming said heat exchanger 10 comprises a plurality of tubular portions 12A, 12B, 12C lying on parallel planes and connected in series, each of which being formed by a single tube.

[0036] In particular, a first tubular portion 12A is provided, directly connected with a first end to said combustion chamber 6A, and extending from the latter to near the ceiling 2C of said cooking chamber 2, a second tubular portion 12B, joined with a first end to the second end of said first portion 12A and extending around said fan 5 so as to have a second end near the bottom 2B of the cooking chamber 2, and a third tubular portion 12C joined with a first end to the second portion 12B and connectable, with the opposite end, to said exhaust opening 7 through the interposition of an exhaust manifold 14 that is substantially vertical.

[0037] Said three portions 12A, 12B, 12C lie essentially along corresponding reciprocally parallel planes and are arranged substantially orthogonal to the axis of rotation X-X of the fan 5, and are connected in series to each other, with an axial extension with respect to said axis of rotation X-X, through a first and a second return element 13, 15, each defining an exchange cavity common to both tube bundles 11 of the heat exchanger 10.

[0038] Furthermore, a terminal confluence element 16 is arranged at the second ends of the third tubular portions 12C of both tube bundles 11 to merge the fumes flowing through them and feed them into the exhaust manifold 14.

[0039] Preferably, said second return element 15 is disposed substantially coaxial with said combustion chamber 6A and can if necessary be joined to it through the interposition of a first partition baffle 61; similarly, said confluence element 16 is preferably disposed coaxial with said first return element 13 and can be joined to the latter by the interposition of a second partition baffle 62.

[0040] From the point of view of the exhaust gases, said tubular portions 12A, 12B and 12C are adapted to carry the gases in opposite flow directions; in particular, as shown by the arrows in figure 2, initially the gases course through said first portion 12A in an essentially ascending direction of flow, to then be returned by said first return element 13 and fed into the second portion 12B, in which the gases flow in an essentially descending direction, and finally they are returned again by said second return element 15 and fed into the third portion 12C, in an ascending direction of flow, until they reach said confluence element 16, which is common to both tube bundles 11 and placed preferably above said fan 5, and finally the gases reach the exhaust opening 7 through said exhaust manifold 14.

DETAILED DESCRIPTION OF A SECOND EMBODIMENT OF THE INVENTION

[0041] With reference to figures 3, 4A - 4E, a heat exchanger 10 is illustrated in accordance with a second embodiment of the present invention; it is substantially similar to the one previously described, being provided with a pair of tube bundles 11 extending advantageously in symmetrical manner with respect to the vertical axis Y-Y of the fan 5 between the combustion chamber 6A of the burner 6, arranged near the bottom wall 2B of the cooking chamber 2, and an exhaust opening 7, formed in the ceiling 2C of the same, as shown in figures 1A and 1C.

[0042] Further, said tube bundles 11 each comprise a plurality of tubular portions arranged on reciprocally parallel planes and orthogonal to the axis of rotation X-X of the fan 5 and connected appropriately through a first and a second return element 13, 15 to extend in an axial direction with respect to said axis of rotation X-X.

[0043] However, unlike the preceding embodiment, each tube bundle 11 of said heat exchanger 10 comprises a first tubular portion 12A' formed by a pair of tubes joined with a first end to said combustion chamber 6A, and being both connected with a respective second end to said first return element 13 arranged above said fan 5 near the ceiling 2C of the cooking chamber 2, defining advantageously a cavity that is common to both tube bundles 11 of the heat exchanger 10.

[0044] In a manner similar to the preceding embodiment, a second tubular portion 12B is foreseen, joined to said first return element 13, as well as a third tubular portion 12C, said second and third tubular portion 12B, 12C being arranged between them in succession and joined by the interposition of a second return element 15 provided in proximity of the bottom 2B of the cooking chamber 2 and defining a cavity common to both tube bundles 11.

[0045] Preferably, said second return element 15 is disposed substantially coaxial with said combustion chamber 6A and can if necessary be joined to it by the interposition of a first partition baffle 61.

[0046] Further, the end parts of the third tubular portions 12C of both tube bundles 11 are advantageously joined to a confluence element 16 preferably coaxial with said first return element 13 and separated from the latter by a second partition baffle 62.

[0047] In particular, from the point of view of the flow of the exhaust gases inside said heat exchanger 10, said pair of tubes forming said first portion 12A' are both directly communicating with the combustion chamber 6A of the burner 6, being essentially arranged parallel to each other and therefore both having the gases course through them in an ascending flow. The exhaust gases are then returned by said first return element 13 and fed into the tube forming said second portion 12B, which is thus arranged in series with respect to said first portion 12A', being coursed in a descending direction, to then

be returned again from said second return element 15 and fed into the tube forming said third portion 12C, with an ascending direction of flow, until they arrive at said confluence element 16, which is common to both tube bundles 11 and placed preferably above said fan 5, and finally they reach the exhaust opening 7 through said exhaust manifold 14.

[0048] In figures 5A - 5E is illustrated a variant embodiment of the heat exchanger just described, which is different from the latter for the fact of being adapted to be joined to an oven structure 1 in which the exhaust opening 7 is formed on the side wall 2A on which said fan 5 is mounted, and preferably located in proximity of the ceiling 2C of the cooking chamber 2, and said exhaust manifold 14, connected to the confluence element 16 common to both tube bundles 11, is arranged substantially parallel to the axis of rotation X-X of the fan 5. This variant embodiment is advantageous in the case in which two or more superimposed oven structures 1 are to be used.

[0049] Further, unlike the embodiment previously described, for reason of size, each tube bundle 11 is provided with its own first return element 13, distinct and separate from the corresponding first return element 13 arranged symmetrically on the other tube bundle 11.

DETAILED DESCRIPTION OF A THIRD EMBODIMENT OF THE INVENTION

[0050] In figures 6A - 6C is illustrated a heat exchanger 10 according to a third embodiment of the present invention. In particular, unlike the embodiments previously described, this heat exchanger 10 is adapted to be joined to an oven structure 1 in which said burner 6 is positioned near the ceiling 2C of the cooking chamber 2 and adjacent to the exhaust opening 7.

[0051] Consequently, each tube bundle 11 of said heat exchanger 10 comprises at least two tubular portions 12A, 12B, each formed by a single tube, lying on two planes parallel to each other and substantially perpendicular to the axis of rotation X-X of the fan 5, connected in series with an axial extension with respect to said axis of rotation X-X through the interposition of a return element 13, advantageously common for both tube bundles 11, and coursed by the exhaust gases in opposite directions, as shown by the arrows.

[0052] Examining the flow of exhaust gases inside this heat exchanger 10, it can be seen that for each tube bundle 11 said first portion 12A is traversed in a descending direction of flow, while said second portion 12B is traversed in an opposite direction of flow with respect to the flow of said first portion 12A, and therefore in an ascending flow, to merge in a confluence element 16, common to both tube bundles 11, and finally reach the exhaust opening 7 through said exhaust manifold 14.

[0053] Preferably, said confluence element 16 is arranged substantially coaxial with said combustion chamber 6A and if necessary can be joined to it by the interposition of a first partition baffle 61.

[0054] In figures 7A - 7E is illustrated a variant embodiment of the just described heat exchanger 10, substantially similar to the one made according to the embodiment just illustrated, foreseeing a pair of tube bundles 11 extending symmetrically around said fan 5 between the combustion chamber 6A of the burner 6, arranged in the upper part of said cooking chamber 2, and the exhaust opening 7, formed near said burner 6. Also, said tube bundles 11 each comprise two tubular portions 12A', 12B' lying on planes parallel and orthogonal to the axis of rotation X-X of the fan 5, connected in series through a return element 13 and adapted to be traversed by the exhaust gases in opposite directions of flow.

[0055] However, said first portion 12A' is formed by a pair of tubes, both joined with one first end to said combustion chamber 6A and both connected with a respective second end to said return element 13, preferably defining within it a cavity common to both tube bundles 11, and to which is also joined said second portion 12B', also formed by a pair of tubes.

[0056] In particular, from the viewpoint of the flow of exhaust gases inside said heat exchanger 10, said pair of tubes forming said first portion 12A' are both directly communicating with the combustion chamber 6A of the burner 6, being essentially arranged in parallel and being therefore both traversed in a descending direction of flow; the gases are then returned by said return element 13 and fed into the tubes placed in parallel to each other and forming said second portion 12B', which is thus disposed in series with respect to said first portion 12A', both flowed through by the gases in an ascending direction, to merge in a confluence element 16 common to both tube bundles 11, and finally reach the exhaust opening 7 through said exhaust header 14.

[0057] Preferably, said confluence element 16 is arranged substantially coaxial with said combustion chamber 6A and can if necessary be associated to it through the interposition of a first partition baffle 61.

[0058] A third partition baffle 63, visible in figure 7E, can if needed be provided inside said first return element 13 to maintain separate the flows of exhaust gases circulating in the two tube bundles 11 and avoid the generation of noise.

DETAILED DESCRIPTION OF A FOURTH EMBODIMENT OF THE INVENTION

[0059] In figures 8A - 8C is shown an oven structure 1 inside of which is built-in a heat exchanger 10 according to a fourth embodiment of the present invention.

[0060] As can better be seen in figure 9, said heat exchanger 10 extends between the combustion chamber 6A of said burner 6, arranged in particular in a lower area of the cooking chamber 2, laterally with respect to the vertical axis of the fan 5, and an exhaust opening 7 formed on the ceiling 2C of said cooking chamber 2, in a lateral and preferably opposite area of the fan 5 with respect to the positioning of the combustion chamber 6A of the burn-

er 6.

[0061] In this fourth embodiment, too, the two tube bundles 11 extend around the fan 5 advantageously in a symmetrical manner with respect to an axis diametrical to the same; however, in this case, said tube bundles 11 are symmetrical with respect to an axis M-M inclined with respect to the vertical axis Y-Y passing through the center of the fan 5.

[0062] In the same way as in the second embodiment of the heat exchanger 10 previously described with reference to figures 3 and 4A - 4E, each tube bundle 11 of said heat exchanger 10 comprises a first tubular portion 12A' formed by a pair of tubes joined with a first end to said combustion chamber 6A, and both connected with a respective second end to said first return element 13 arranged near the ceiling 2C of the cooking chamber 2, in a region diametrically opposite the fan 5 with respect to the position of said burner 6, and advantageously defining a cavity common for both tube bundles 11 of the heat exchanger 10.

[0063] The embodiment also foresees a second tubular portion 12B, joined to said first return element 13, and a third tubular portion 12C, said second and third tubular portion 12B, 12C each being formed by a single tube and arranged in succession to each other, joined with an axial extension with respect to said axis of rotation X-X by the interposition of a second return element 15 included in proximity of the bottom 2B of the cooking chamber 2 and defining a cavity common to both tube bundles 11.

[0064] Preferably, said second return element 15 is arranged substantially coaxial with said combustion chamber 6A and if necessary can be joined to it by the interposition of a first partition baffle 61.

[0065] Further, the terminal ends of the third tubular portions 12C of both tube bundles 11 are advantageously joined to a confluence element 16, preferably coaxial to said first return element 13 and separated from the latter by a second partition baffle 62.

[0066] In particular, from the viewpoint of the flow of exhaust gases inside said heat exchanger 10, said pair of tubes forming said first portion 12A' are both directly communicating with the combustion chamber 6A of the burner 6, being arranged essentially parallel to each other and therefore both having the gases flowing through them in an ascending direction. The exhaust gases are then returned from said first return element 13 and fed into the tube forming said second portion 12B, which is thus disposed in series with respect to said first portion 12A', being coursed by the gases in a descending direction of flow, to then be returned again from said second return element 15 and introduced into the tube forming said third portion 12C, with an ascending direction of flow, until they arrive at said confluence element 16, common to both tube bundles 11 and placed preferably above said fan 5, and finally they reach the exhaust opening 7 through said exhaust manifold 14.

DETAILED DESCRIPTION OF A FIFTH EMBODIMENT OF THE INVENTION

[0067] With reference to figures 10, 11A - 11D, a heat exchanger 10 is illustrated in accordance with a fifth embodiment of the invention; said heat exchanger 10 is functionally substantially identical to the heat exchanger illustrated in figures 6A - 6C but it has the distinguishing feature of being installed in a cooking oven structure equipped with a plurality of fans 5, three for example, stacked and preferably aligned with their centers of rotation along a vertical axis Y-Y.

[0068] For this purpose, therefore, the tube bundles 11 of said heat exchanger 10 can, if necessary, be shaped in an undulating manner, so as follow the contours of said fans 5.

[0069] In such embodiment, the heat exchanger 10 is also adapted to be connected to an oven structure in which said burner 6 is positioned near the ceiling of the cooking chamber and adjacent to the exhaust opening 7.

[0070] Consequently, each tube bundle 11 of said heat exchanger 10 comprises at least two tubular portions 12A, 12B, each formed by a single tube, lying on planes parallel to each other and substantially perpendicular to the axis of rotation X-X of the fan 5, connected in series with an axial extension with respect to said axis of rotation X-X by the interposition of a return element 13, and carrying the exhaust gases in opposite directions, as is shown by the arrows in figure 11B.

[0071] Examining the flow of exhaust gases inside this heat exchanger 10, it can be seen that for each tube bundle 11 said first portion 12A is traversed in a descending direction of flow, while said second portion 12B is traversed in an opposite direction of flow with respect to the flow of said first portion 12A, and therefore in an ascending flow, to merge in a confluence element 16, common to both tube bundles 11, and finally reach the exhaust opening 7 through said exhaust manifold 14.

[0072] Preferably, said confluence element 16 is arranged substantially coaxial with said combustion chamber 6A and can if necessary be joined to it by the interposition of a first partition baffle 61.

[0073] A third partition baffle 63 may if necessary be provided inside said return element 13 to maintain separate the flows of exhaust gases circulating in the two tube bundles 11 and avoid the generation of noise.

[0074] Clearly, in general a heat exchanger 10 according to the present invention can be configured in such a way as to adapt itself to the arrangement of the burner 6 and of the exhaust opening 7 of the cooking chamber 2 of the gas oven 1 to which it is to be applied and to the number and arrangement of the fans 5.

[0075] For example, if the oven 1 is equipped with a burner 6 arranged near the bottom 2B of the cooking chamber 2, laterally with respect to the vertical axis Y-Y of the fan 5, and if the exhaust opening 7 is instead arranged at the ceiling 2C of the cooking chamber 2 but substantially in alignment with the vertical axis Y-Y of

said fan 5, a heat exchanger 10 according to the present invention will be provided with two tube bundles 11 extending around the fan 5 but asymmetrical with respect to an imaginary axis connecting the exhaust opening 7 and the burner 6.

[0076] In conclusion, from what is disclosed above it is evident how a heat exchanger 10 for a gas burning oven 1 according to any of the embodiments, and relative variants, of the present invention achieves the initially intended purposes and advantages.

[0077] In fact, a heat exchanger was realized which, thanks to its particular configuration makes it possible to increase the thermal efficiency of the heat exchange between the exhaust gases and the atmosphere of the cooking chamber of a gas burning oven. In fact, thanks to the considerable extension of the tubular portions forming the two tube bundles 11, an appreciable increase of the exchange surface available was achieved, together, consequently, with the thermal performance of the exchanger, and therefore the overall efficiency of the oven.

[0078] In addition, since each of the two tube bundles 11 of a heat exchanger 10 according to the present invention has at least two tubular portions adapted to be traversed by the exhaust gases in opposite directions of flow, an improvement in the distribution of the temperature of the air can be observed inside the cooking chamber 2, without however imposing an increase of the spaces required to house it.

[0079] It can be seen that by designing an overall extension in depth of the various tubular portions of the exchanger 10, that is, an axial extension with respect to the axis of rotation X-X of the fan 5 instead of a radial extension as foreseen by the document JP2011141098, it is possible to give an absolute compactness to the heat exchanger. Moreover, advantageously, this characteristic causes the air scattered radially by the fan 5 toward the cooking chamber to exchange heat simultaneously with all the tubular portions of the exchanger 10, thus achieving an increased thermal efficiency of the exchanger 10, compared to the prior art.

[0080] Advantageously, in the case in which the two tube bundles 11 of the exchanger 10 are shaped in such a manner as to be symmetrical with respect to the vertical axis of the fan 5, as shown by way of example in the first three embodiments of the invention, the distribution of the temperatures is most uniform along a vertical axis of reference, thus giving an optimal homogeneous cooking of the food.

[0081] Advantageously, with particular reference to the third embodiment, a heat exchanger 10 is so compact as to make it sometime possible to use, with small and low-cost alterations, previous cooking chambers of electric ovens to obtain other cooking chambers that are adapted to be used with gas heating, thus allowing a reduction of the industrial costs connected with the production of the ovens.

[0082] Moreover, a heat exchanger 10 according to

the fourth embodiment of the invention can be advantageously applied to ovens in which, for purposes of containing the dimensions, the burner 6 is positioned laterally with respect to the vertical axis passing through the center of the fan 5, while still guaranteeing an excellent efficiency in terms of heat exchange, and an acceptable uniformity in the distribution of the temperatures in the cooking chamber 2.

[0083] Finally, it is emphasized that an exchanger as defined by the enclosed claim 1 can be configured in the most suitable manner to extend around the fan 5, or fans 5, between the burner 6 and the exhaust opening 7, without thereby departing from the scope of protection of the present invention.

[0084] Naturally, the present invention is susceptible to many applications, modifications or variants without thereby departing from the scope of patent protection, as defined by the enclosed claims. Moreover, the materials and equipment used to implement the present invention, as well as the shapes and dimensions of the individual components, may be the most suitable for the specific requirements.

Claims

- Heat exchanger (10) of a gas burning oven (1) comprising at least two tube bundles (11) being adapted to extend at opposite sides between an exhaust gases inlet (6A), connectable with a gas burner (6) of said oven (1), and an exhaust gases outlet (7), connectable with an exhaust manifold (14) of said oven (1), each tube bundle (11) comprising at least two tubular portions (12A, 12B, 12C, 12A', 12B'), each formed by at least one tube, said tubular portions lying on planes parallel to each other and perpendicular to an horizontal axis (X-X) and being joined in series through at least one return element (13, 15) such that each tubular portion is adapted to be traversed by the exhaust gases in a flowing direction opposite to a flowing direction of a tubular portion lying on an adjacent plane, **characterized in that** said tubular portions (12A, 12B, 12C, 12A', 12B') are arranged adjacent to each other, overlapped and axially aligned with respect to said horizontal axis (X-X).
- Heat exchanger (10) according to claim 1, wherein at least one of said tubular portions (12A, 12B, 12C) is formed by a single tube.
- Heat exchanger (10) according to any one of claims 1 or 2, wherein at least one of said tubular portions (12A', 12B') is formed by a plurality of tubes arranged in parallel and lying on planes parallel to each other and perpendicular to said horizontal axis (X-X).
- Heat exchanger (10) according to any one of the preceding claims, wherein said tubular portions

(12A, 12B, 12C, 12A', 12B') have a cross section of circular or oval shape.

5. Heat exchanger (10) according to any one of the preceding claims, wherein the dimensions of the cross sections of the tubes forming said tubular portions (12A, 12B, 12C, 12A', 12B') are constant for the entire extension of the respective tube bundle (11).
6. Heat exchanger (10) according to any one of the claims from 1 to 4, wherein the dimensions of the cross sections of the tubes forming said tubular portions (12A, 12B, 12C, 12A', 12B') decrease progressively along the extension of the respective tube bundle (11).
7. Heat exchanger (10) according to any one of the preceding claims, wherein said at least one return element (13, 15) is common to both tube bundles (11).
8. Heat exchanger (10) according to claim 7, wherein said at least one return element (13, 15) extends along an axis essentially parallel to said horizontal axis (X-X).
9. Heat exchanger (10) according to any one of the preceding claims, wherein said at least two tube bundles (11) extend symmetrically between said exhaust gases inlet (6A) and said exhaust gases outlet (7).
10. Gas burning oven (1) comprising a cooking chamber (2) provided with a bottom wall (28) and a ceiling wall (2C), a fan (5) with a horizontal axis of rotation (X-X), a premixed burner (6), an exhaust manifold (14) and a heat exchanger (10) according to any one of the preceding claims.
11. Gas burning oven (1) according to claim 10, wherein said burner (6) is positioned in the proximity of said ceiling wall (2C), said heat exchanger (10) comprising a first tubular portion (12A, 12A') adapted to be traversed by the exhaust gases in a descending direction of flow, and a second tubular portion (12B, 12B') adapted to be traversed by the exhaust gases in an ascending direction of flow, said first and second tubular portions being connected to each other in series through a return element (13).
12. Gas burning oven (1) according to claim 10, wherein said burner (6) is positioned in proximity of said bottom wall (2B), said heat exchanger (10) comprising a first tubular portion (12A, 12A'), adapted to be traversed by the exhaust gases according to an ascending direction of flow, a second tubular portion (12B, 12B') adapted to be traversed by the exhaust

gases according to a descending direction of flow, said first and second tubular portions being connected to each other in series through a first return element (13), and a third tubular portion (12C) adapted to be traversed by the exhaust gases according to an ascending direction of flow, and connected in series to said second tubular portion (12B, 12B') through a second return element (15).

13. Gas burning oven (1) according to any one of the claims from 10 to 12, wherein said burner (6) is arranged laterally with respect to said fan (5), said exchanger (10) comprising a pair of tube bundles (11) arranged in a symmetrical manner around said fan (5).

14. Gas burning oven (1) according to any one of the claims from 10 to 12, wherein said burner (6) is arranged laterally with respect to said fan (5), said exchanger (10) comprising a pair of tube bundles (11) arranged in an asymmetrical manner around said fan (5).

25 Patentansprüche

1. Wärmetauscher (10) eines GasverbrennungsOfens (1) mit mindestens zwei Rohrbündeln (11), die ausgebildet sind, sich auf gegenüberliegenden Seiten zwischen einem Abgaseinlass (6A), der mit einem Gasbrenner (6) des Ofens (1) verbindbar ist, und zwischen einem Abgasauslass (7) zu erstrecken, der mit einer Abgasverteilungsleitung (14) des Ofens (1) verbindbar ist, wobei jedes Rohrbündel (11) mindestens zwei Rohrbereiche (12A, 12B, 12C, 12A', 12B') aufweist, wovon jeder durch mindestens ein Rohr gebildet ist, wobei die Rohrbereiche in Ebenen liegen, die parallel zueinander und senkrecht zu einer horizontalen Achse (X-X) sind und durch mindestens ein Rückleitungselement (13, 15) in Reihe derart miteinander verbunden sind, dass jeder Rohrbereich ausgebildet ist, von den Abgasen in einer Strömungsrichtung, die entgegengesetzt zu einer Strömungsrichtung eines Rohrbereichs ist, der auf einer benachbarten Ebene liegt, durchlaufen zu werden,

dadurch gekennzeichnet, dass

die Rohrbereiche (12A, 12B, 12C, 12A', 12B') benachbart zueinander, überlappend und axial ausgerichtet in Bezug auf die horizontale Achse (X-X) angeordnet sind.

2. Wärmetauscher (10) nach Anspruch 1, wobei mindestens einer der Rohrbereiche (12A, 12B, 12C) durch ein einziges Rohr gebildet ist.
3. Wärmetauscher (10) nach Anspruch 1 oder 2, wobei mindestens einer der Rohrbereiche (12A', 12B')

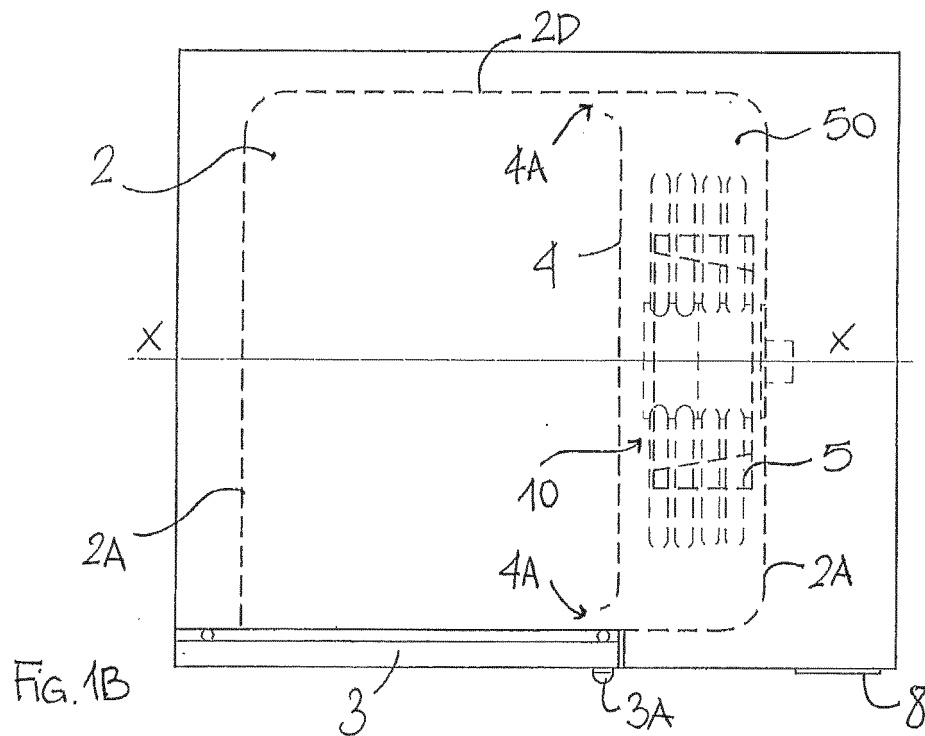
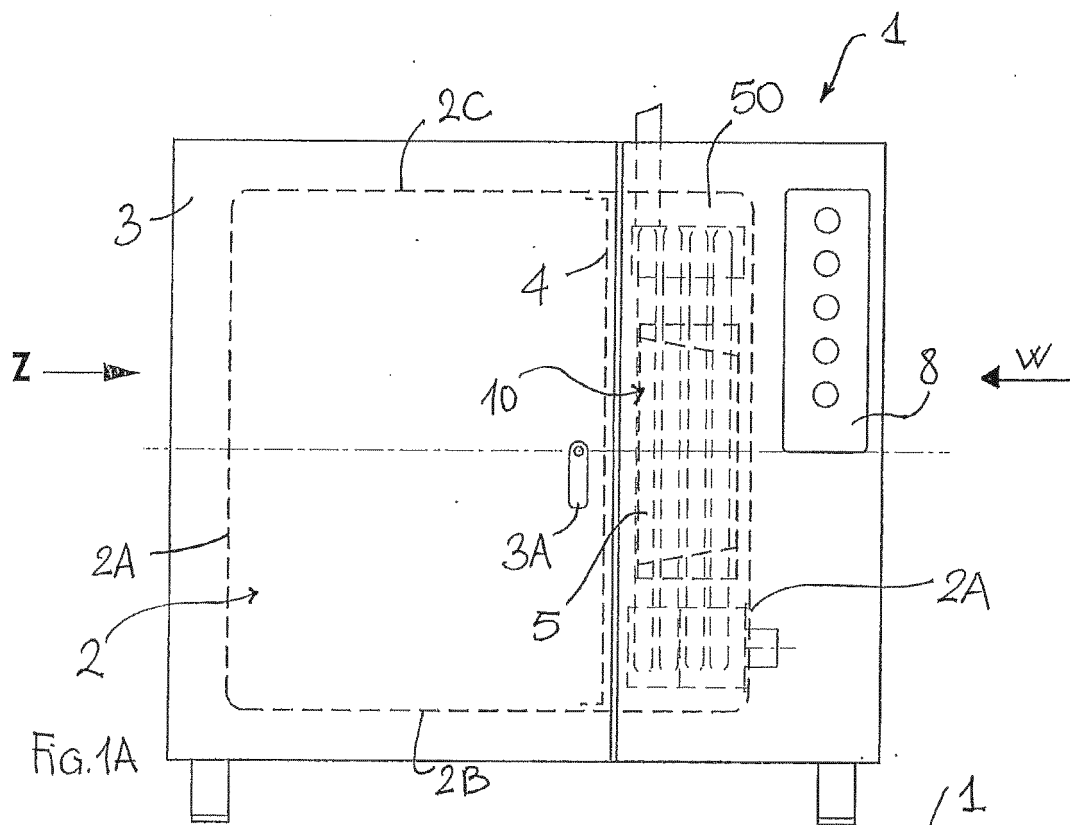
- durch mehrere Rohre gebildet ist, die parallel angeordnet sind und in Ebenen liegen, die parallel zueinander und senkrecht zu der horizontalen Achse (X-X) sind.
4. Wärmetauscher (10) nach einem der vorhergehenden Ansprüche, wobei die Rohrbereiche (12A, 12B, 12C, 12A', 12B') im Querschnitt eine Kreisform oder eine ovale Form haben.
 5. Wärmetauscher (10) nach einem der vorhergehenden Ansprüche, wobei die Abmessungen der Querschnitte der Rohre, die die Rohrbereiche (12A, 12B, 12C, 12A', 12B') bilden, über die gesamte Länge des jeweiligen Rohrbündels (11) gleichbleibend sind.
 6. Wärmetauscher (10) nach einem der Ansprüche 1 bis 4, wobei die Abmessungen der Querschnitte der Rohre, die die Rohrbereiche (12A, 12B, 12C, 12A', 12B') bilden, entlang der Länge des jeweiligen Rohrbündels (11) progressiv kleiner werden.
 7. Wärmetauscher (10) nach einem der vorhergehenden Ansprüche, wobei das mindestens eine Rückleitungselement (13, 15) für beide Rohrbündel (11) gemeinsam ist.
 8. Wärmetauscher (10) nach Anspruch 7, wobei das mindestens eine Rückleitungselement (13, 15) entlang einer Achse verläuft, die im Wesentlichen parallel zu der horizontalen Achse (X-X) ist.
 9. Wärmetauscher (10) nach einem der vorhergehenden Ansprüche, wobei die mindestens zwei Rohrbündel (11) sich symmetrisch zwischen dem Abgasseinlass (6A) und dem Abgasauslass (7) erstrecken.
 10. Gasverbrennungssofen (1) mit einer Kochkammer (2), die mit einer Bodenwand (28) und einer Deckenwand (2C) versehen ist, einem Gebläse (5) mit einer horizontalen Drehachse (X-X), einem vorgemischten Brenner (6), einer Abgasverteilungsleitungen (14) und einem Wärmetauscher (10) nach einem der vorhergehenden Ansprüche.
 11. Gasverbrennungssofen (1) nach Anspruch 10, wobei der Brenner (6) in der Nähe der Deckenwand (2C) angeordnet ist, der Wärmetauscher (10) einen ersten Rohrbereich (12A, 12A'), der ausgebildet ist, von den Abgasen in einer absteigenden Strömungsrichtung durchlaufen zu werden, und einen zweiten Rohrbereich (12B, 12B') aufweist, der ausgebildet ist, von den Abgasen in einer aufsteigenden Strömungsrichtung durchlaufen zu werden, wobei der erste und der zweite Rohrbereich durch ein Rückleitungselement (13) in Reihe miteinander verbunden sind.

12. Gasverbrennungssofen (1) nach Anspruch 10, wobei der Brenner (6) in der Nähe der Bodenwand (2B) angeordnet ist, und der Wärmetauscher (10) einen ersten Rohrbereich (12A, 12A'), der ausgebildet ist, von den Abgasen in einer aufsteigenden Strömungsrichtung durchlaufen zu werden, und einen zweiten Rohrbereich (12B, 12B') aufweist, der ausgebildet ist, von den Abgasen in einer absteigenden Strömungsrichtung durchlaufen zu werden, und wobei der erste und der zweite Rohrbereich durch ein erstes Rückleitungselement (13) miteinander in Reihe verbunden sind, und ein dritter Rohrbereich (12C) vorgesehen ist, der ausgebildet ist, von den Abgasen in einer aufsteigenden Strömungsrichtung durchlaufen zu werden und der mit dem zweiten Rohrbereich (12B, 12B') durch ein zweites Rückleitungselement (15) in Reihe verbunden ist.
13. Gasverbrennungssofen (1) nach einem der Ansprüche 10 bis 12, wobei der Brenner (6) in Bezug auf das Gebläse (5) seitlich angeordnet ist, und wobei der Wärmetauscher (10) ein Paar aus Rohrbündeln (11) aufweist, die symmetrisch um das Gebläse (5) angeordnet sind.
14. Gasverbrennungssofen (1) nach einem der Ansprüche 10 bis 12, wobei der Brenner (6) in Bezug auf das Gebläse (5) seitlich angeordnet ist und wobei der Wärmetauscher (10) ein Paar aus Rohrbündeln (12) aufweist, die asymmetrisch um das Gebläse (5) angeordnet sind.

Revendications

1. Echangeur de chaleur (10) d'un four à gaz (1) comprenant au moins deux faisceaux de tubes (11) adaptés pour s'étendre aux cotés opposés entre une entrée de gaz d'échappement (6A), pouvant être reliée à un brûleur à gaz (6) dudit four (1), et une sortie de gaz d'échappement (7), pouvant être reliée à un collecteur d'échappement (14) dudit four (1), chaque faisceau de tubes (11) comprenant au moins deux parties tubulaires (12A, 12B, 12C, 12A', 12B'), chacun étant formé par au moins un tube, lesdites parties tubulaires s'étendant dans des plans parallèles les uns aux autres et perpendiculaires à un axe horizontal (X-X) et étant reliés en série par au moins un élément de retour (13, 15) de manière ce que chaque parties tubulaires est apte à être traversée par les gaz d'échappement dans un sens d'écoulement opposé à un sens d'écoulement d'une partie tubulaire s'étendant sur un plan adjacent, **caractérisé en ce que** lesdites parties tubulaires (12A, 12B, 12C, 12A', 12B') sont disposées de manière adjacente les unes par rapport aux autres, se chevauchant et axialement alignées par rapport audit axe horizontal (X-X).

2. Echangeur de chaleur (10) selon la revendication 1, dans lequel au moins l'une desdites parties tubulaires (12A, 12B, 12C) est formée par un seul tube.
3. Echangeur de chaleur (10) selon l'une quelconque des revendications 1 ou 2, dans lequel au moins l'une desdites parties tubulaires (12A', 12B') est formée par une pluralité de tubes disposés parallèlement et s'étendant dans des plans parallèles les uns aux autres et perpendiculairement audit axe horizontal (X-X).
4. Echangeur de chaleur (10) selon l'une quelconque des revendications précédentes, dans lequel lesdites parties tubulaires (12A, 12B, 12C, 12A', 12B') ont une section transversale de forme circulaire ou ovale.
5. Echangeur de chaleur (10) selon l'une quelconque des revendications précédentes, dans lequel les dimensions des sections transversales des tubes formant lesdites parties tubulaires (12A, 12B, 12C, 12A', 12B') sont constantes pour toute l'extension des zones respectives du faisceau de tubes (11).
6. Echangeur de chaleur (10) selon l'une quelconque des revendications 1 à 4, dans lequel les dimensions des sections transversales des tubes formant lesdites parties tubulaires (12A, 12B, 12C, 12A', 12B') diminuent progressivement le long du prolongement du faisceau de tubes (11) respectif.
7. Echangeur de chaleur (10) selon l'une quelconque des revendications précédentes, dans lequel ledit au moins un élément de retour (13, 15) est commun aux deux faisceaux de tubes (11).
8. Echangeur de chaleur (10) selon la revendication 7, dans lequel ledit au moins un élément de retour (13, 15) s'étend suivant un axe essentiellement parallèle audit axe horizontal (X-X).
9. Echangeur de chaleur (10) selon l'une quelconque des revendications précédentes, dans lequel lesdits au moins deux faisceaux de tubes (11) s'étendent de manière symétrique entre ladite entrée de gaz d'échappement (6A) et ladite sortie de gaz d'échappement (7).
10. Four à gaz (1) comprenant une chambre de cuisson (2) munie d'une paroi de fond (28) et d'une paroi de plafond (2C), d'un ventilateur (5) à axe de rotation horizontal (X-X), d'un brûleur (6) prémélangé, un collecteur d'échappement (14) et un échangeur de chaleur (10) selon l'une quelconque des revendications précédentes.
11. Four à gaz (1) selon la revendication 10, dans lequel ledit brûleur (6) est positionné à proximité de ladite paroi de plafond (2C), ledit échangeur de chaleur (10) comprenant une première partie tubulaire (12A, 12A') adaptée pour être traversée par les gaz d'échappement dans un sens d'écoulement descendant, et une seconde partie tubulaire (12B, 12B') adaptée pour être traversée par les gaz d'échappement dans un sens d'écoulement ascendant, lesdites première et seconde parties tubulaires étant connectées l'une à l'autre en série à travers un élément de retour (13).
12. Four à gaz (1) selon la revendication 10, dans lequel ledit brûleur (6) est positionné à proximité de ladite paroi de fond (2B), ledit échangeur de chaleur (10) comprenant une première partie tubulaire (12A, 12A') adaptée pour être traversée par les gaz d'échappement selon un sens d'écoulement ascendant, une seconde partie tubulaire (12B, 12B') adaptée pour être traversée par les gaz d'échappement selon un sens d'écoulement descendant, lesdites première et seconde parties tubulaires étant connectées l'une à l'autre en série à travers un premier élément de retour (13) et une troisième partie tubulaire (12C) adaptée pour être traversée par les gaz d'échappement selon un sens d'écoulement ascendant et reliée en série à ladite seconde partie tubulaire (12B, 12B') à travers un second élément de retour (15).
13. Four à gaz (1) selon l'une quelconque des revendications 10 à 12, dans lequel ledit brûleur (6) est disposé latéralement par rapport audit ventilateur (5), ledit échangeur (10) comprenant une paire de faisceaux de tubes (11) disposés symétriquement autour dudit ventilateur (5).
14. Four à gaz (1) selon l'une quelconque des revendications 10 à 12, dans lequel ledit brûleur (6) est disposé latéralement par rapport audit ventilateur (5), ledit échangeur (10) comprenant une paire de faisceaux de tubes (11) disposés de manière asymétrique autour dudit ventilateur (5).



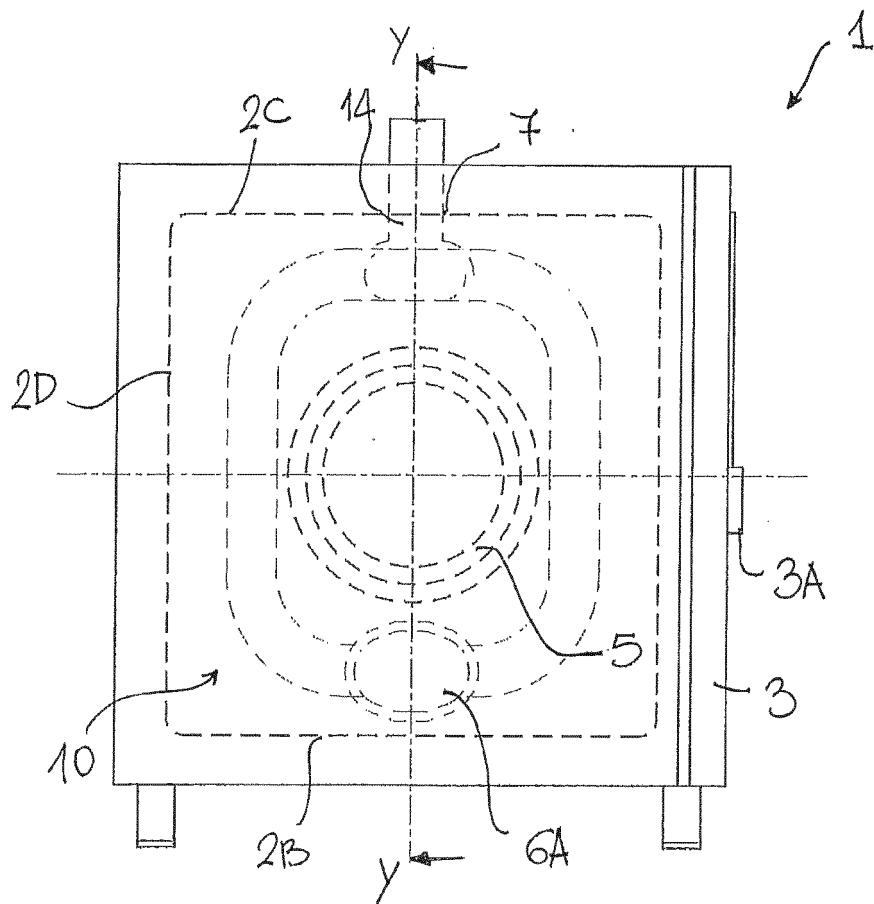


FIG. 1C

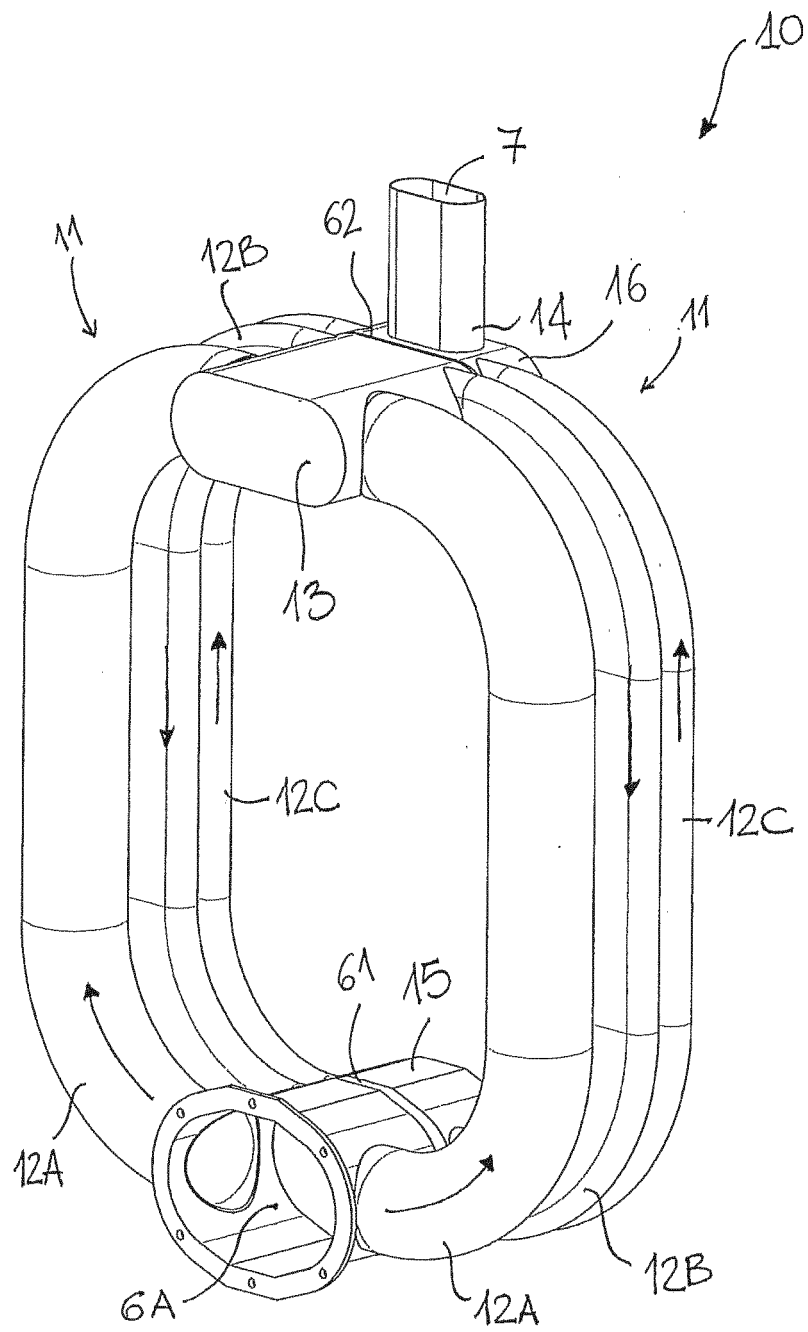


Fig.2

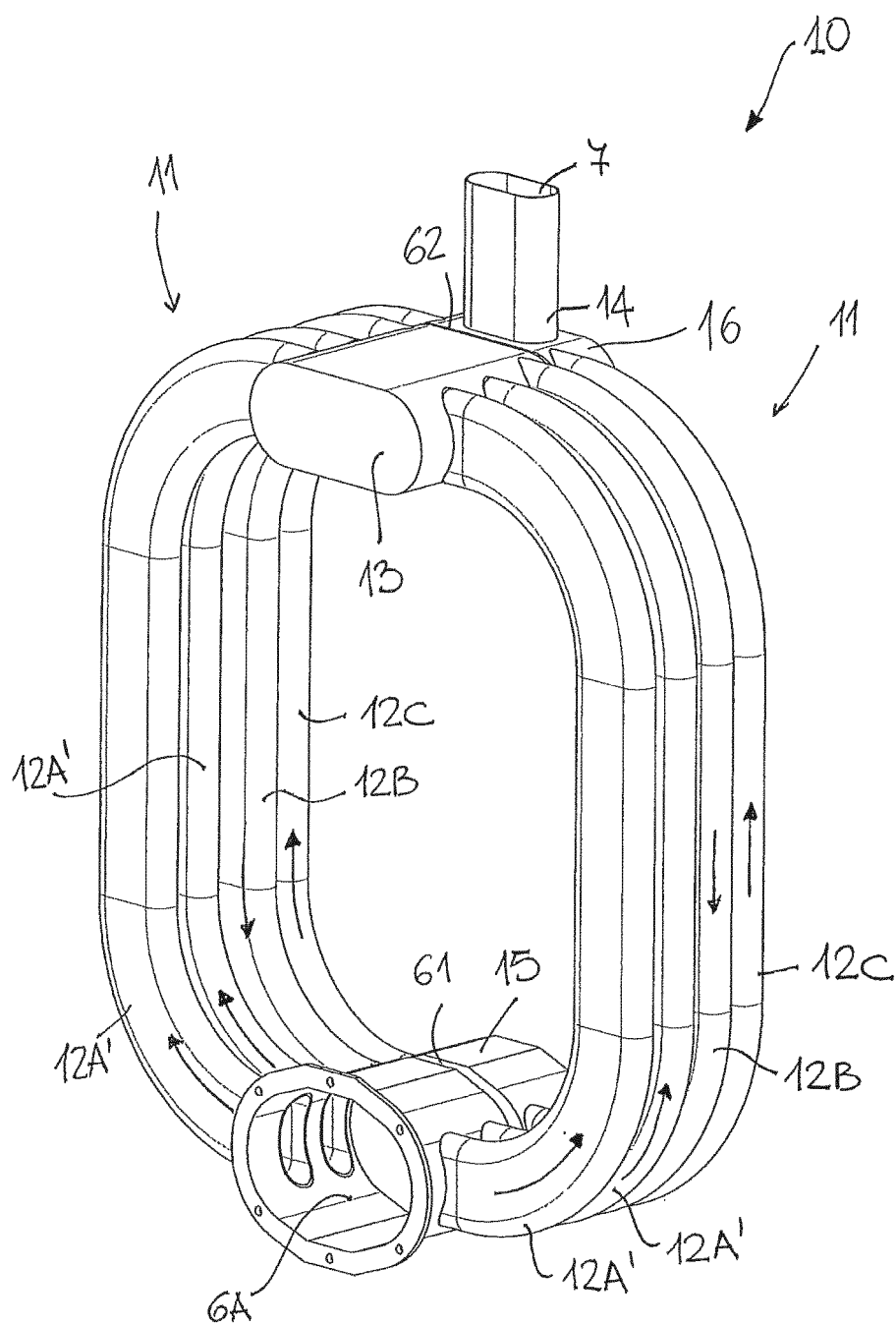
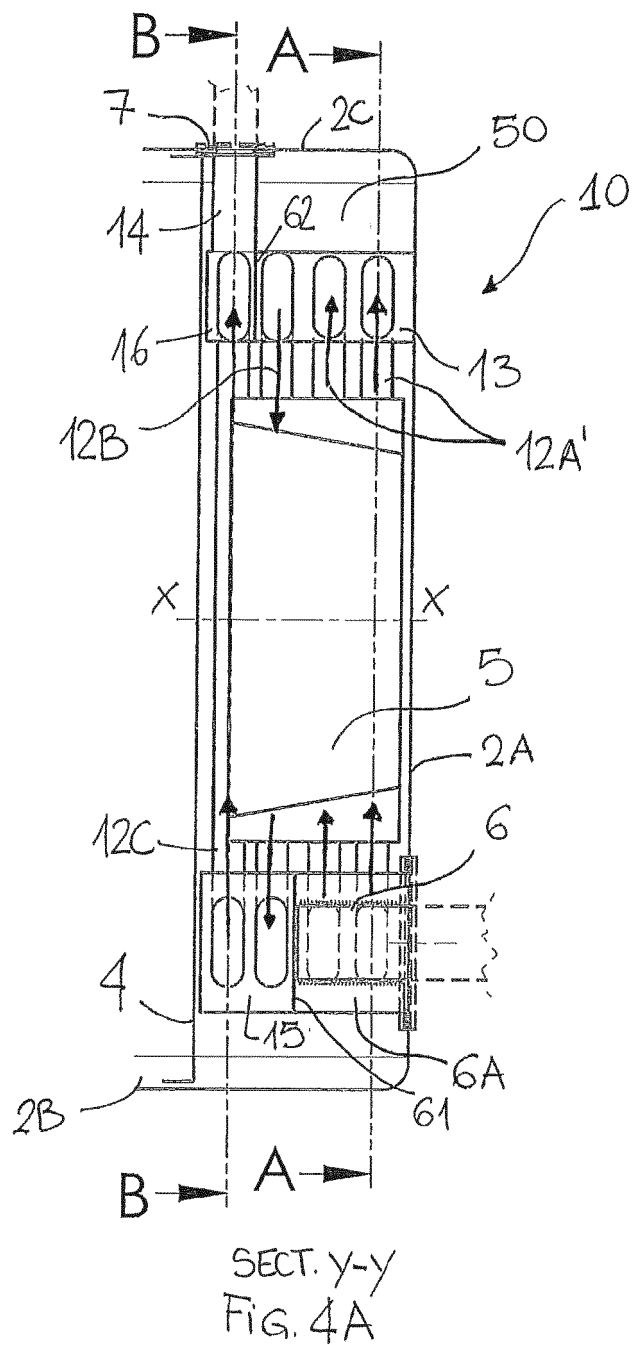
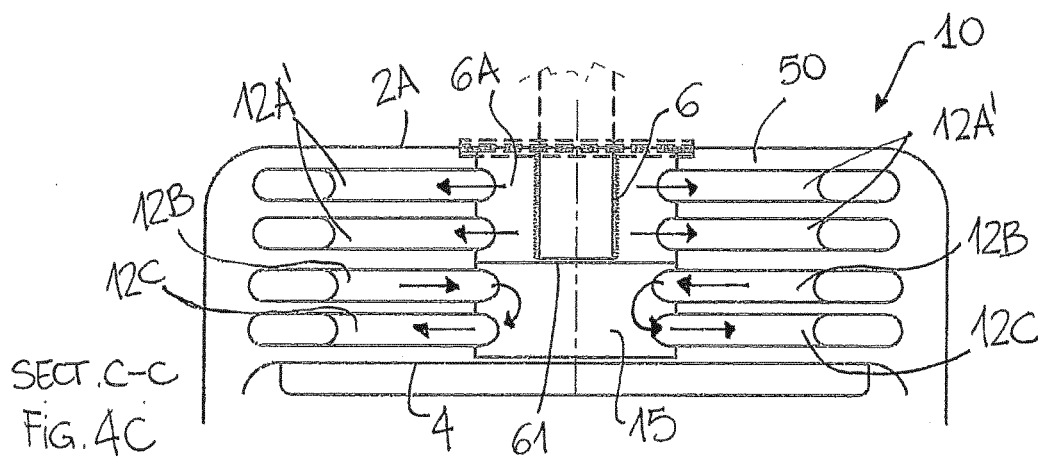
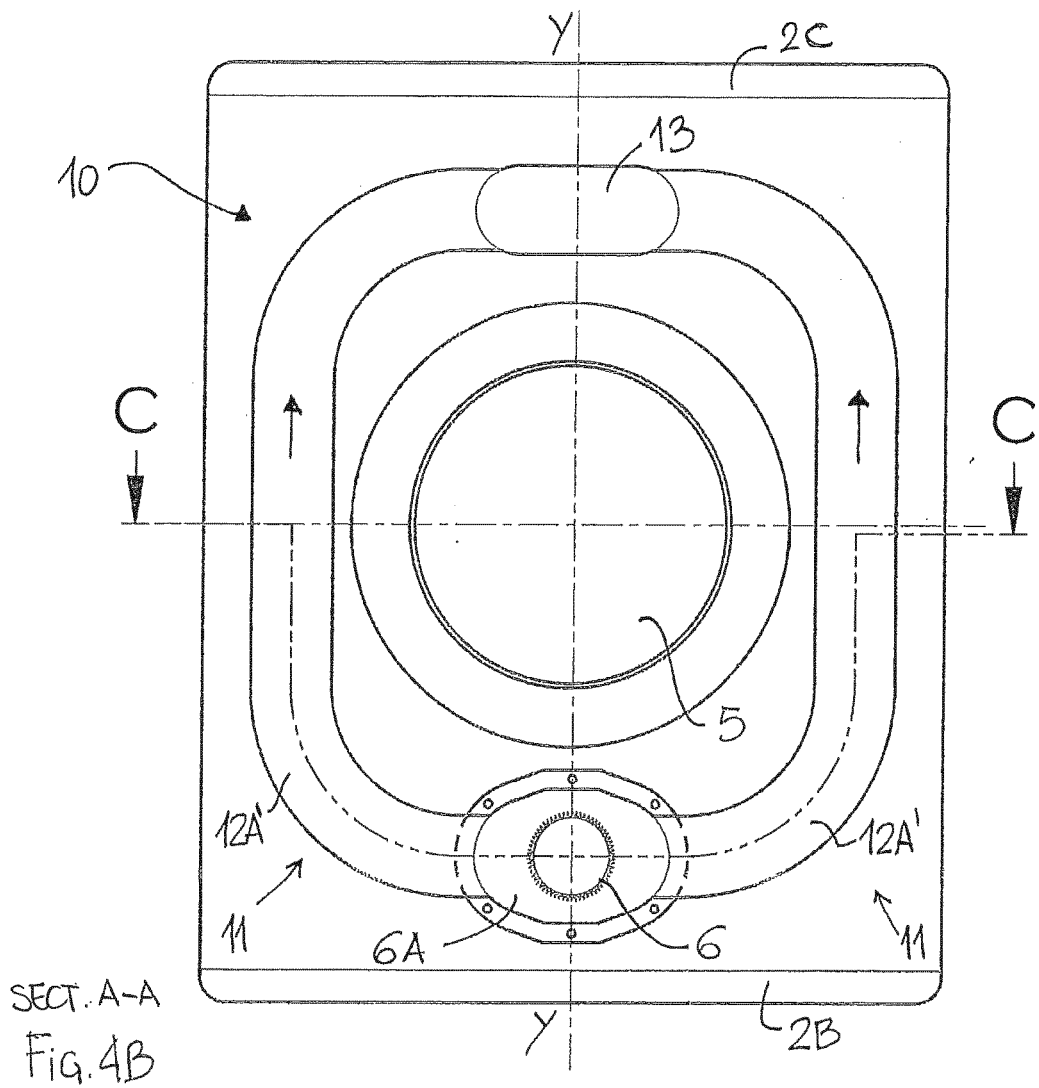
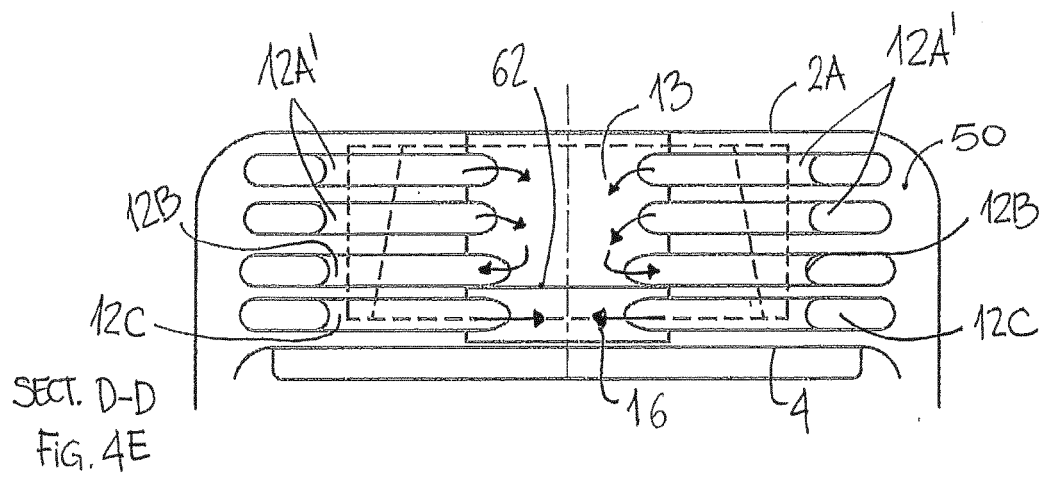
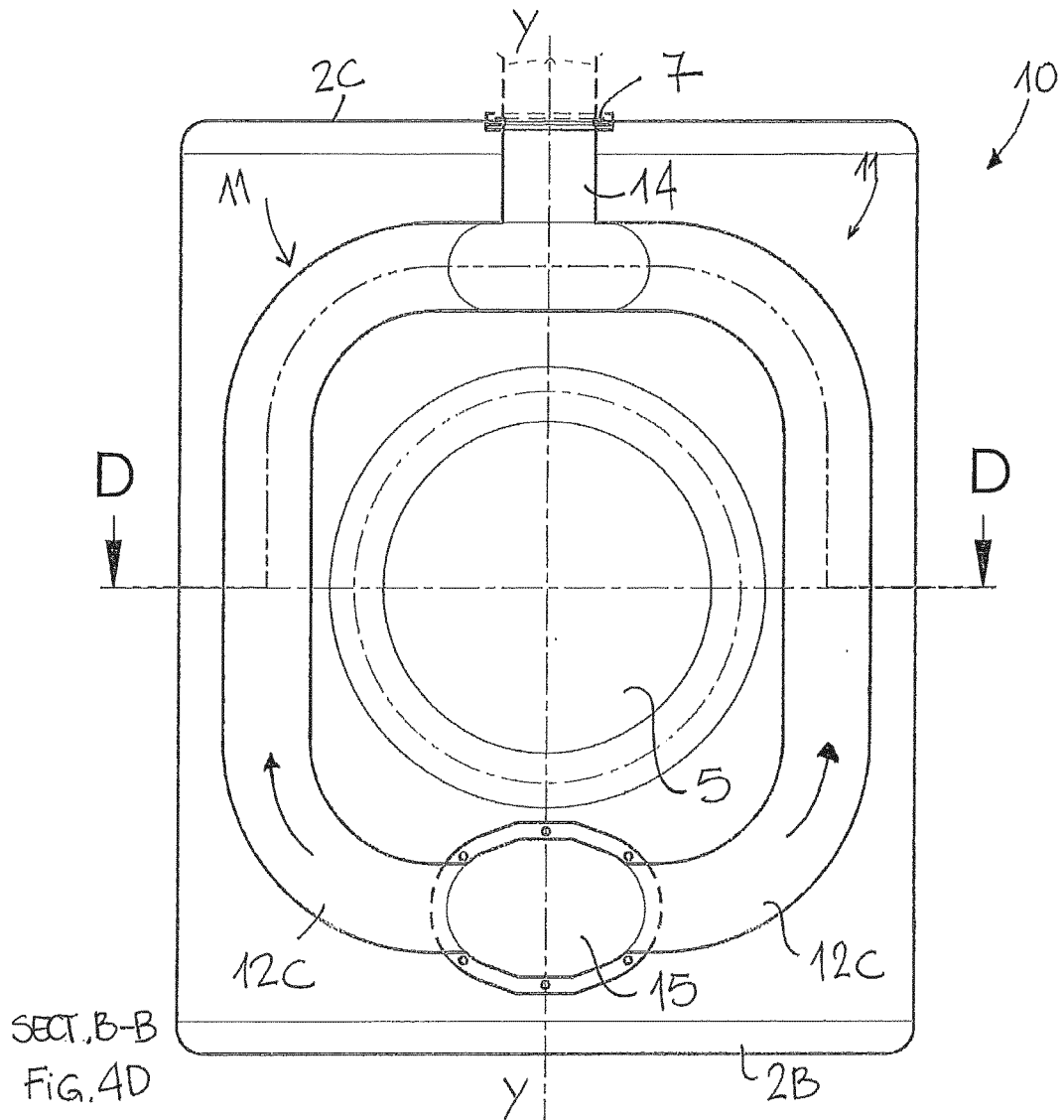
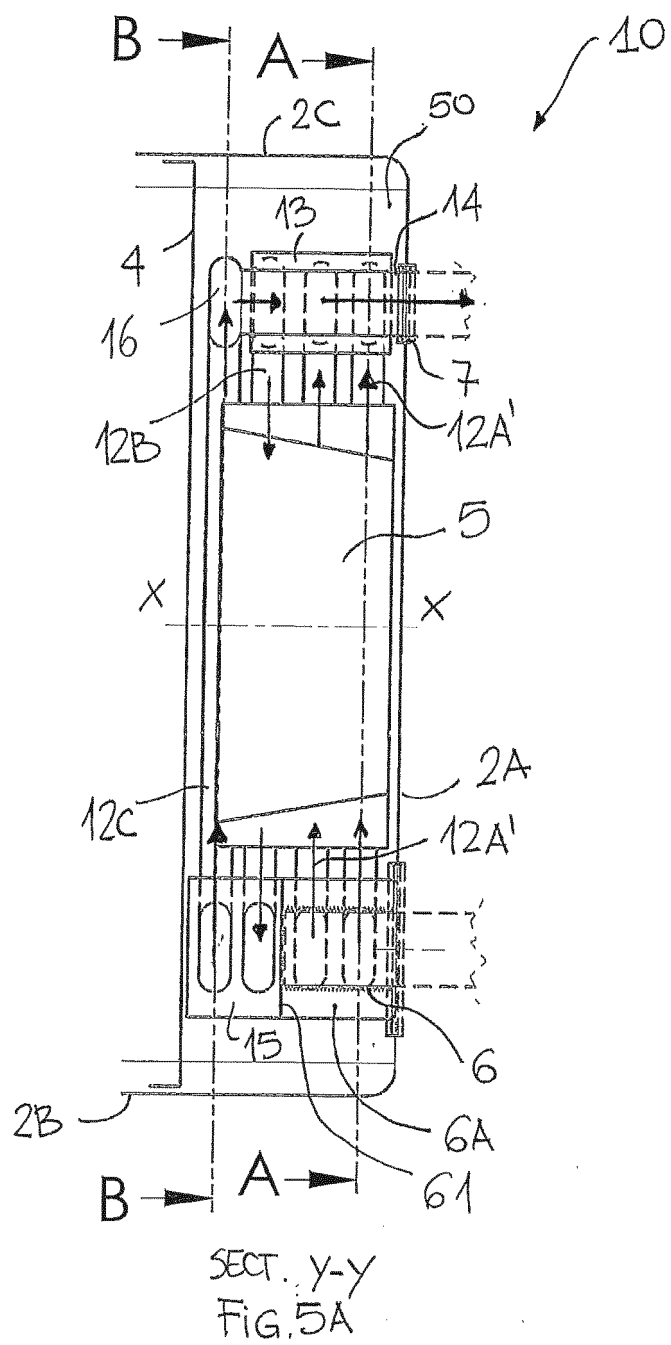


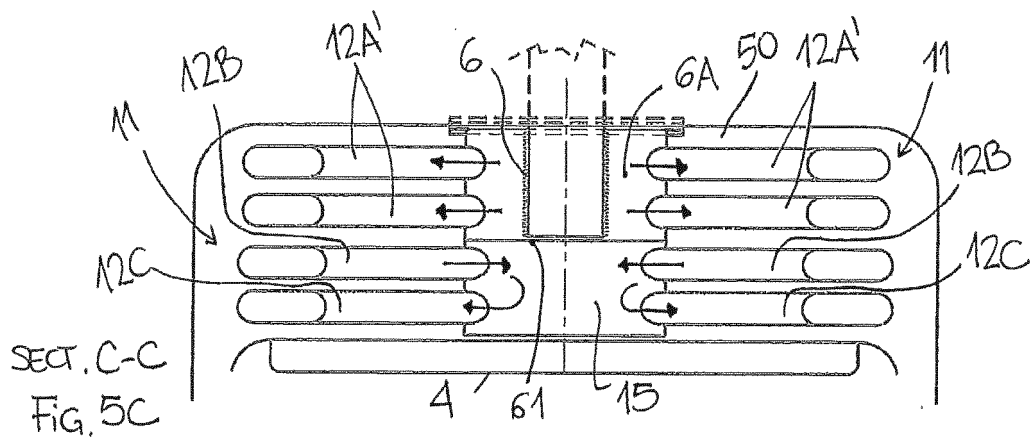
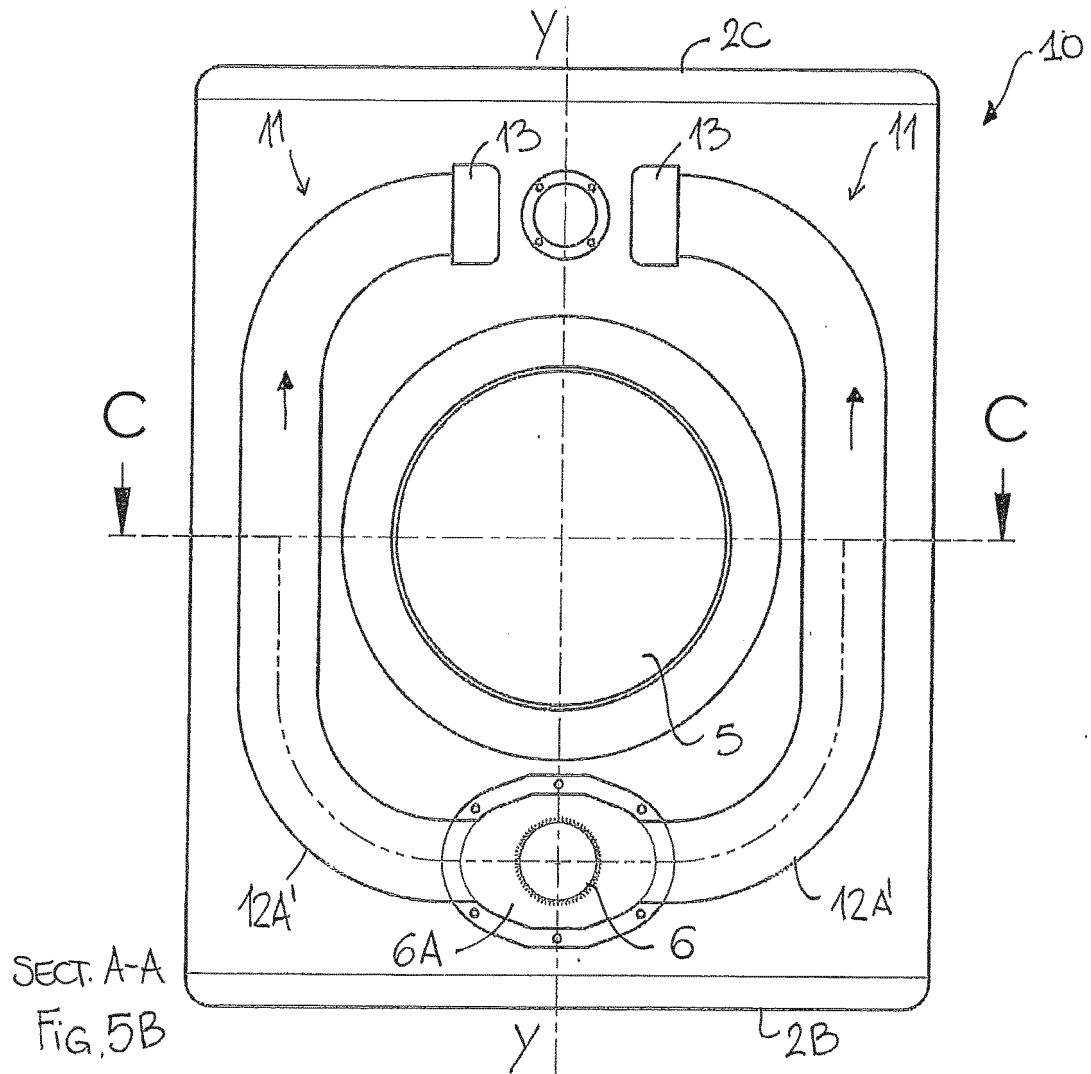
FIG. 3

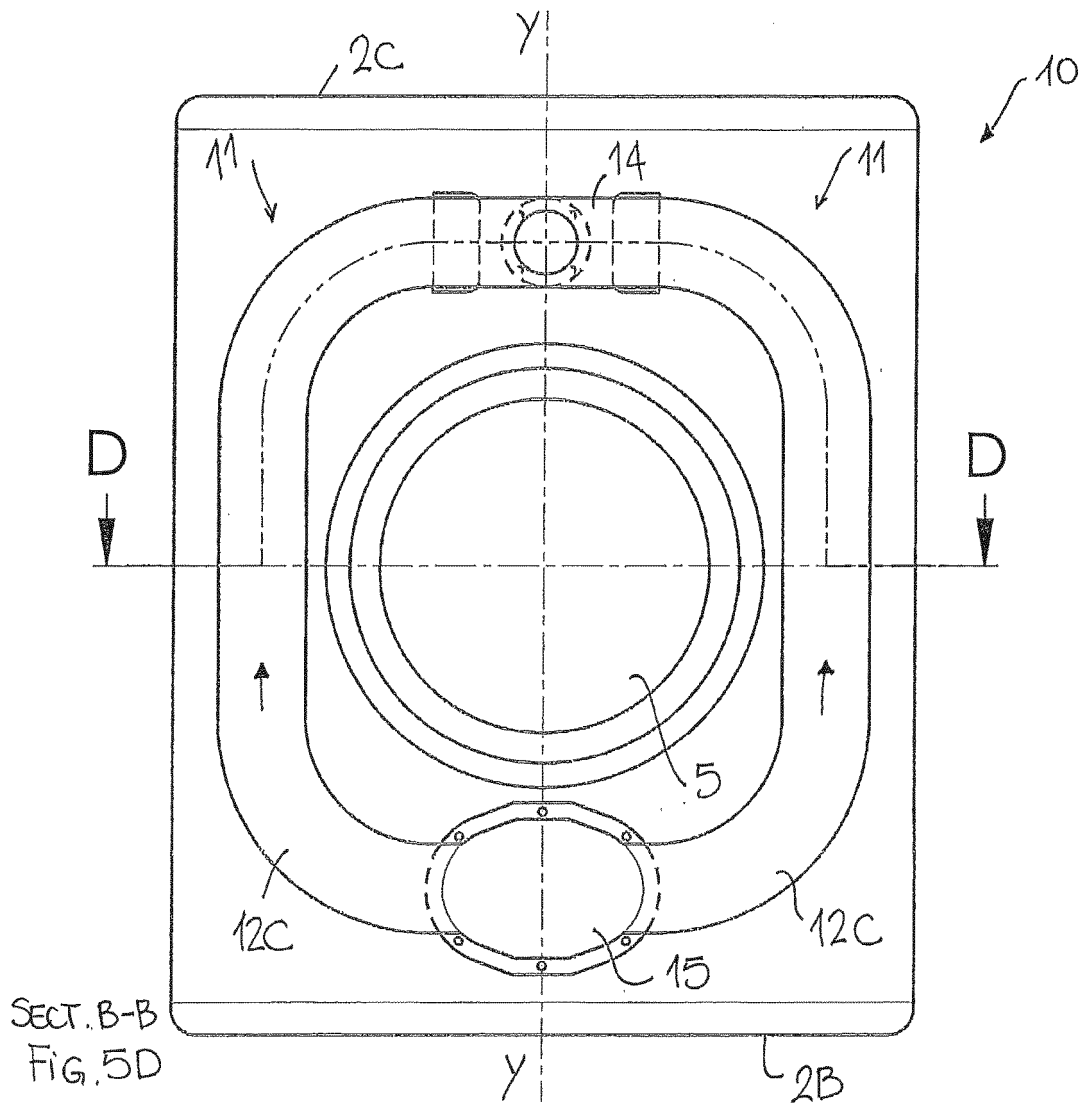




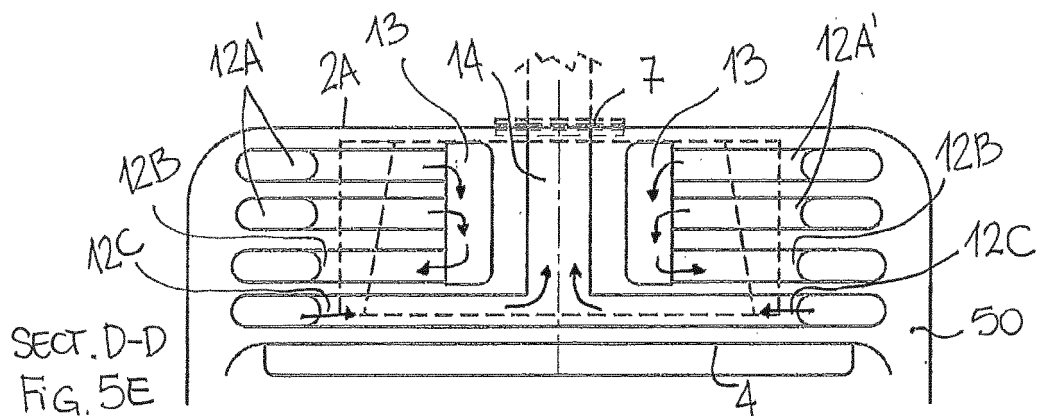




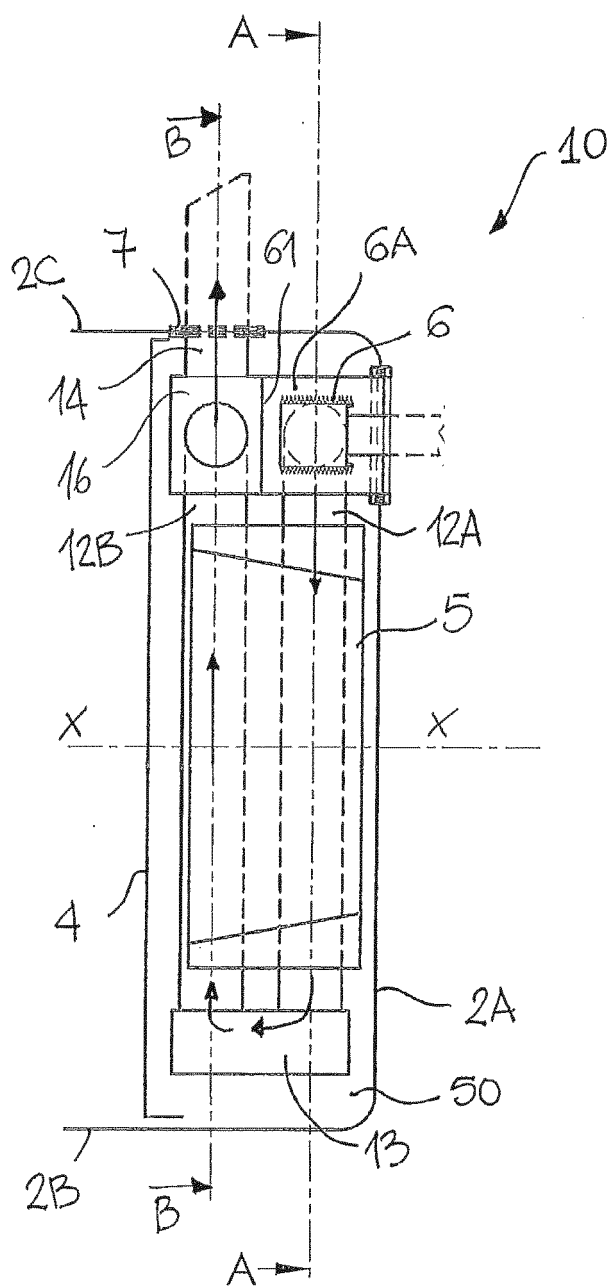




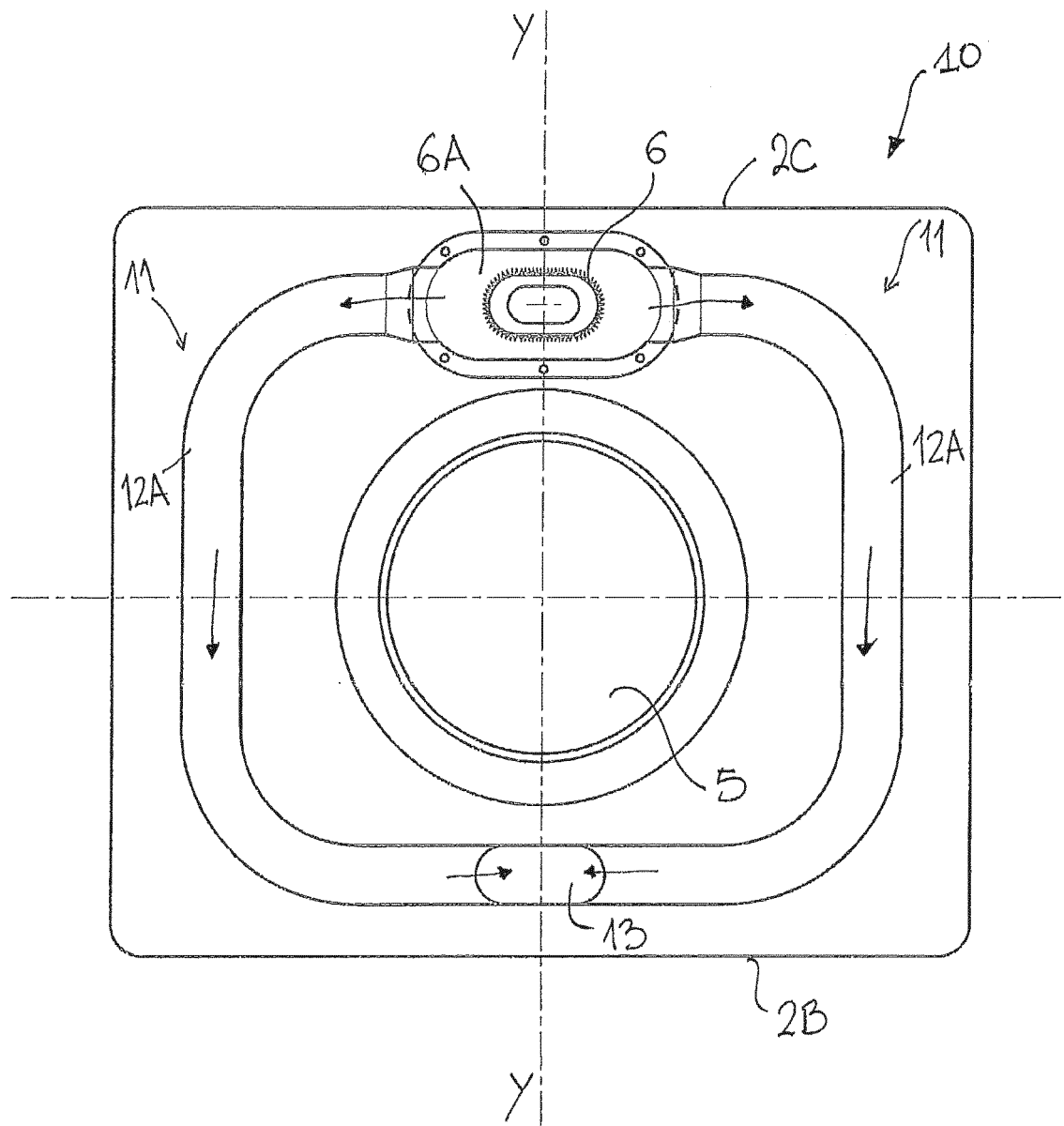
SECT. B-B
FIG. 5D



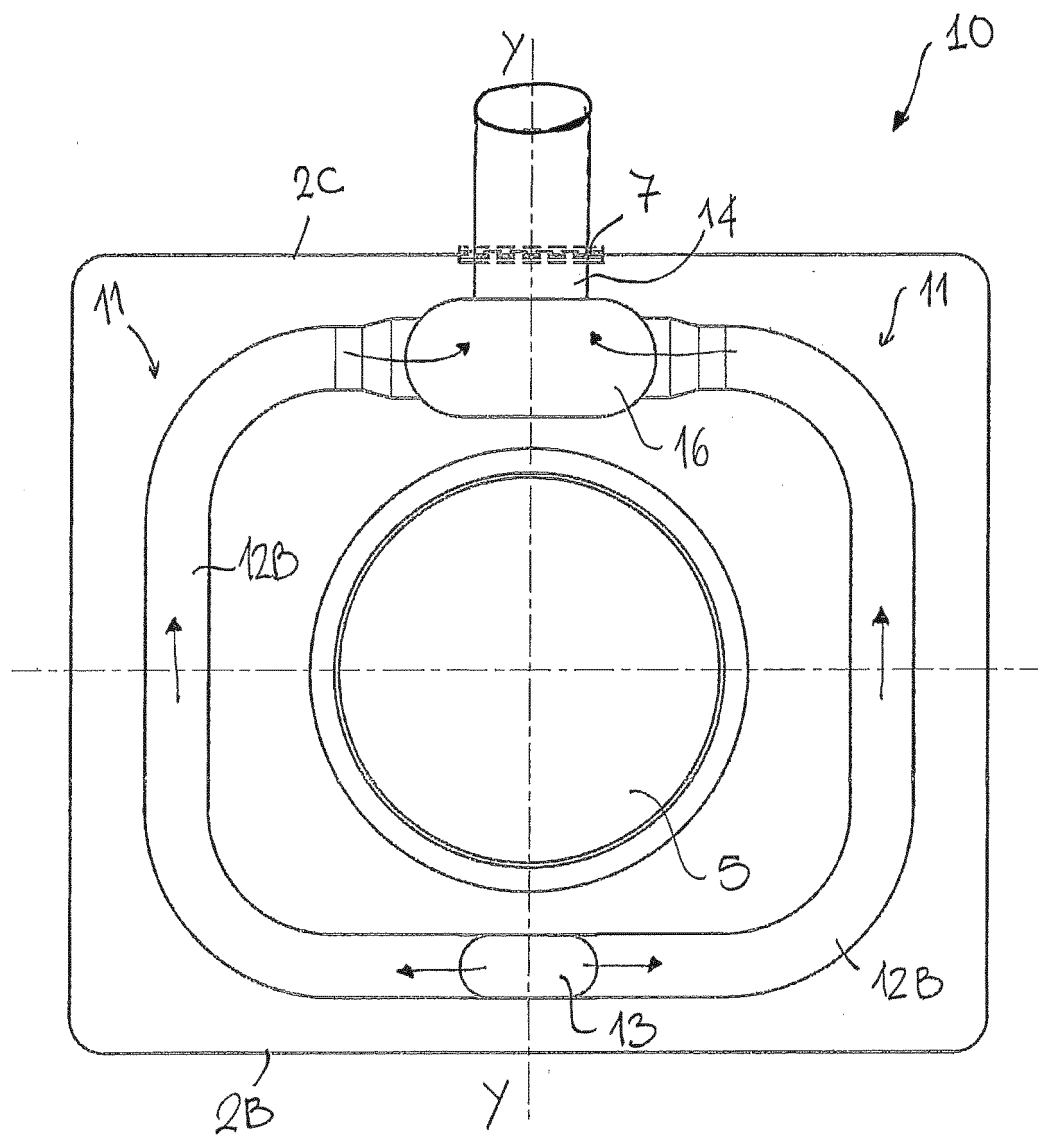
SECT. D-D
FIG. 5E



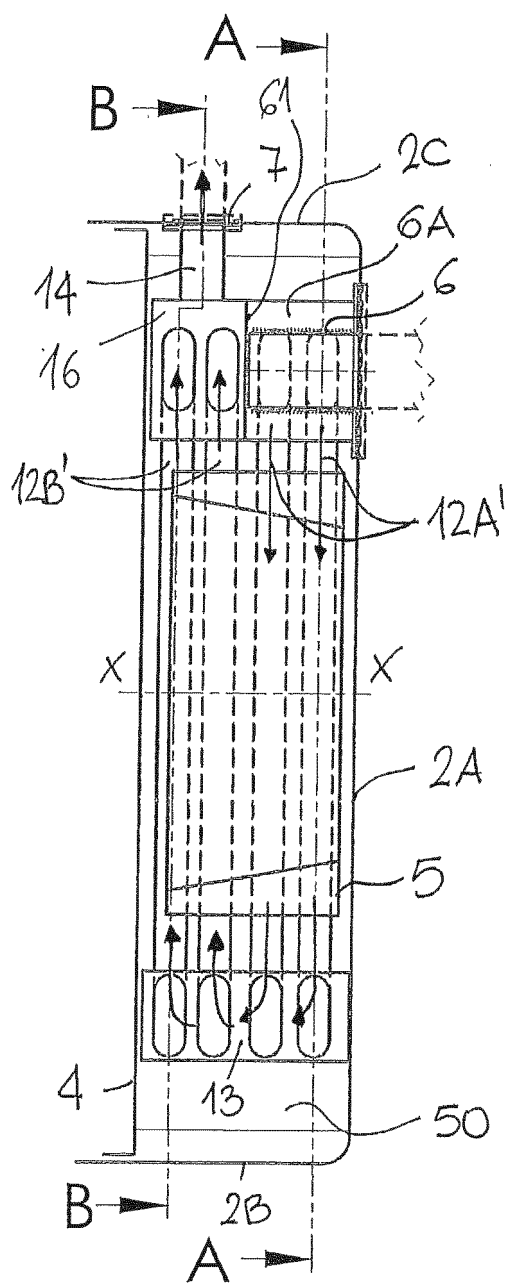
SECT. Y-Y
FIG. 6A



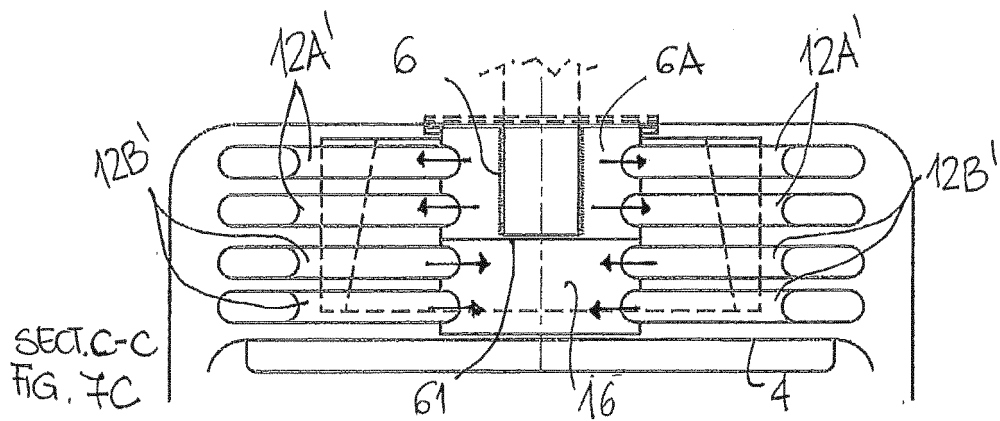
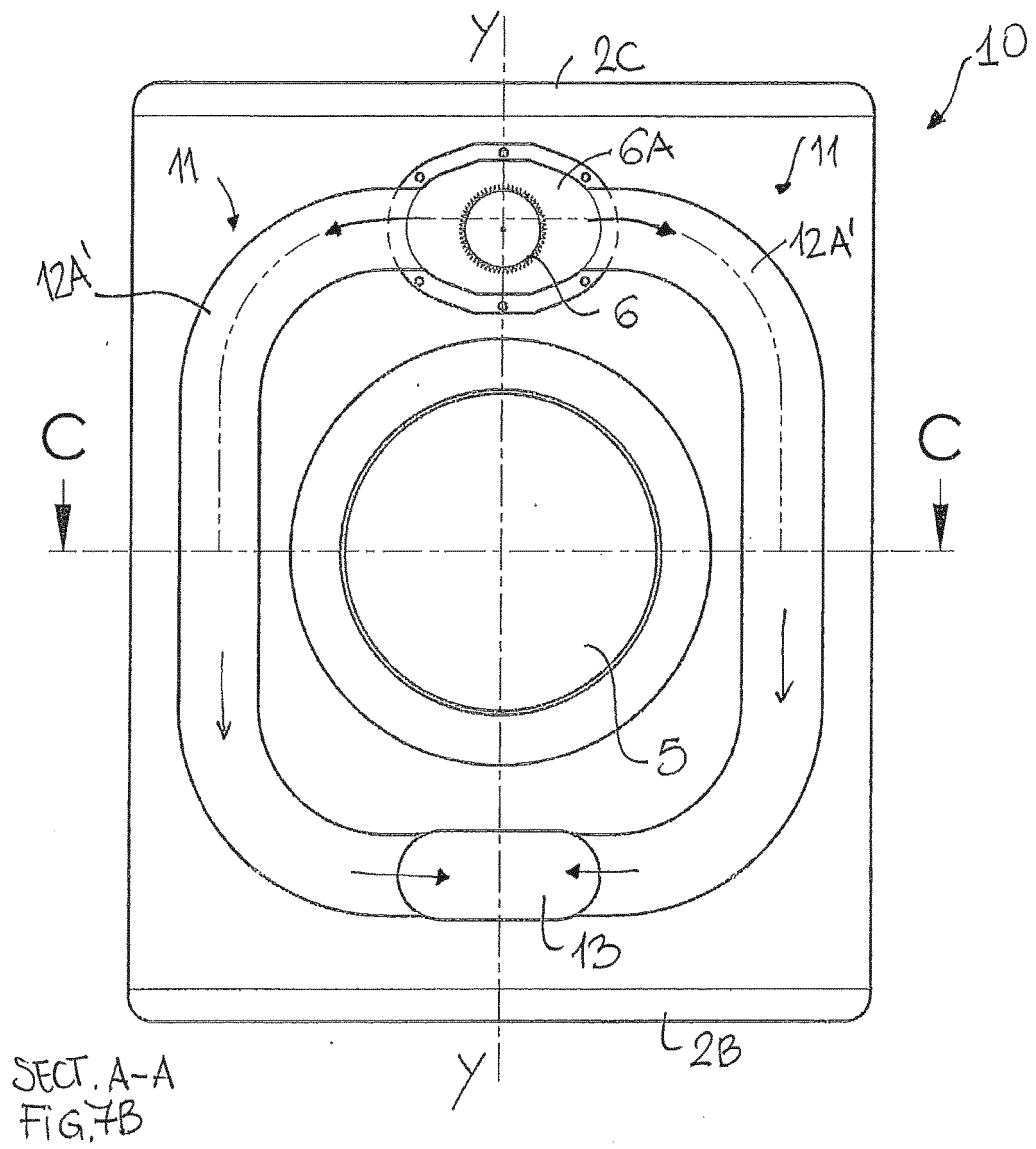
SECT. A-A
FIG. 6B

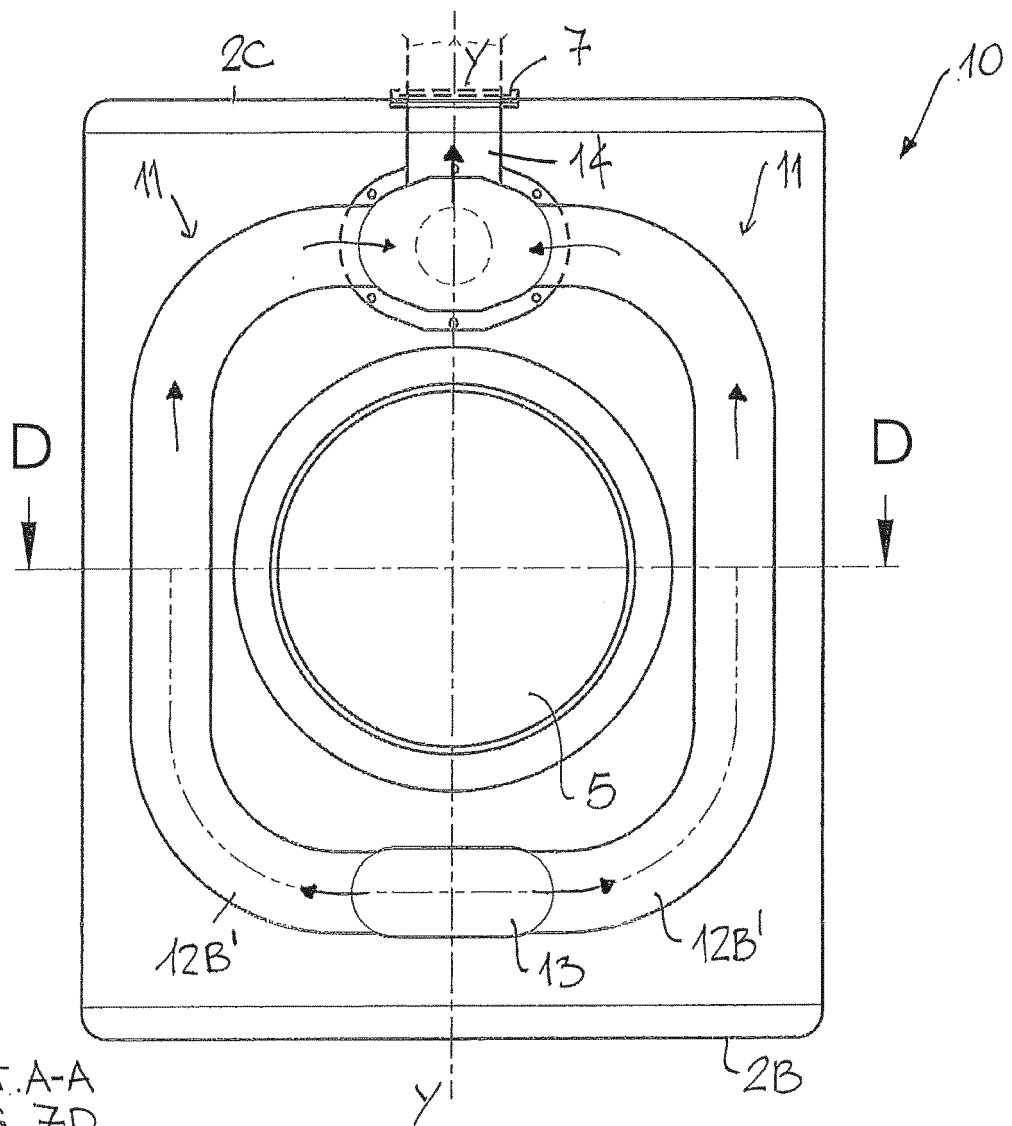


SECT. B-B
FIG. 6C

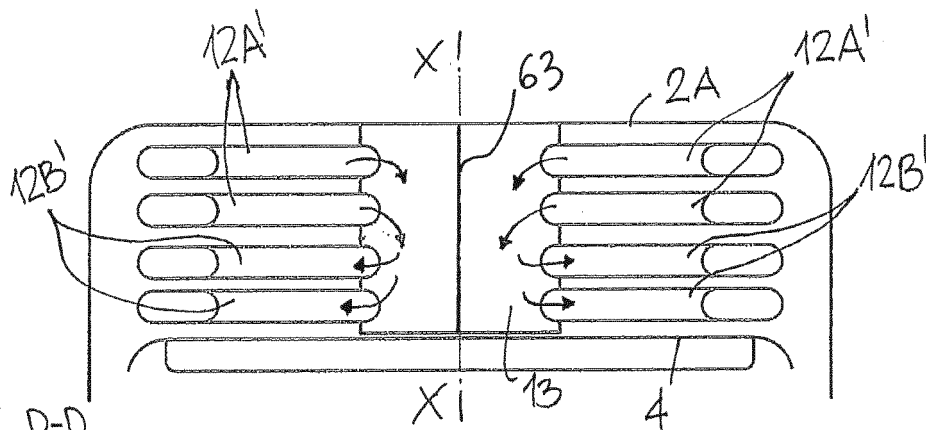


SECT. Y-Y
FIG. 7A





SECT. A-A
FIG. 7D



SECT. D-D
FIG. 7E

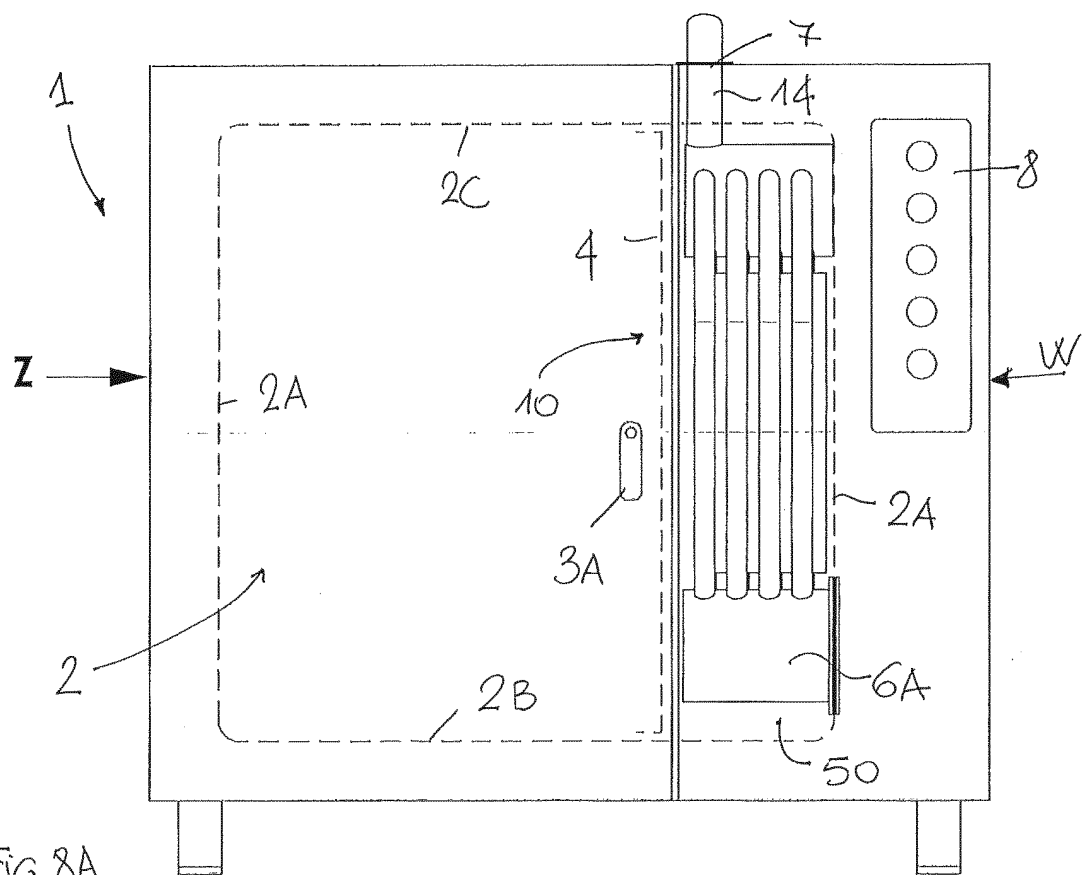


FIG. 8A

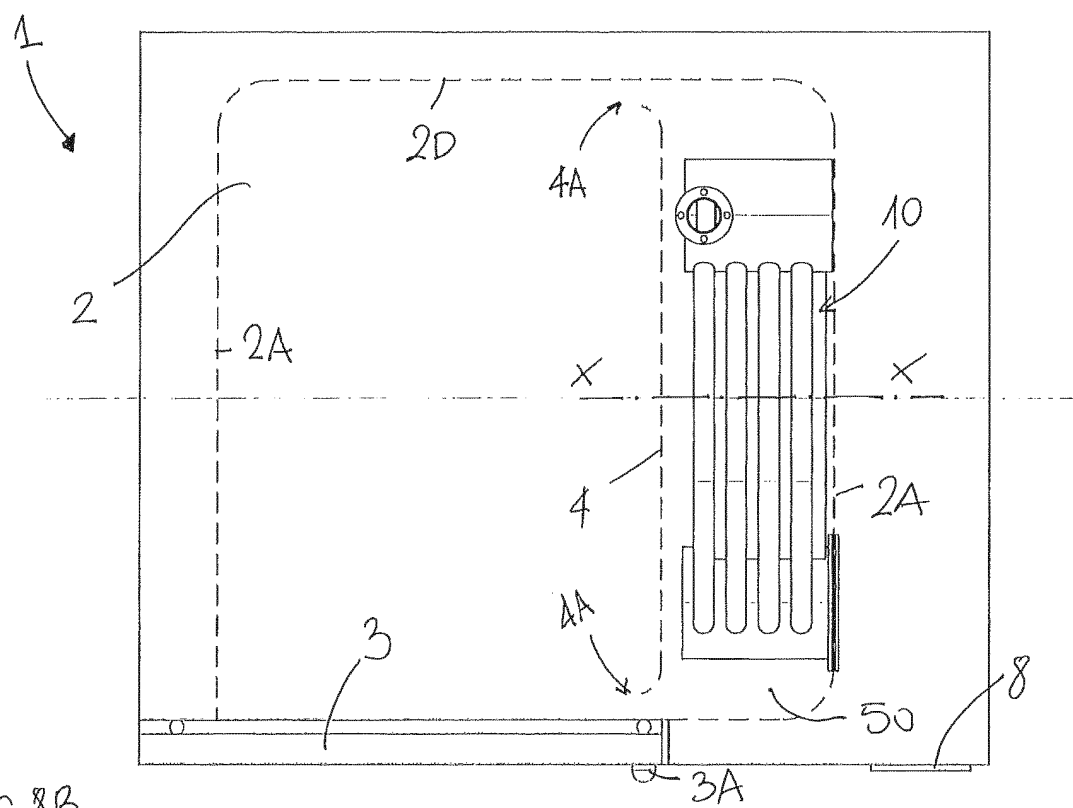


FIG. 8B

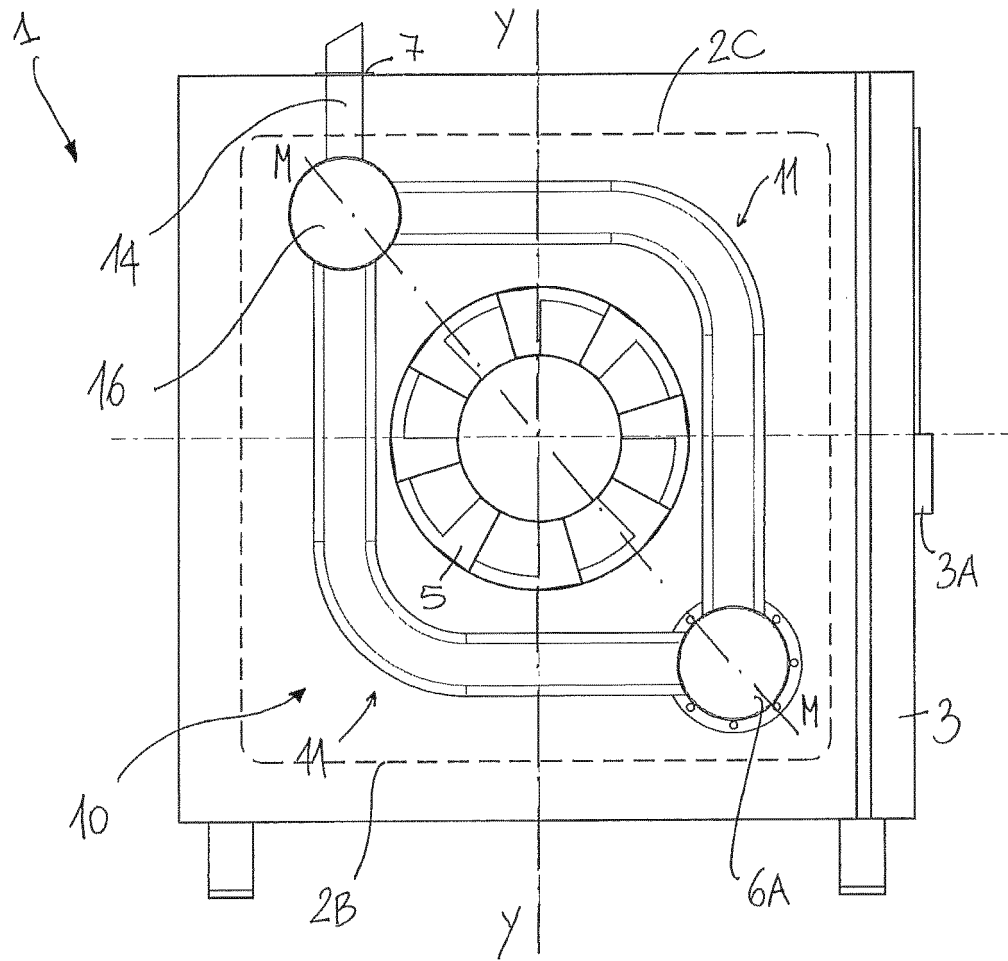


Fig. 8C

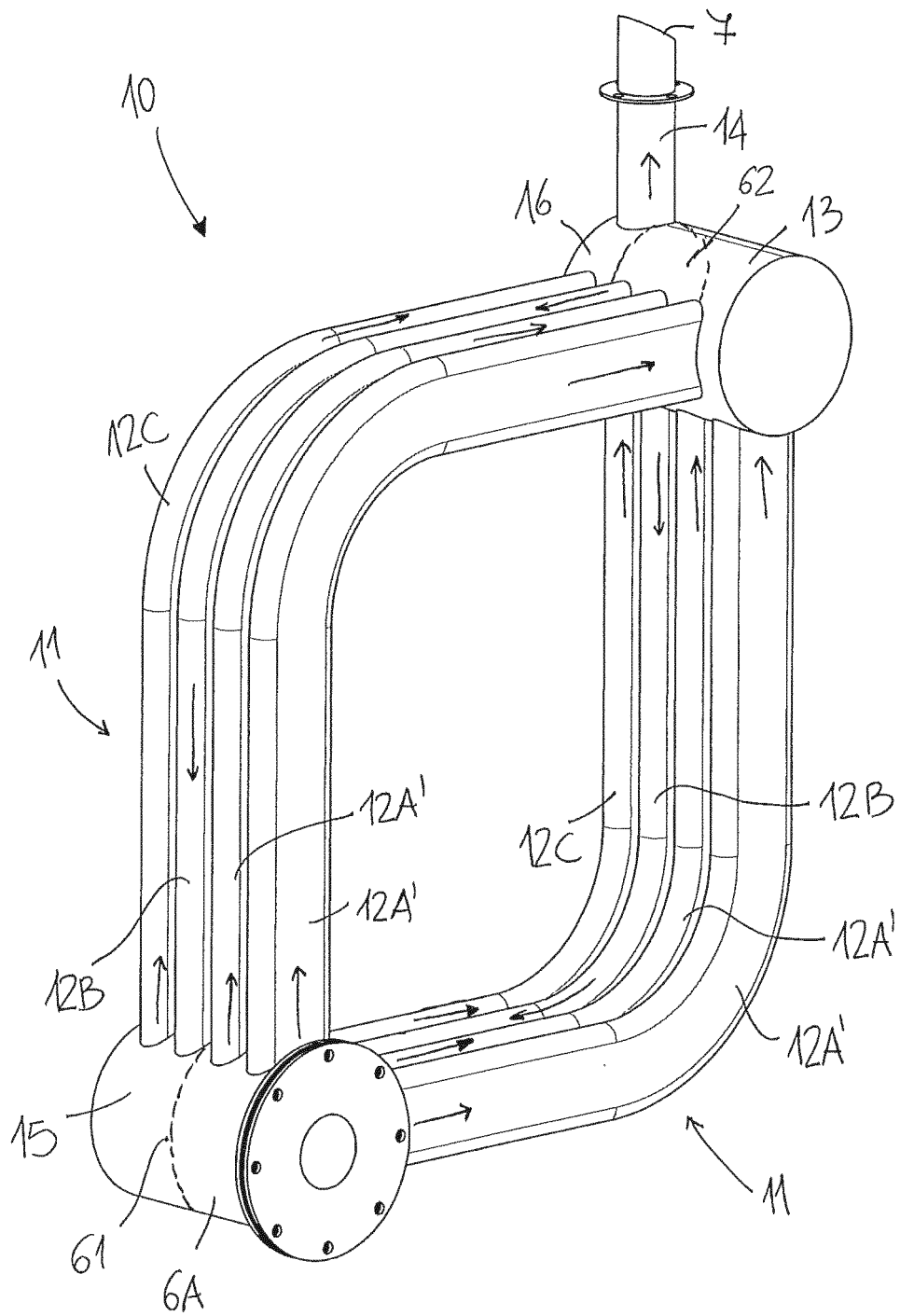


Fig. 9

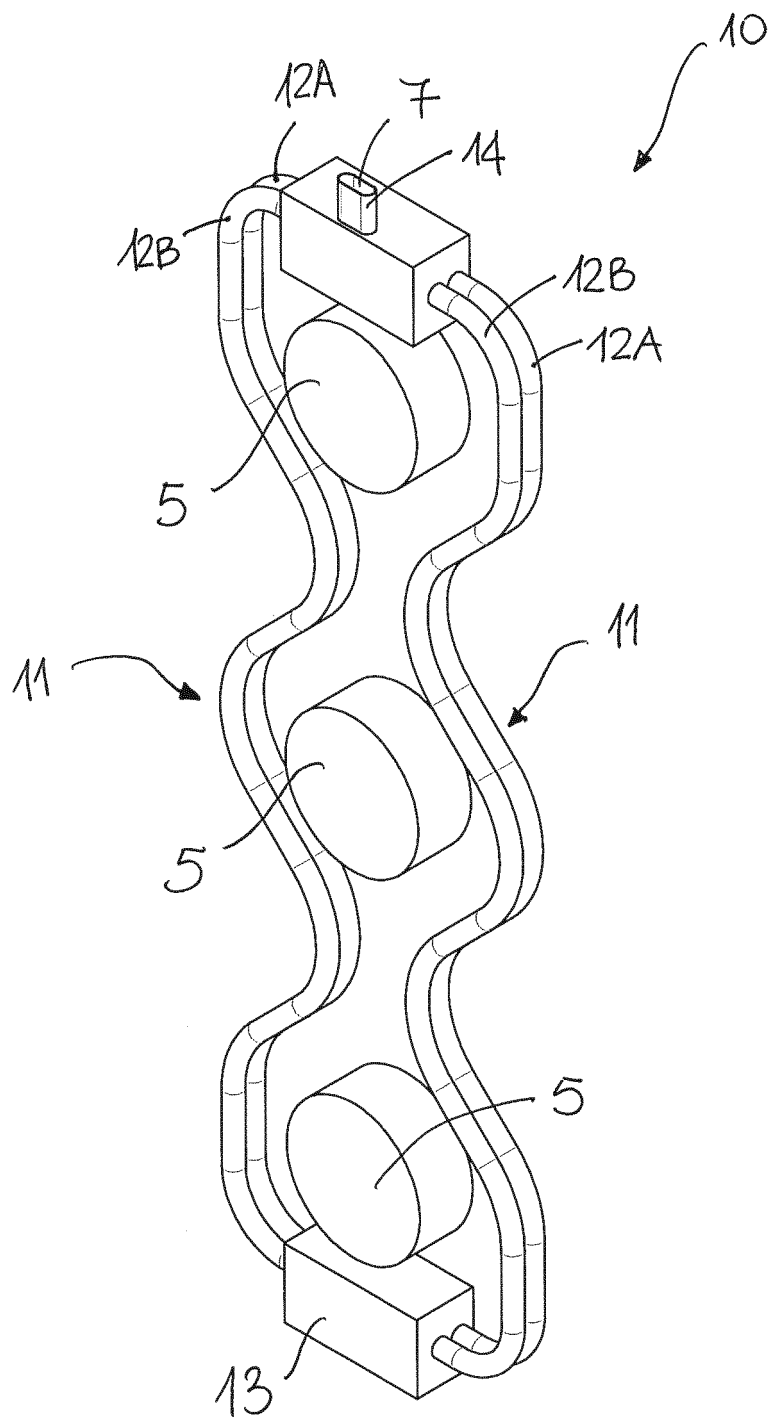
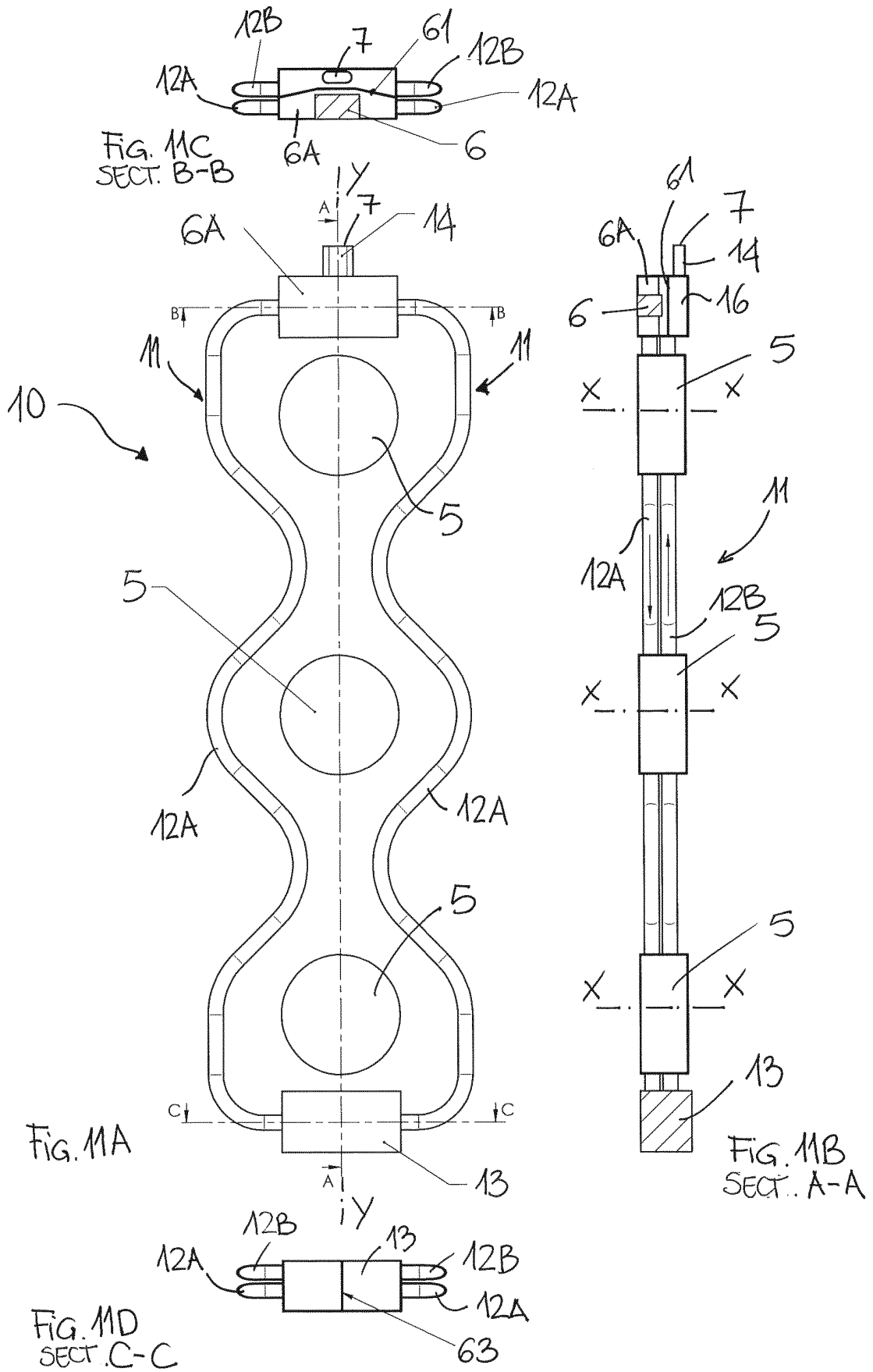


FIG. 10



REFERENCES CITED IN THE DESCRIPTION

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