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Description

[0001] The present invention relates to an evaporator.

[0002] In particular, the present invention relates to an evaporator that is adapted to be used in refrigeration cycles based on the expansion of coolant gas, for conditioning and refrigeration applications.

[0003] As is known, cooling apparatuses, known as refrigerators or chillers, comprise, very basically, a compressor, an expansion device, an evaporator and a condenser.

[0004] In particular, in cooling apparatuses evaporators are in use which are constituted, in essence, by heat exchangers, which generally have a containment enclosure provided with a cylindrical shell which accommodates a tube bundle, which is composed of a plurality of exchanger tubes, and in which a first working fluid, which is constituted by a coolant fluid and is arranged outside exchanger tubes, evaporates, thus absorbing heat from a second working fluid, which is constituted typically by water or by an aqueous solution, which flows inside the exchanger tubes and which is thus cooled.

[0005] Two types of evaporators are known: falling film evaporators and pool boiling evaporators.

[0006] In falling film evaporators, the coolant fluid is fed from above by a dispenser so as to form, on the outer surface of the exchanger tubes, a film of coolant fluid which by gravity falls progressively downward, flowing along the outer surface of the exchanger tubes.

[0007] In a pool boiling evaporator, instead, the exchanger tubes are arranged inside a container which is designed to be flooded with the coolant in the liquid phase, so as to keep the exchanger tubes submerged in the coolant fluid, while this evaporates.

[0008] A drawback of falling film evaporators is constituted by the fact that traditionally the dispenser of this type of evaporator works with a biphasic coolant fluid, i. e. made up of a liquid phase and a vapor phase, such that it is difficult to obtain a good distribution of the coolant fluid over the exchanger tubes.

[0009] A drawback that is found with pool boiling evaporators derives from the fact that when the refrigerator works with a partial load, such that less thermal power needs to be exchanged, the level of coolant liquid inside the container of the evaporator generally decreases and some rows of exchanger tubes, arranged in the upper part, remain dry, or in a condition known in the jargon as "dry-out". It is evident that under such operating conditions, which are the most common kind in a pool boiling evaporator, it is not possible to take full advantage of the heat exchange surface made available by the exchanger tubes.

[0010] Another disadvantage of pool boiling evaporators is that they require a considerable quantity of coolant liquid for their operation, which however contrasts with current environmental regulations which require the use of coolants that have a low environmental impact but which are high cost.

[0011] In an attempt to overcome these and other drawbacks, hybrid evaporators have been proposed in which, in the upper part of the containment enclosure, the coolant liquid is deposited on the outer surface of some exchanger tubes of the tube bundle so as to form a film, so as to have an operation similar to that of falling film evaporators, while other exchanger tubes, located in the lower part of the enclosure, remain immersed in the coolant liquid, with an operation similar to that of pool boiling evaporators.

[0012] Hybrid evaporators therefore have a clear separation between the part that is operating like a falling film evaporator and the part that is operating like a pool boiling evaporator, with the consequence that the advantages of one part do not make it possible to fully compensate the drawbacks of the other.

[0013] From CN2708220 an evaporator is known with pool boiling operation which is used in absorption systems and which has a plurality of trays for collecting the coolant liquid, each one of which is arranged below a respective horizontal row of exchanger tubes, so that the exchanger tubes are partially immersed in the coolant liquid gathered in the respective tray. In such prior art document, each tray is supplied with the coolant liquid by way of a corresponding draining tube that originates from a dispenser arranged above the tube bundle or, according to another embodiment, exclusively by overflowing of the coolant liquid from the outer lateral edge of the immediately overlying tray. This solution makes it possible to reduce the quantity of coolant liquid required and to avoid the use of a recirculation pump. However, feeding the trays exclusively by virtue of the overflow of the coolant liquid is not efficient, in that it risks the trays in the lower part of the evaporator not receiving coolant liquid, thus leaving the corresponding exchanger tubes in dry-out. Furthermore, in the evaporator in CN2708220 the possibility is not prevented that droplets of coolant liquid drawn from the vapor of the coolant originating from the trays arranged higher up inside the shell of the evaporator could reach the compressor of the cooling apparatus, with the consequent risk of compromising the operation of the compressor.

[0014] CN104819604 describes an evaporator with pool boiling operation, which is conceptually similar to what is described in CN2708220, with the difference that it has a dispenser that is rather complex in implementation, which is situated in a lateral region of the shell. In CN104819604, there are again trays which are fed by overflowing the coolant liquid from the outer lateral edge of the overlying trays, and the possibility is not prevented of drawing the droplets of coolant liquid into the intake line of the compressor.

[0015] CN205807912U also describes a pool boiling evaporator, similar to those of the prior art documents cited previously. In particular, in this prior art document, the evaporator has a lateral shell containing a bundle of tubes which is divided into a plurality of layers, each one of which is arranged in a respective tray for collecting the

coolant liquid, which falls by overflowing from one tray to the underlying tray, while the part of the coolant liquid that collects in the lower region of the shell is made to boil by exchanger tubes arranged on the bottom. To enable each tray to collect the coolant liquid that overflows from the overlying tray, the trays have a lateral space occupation that progressively increases, going from the tray located highest toward the tray located lowest, with the consequence that the tube bundle has, in a plane perpendicular to the axis of the lateral wall, a triangular arrangement which however limits the maximum number of exchanger tubes that can be positioned inside the shell proper.

[0016] Furthermore, even in CN205807912U, there is no solution to the problem of drawing droplets of coolant liquid toward the compressor.

[0017] US2008149311A1 then describes an evaporator that operates using the falling film method, in the upper part, and which has flat distribution units, provided with holes, which make it possible to evenly distribute the coolant liquid that drips onto the exchanger tubes. This evaporator too exhibits problems relating to the optimal distribution of the coolant liquid over the exchanger tubes, and offers no solution to the problem of drawing droplets of coolant liquid into the compressor.

[0018] In US2015013951, an evaporator is described that operates using the falling film method in the upper and central part of the lateral shell and using the pool boiling method in the lower part. The evaporator in this document has trays the purpose of which is to collect the coolant liquid in the lower part of the shell and to ensure, if there are compressors lubricated with oil, that the oil drains from the bottom. In such document, furthermore, above the tube bundle there is a deflector structure, the purpose of which is to capture the droplets of coolant liquid contained in the coolant vapor, but which however extends only to the upper region of the evaporator, such that it is not capable of offering valid assurances of certainty of interception of the droplets of coolant liquid drawn from the vapor originating from all the exchanger tubes of the evaporator.

[0019] DE 3124796 A1 discloses an evaporator according to the preamble of claim 1.

[0020] The aim of the present invention is to provide an evaporator which is capable of improving the prior art in one or more of the above mentioned aspects.

[0021] Within this aim, an object of the invention is to provide an evaporator that is capable of positively combining the advantages of pool boiling evaporators with those of falling film evaporators, without exhibiting the respective drawbacks.

[0022] Another object of the invention is to provide an evaporator that is capable of operating efficiently even under partial load conditions, by preventing situations in which the exchanger tubes end up in dry-out.

[0023] Another object of the invention is to provide an evaporator that makes it possible to prevent the drawing of droplets of coolant liquid toward the compressor.

[0024] Another object of the invention is to provide an evaporator that makes it possible to have an even distribution of the exchanger tubes inside the shell.

[0025] Furthermore, another object of the present invention is to overcome the drawbacks of the prior art in an alternative manner to any existing solutions.

[0026] Another object of the invention is to provide an evaporator that is highly reliable and which, furthermore, is easy to implement and at low cost.

[0027] This aim and these and other objects which will become better apparent hereinafter are achieved by an evaporator according to claim 1, optionally provided with one or more of the characteristics of the dependent claims.

[0028] Further characteristics and advantages of the invention will become better apparent from the description of some preferred, but not exclusive, embodiments of the evaporator according to the invention, which are illustrated for the purposes of non-limiting example in the accompanying drawings wherein:

Figure 1 is a perspective view of the evaporator according to the invention;

Figure 2 is a perspective and longitudinal cross-sectional view of the evaporator according to the invention;

Figure 3 is a perspective and longitudinal cross-sectional view of the evaporator according to the invention from which the shell, the dispenser and a shielding wall have been omitted, in order to better show the interior of the evaporator;

Figure 4 is a perspective view of the evaporator according to the invention with the shell omitted;

Figure 5 is a perspective view of a tray for collecting and distributing the cooling liquid belonging to the evaporator according to the invention with a row of exchanger tubes that are associated therewith;

Figure 6 is a perspective view of a tray of the evaporator according to the invention without the exchanger tubes;

Figure 7 is a longitudinal cross-sectional view of the evaporator according to the invention;

Figure 8 is a transverse cross-sectional view of a detail of the evaporator according to the invention;

Figure 9 is a perspective and longitudinal cross-sectional view of the dispenser of coolant fluid arranged inside of the evaporator according to the invention;

Figure 10 is a cross-sectional view of some exchanger tubes of the evaporator according to the invention;

Figure 11 is a transverse cross-sectional view of the evaporator according to the invention;

Figure 12 is a perspective and transverse cross-sectional view of the evaporator according to the invention;

Figure 13 is a perspective and transverse cross-sectional view from a different angle with respect to Figure 12 of the evaporator according to the invention;

Figure 14 is a perspective view of different embodi-

ment of the evaporator according to the invention, with several components omitted in order to show a first group of exchanger tubes and the corresponding trays; and

Figure 15 is an enlarged-scale detail of Figure 14;

Figure 16 is a schematic perspective view of a possible embodiment of the trays for collecting and distributing the liquid coolant fluid, in a condition of operation;

Figure 17 is a transverse cross-sectional view of the tray in Figure 16;

Figure 18 is a schematic perspective view of the embodiment in Figure 16 in a different condition of operation;

Figure 19 is a transverse cross-sectional view of the tray in Figure 18.

[0029] With reference to the figures, the evaporator according to the invention, generally designated by the reference numeral 1, comprises an enclosure 2 which is provided with a lateral confinement shell 3 with a substantially horizontal axis, which internally defines a heat exchange chamber 3a.

[0030] Accommodated inside the shell 3 is a dispenser 4, the function of which is to introduce a coolant fluid into the heat exchange chamber 3a of the shell 3, such fluid being fed to the dispenser 4 by way of a connector 5 passing through the shell 3. It should be noted that the coolant fluid that is fed to the dispenser 4 is, generally, in a biphasic condition, i.e. it is made up of a liquid phase, hereinafter referred to as liquid coolant fluid, and by a vapor phase, hereinafter referred to as vapor of the coolant fluid.

[0031] Also accommodated inside the shell 3 is at least one tube bundle 6, which is arranged below the dispenser 4 and which comprises a plurality of exchanger tubes 7, which extend substantially parallel to the axis of the shell 3.

[0032] For example, the dispenser 4 comprises a distribution duct 4a, which extends substantially parallel to the axis of the shell 3 and is connected to the connector 5, by way of an own intake port 5a, which is arranged substantially in a central position along its longitudinal extension. Conveniently, the distribution duct 4a has a polygonal cross-section, with a flat lower wall 4b which has a plurality of delivery openings 4c from which the coolant fluid is drained downward in the direction of the tube bundle 6.

[0033] The exchanger tubes 7 are designed to be passed through by a fluid to be cooled, which is constituted, for example, by water or by an aqueous solution.

[0034] Conveniently, the shell 3 is closed, at one end, by a first head 8a, which is provided with an entry connection 9a and with an exit connection 9b for the fluid to be cooled, and, at its opposite end, by a second head 8b. Defined inside the first head 8a and the second head and 8b are channels 10 for the fluid to be cooled to circulate, which are connected to the inside of the exchanger tubes 7, in order to allow the fluid to be cooled, once it is introduced into the shell 3 through the entry connection 9a, to follow a path, inside the exchanger tubes 7, with various passes along the longitudinal extension of the shell 3, prior to exiting from the wall through the exit connection 9b, as shown schematically in Figure 7.

[0035] Also inside the shell 3 there is a plurality of trays 11 for collecting and distributing the liquid coolant fluid, at least some of which are arranged one over the other.

[0036] In more detail, the tube bundle 6 comprises at least one first group of exchanger tubes 7 which is arranged along rows which extend on substantially horizontal and mutually superimposed planes.

[0037] In particular, the exchanger tubes 7 of each one of these rows are arranged in at least one respective tray 11, which is adapted to collect the liquid coolant fluid, so as to be able to keep the exchanger tubes 7 of each row at least partially immersed in the liquid coolant fluid, and to distribute it in the exchanger tubes 7 which are arranged in an underlying tray 11.

[0038] More specifically, according to the invention, each tray 11 has, along at least one first longitudinal edge, at least one first containment sidewall 12 which is adapted to allow the liquid coolant fluid contained therein to fall by overflowing into an underlying tray 11.

[0039] Also according to the invention, each tray is furthermore provided in its bottom 11a with a plurality of openings for draining 11b the liquid coolant fluid, such holes being arranged at the exchanger tubes 7 contained in the underlying tray 11 in order to allow the fall of the liquid coolant fluid from each tray 11 onto the outer surface of the exchanger tubes 7 placed below it.

[0040] In this manner, an optimal distribution is ensured of the liquid coolant fluid onto the exchanger tubes 7 in that the liquid coolant fluid is supplied around the exchanger tubes 7 in two ways i.e. not only by way of its falling by overflowing over the side of the overlying tray 11 but also by way of its falling through the openings for draining 11b of the overlying tray 11.

[0041] Advantageously, each tray 11 is furthermore provided with a second containment sidewall 13, which extends upward so as to contain, at least partially, the overlying tray 11. Conveniently, such second containment sidewall 13 is arranged along a second longitudinal edge of the tray 11, opposite to the first longitudinal edge along which the first containment sidewall 12 is present.

[0042] Advantageously, the second containment sidewall 13 has a portion, the extension of which is inclined toward the outside of the corresponding tray 11, which conveniently is connected to a vertical portion that protrudes upward from the bottom 11a of the tray 11 so as to create, between the second containment sidewall 13 of each tray 11 and the overlying tray 11, a space for the outflow of the vapor produced by the boiling of the liquid coolant fluid contained in each tray 11.

[0043] It should be noted that in the figures and, in particular, in Figures 8, 10 and 11, the path of the liquid coolant fluid inside the shell 3 is indicated with arrows

with dotted lines, while the path of the vapor of the coolant fluid is indicated with arrows with continuous lines.

[0044] Conveniently, in their succession along a vertical direction, the trays 11 present their first longitudinal edge, with the corresponding first containment sidewall 12, alternately directed toward one side of the shell 3 or toward the opposite side.

[0045] Such alternating arrangement, toward one side or the other of the shell 3, of the first containment sidewall 12 of the various trays 11 allows an arrangement of the exchanger tubes 7 that is square or rectangular, when seen in transverse cross-section, with the consequence of enabling the positioning in the shell 3 of a greater number of exchanger tubes 7 with respect to triangular arrangements, as in the prior art.

[0046] It should be furthermore noted that, in their mutual arrangement, the trays 11 have the corresponding first containment sidewall 12 arranged laterally spaced apart toward the inside of the shell 3 with respect to the second confinement sidewall 13 of the underlying tray 11, so that the liquid coolant fluid overflowing from each tray 11 over the corresponding first containment sidewall 12 can fall, without losses, into the underlying tray 11.

[0047] Conveniently, the openings for draining 11b defined in the bottom 11a of the trays 11 have a size that is calibrated to balance the quantity of liquid coolant fluid that enters each tray 11 with the quantity of coolant fluid that exits in vapor form from each tray 11. To this end, equal importance lies with the total passage section made available for the liquid coolant fluid by the set of the openings for draining 11b, in combination with the size of each one of these openings.

[0048] In this manner, the heat exchange is ensured between the exchanger tubes 7 and the liquid coolant fluid according to a method typical of evaporators of the film falling type, and a supply to the underlying trays is ensured even when operating under a partial load.

[0049] Advantageously, the size of the openings for draining 11b can be the same for all the trays 11 or different from tray to tray. In particular, the sizes of the openings for draining 11b can conveniently vary substantially from 1 mm to 20 mm.

[0050] For example, it is possible for the size of the openings for draining 11b to progressively decrease starting from the tray 11 located highest and proceeding progressively toward the tray located lowest.

[0051] It is also possible for each tray 11 to provide means of flow control which are adapted to at least partially block the openings for draining 11b and can move on command in order to vary the degree of opening of the openings for draining 11b. For example, such means of flow control can comprise, for each tray 11, a plate 110 which is provided with passage openings 111, which have, conveniently, a size and an arrangement that are substantially the same as the openings for draining 11b. In particular, the plate 110 is slideably mounted with respect to the bottom 11a of the respective tray 11 in order to pass from a first condition, shown in Figures 18 and 19, in which its passage openings 111 are arranged in alignment with the openings for draining 11b of the corresponding tray 11, to at least one second condition, shown in Figures 16 and 17, in which the plate 110 at least partially occludes the openings for draining 11b of the corresponding tray 11b, and vice versa.

[0052] According to the preferred embodiment, each tray 11 is stacked by interlocking on the underlying tray 11, advantageously without requiring welding or other types of fixing, so as to provide a supporting structure capable of supporting at least the exchanger tubes 7 of the first group.

[0053] Conveniently, the trays 11 are arranged alternately staggered toward one side or toward the other side of the shell 3, so as to create between each tray 11 and the overlying tray the space for the passage of the liquid coolant fluid overflowing over the first confinement sidewall 12 of the overlying tray and for the egress from each tray 11 of the vapor of the coolant fluid.

[0054] In greater detail, as shown in Figures 5 and 6, each tray 11, at its longitudinal ends, arranged along its axis of extension parallel to the axis of the shell 3, is provided, advantageously, with containment end walls 14 which define receptacles 15 for the respective exchanger tubes 7, which are constituted by holes that are passed through hermetically by the exchanger tubes 7, so that each tray 11 can also act as a support per the corresponding exchanger tubes 7.

[0055] Advantageously, the trays 11 are provided with the same shape and each one is arranged rotated by 180° about a vertical axis with respect to the two contiguous ones, in succession along the direction of stacking, so as to alternately present the first containment sidewall 12 toward one side or toward the other side of the shell 3.

[0056] In more detail, each tray 11 is provided with at least one supporting partition 16 for the overlying tray 11.

[0057] More preferably, each tray 11 has a pair of supporting partitions 16, which are arranged at its opposing longitudinal ends and are preferably defined continuously with the containment end walls 14. Each one of such supporting partitions 16 protrudes laterally outward with respect to the first confinement sidewall 12 of each tray 11.

[0058] Conveniently, in their upper part, such supporting partitions 16 define a positioning abutment for the tray 11 stacked on top of the corresponding tray 11. In particular, the supporting partitions 16 define, in a position laterally spaced apart and outward with respect to the first containment sidewall 12 of the corresponding tray 11, at least one lateral abutment shoulder 16a, on which the second confinement sidewall 13 of the tray 11 stacked above is placed, so as to ensure the arrangement in a mutually spaced apart position between the first confinement sidewall 12 of each tray 11 and the second confinement sidewall 13 of the underlying tray.

[0059] The vapor produced by the boiling of the liquid coolant fluid is conveyed outside the shell 3 by way of an exit connector 17 defined in the upper part of the shell 3.

[0060] Advantageously, inside the shell 3 and laterally to the tube bundle 6, there is at least one shielding wall 18, which makes it possible to prevent the egress, by way of an exit connector 17, of droplets of liquid together with the vapor of the coolant fluid.

[0061] Preferably, the shielding wall 18 extends downward, with two portions that are mutually opposite with respect to the tube bundle 6, and defines, for the vapor of the coolant fluid exiting from the trays 11, at least one respective first flow channel 18a and at least one respective second flow channel 18b. In particular, the first flow channel 18a extends downward and is delimited between the tube bundle 6 and the shielding wall 18, while the second flow channel 18b extends upward and is delimited between the shell 3 and the shielding wall 18.

[0062] Conveniently, the shielding wall is arc-shaped with the concavity directed toward the tube bundle 6 so as to cover the upper part thereof and at least partially the lateral part thereof and is passed through by the intake port 5a of the distribution duct 4a. Conveniently, the shielding wall 18 is supported at its longitudinal ends by a pair of tuyere plates 19a and 19b, between which the shell 3 is interposed and to which the heads 8a and 8b are fixed, on the side thereof opposite the shell 3.

[0063] Advantageously, below the first group of exchanger tubes 7 i.e. the exchanger tubes 7 arranged in the trays 11, there can also be a second group of exchanger tubes 7, proximate to the bottom of the shell 3, which are designed to evaporate the excess liquid coolant fluid that collects in the lower part of the shell 3. In this manner, there is no need to install a pump or an ejection system to make the liquid coolant fluid recirculate from the bottom of the shell to the connector 5.

[0064] It should be added that it is also possible to arrange two or more trays 11 arranged mutually laterally adjacent on respective horizontal levels in order to accommodate the same row of exchanger tubes 7, if it is intended to use exchanger tubes 7 that are longer than the longitudinal extension of the single trays 11, as shown in particular in Figures 14 and 15.

[0065] For the sake of completeness it should be added that in the lower part of the shell 3, preferably below the second group of exchanger tubes 7, there is, advantageously, at least one discharge outlet 20, which is provided, conveniently, with an adapted connector 21, in order to allow, in the eventuality that the evaporator is used in refrigeration systems in which oil-lubricated compressors are used, the extraction from the shell 3 of the oil originating from the compressor, so as to permit the return of same to the compressor.

[0066] Operation of the evaporator, according to the invention, is the following.

[0067] The coolant fluid, generally in the form of a biphasic mixture composed of a liquid phase and a vapor phase, enters, from the upper part of the shell 3, through the connector 5, into the dispenser 4, feeding the distribution duct 4a, from which it exits, through the delivery openings 4c, so as to be evenly distributed in the first tray 11 which is arranged higher than the others.

[0068] The fluid to be cooled is made to enter the shell 3, through the entry connection 9a, so that it can run through the exchanger tubes 7 until it arrives at the exit connection as shown in Figure 7, where arrows show the possible path of the fluid to be cooled.

[0069] In the first tray 11, the coolant fluid, coming into contact with the exchanger tubes 7 passed through by the fluid to be cooled, starts to evaporate and the two phases, vapor and liquid, of the coolant fluid separate, following different paths.

[0070] The liquid coolant fluid, which does not evaporate, falls onto the row of exchanger tubes 7 arranged in the second tray 11, arranged below the first tray 11, in two possible ways: either by overflowing over the first confinement sidewall 12 or by passing through the openings for draining 11b.

[0071] In particular, when the level of liquid coolant fluid in the first tray 11 exceeds the height of the first confinement sidewall 12, a part of the liquid coolant fluid falls into the second tray 11 by overflowing, while another part of the liquid coolant fluid can fall at each exchanger tube 7 of the underlying row arranged in the second tray 11, through the openings for draining 11b arranged on the bottom 11a of the first tray 11, as shown in Figure 8, with a falling film operating method.

[0072] If, under partial load conditions, the level of liquid coolant fluid drops below the height of the first confinement sidewall 12, supply of the underlying tray 11 and therefore the wettability of the lower exchanger tubes 7 is still ensured by the openings for draining 11b.

[0073] In the same way, all the other trays 11 are progressively supplied, as shown in Figure 10.

[0074] The coolant fluid that evaporates exits from the lateral parts of the trays 11 and, as shown in Figure 11, is channeled into the first flow channels 18a, defined between the tube bundle 6 and the shielding wall 18, and, subsequently, into the second flow channels 18b, defined between the shielding wall 18 and the shell 3, before arriving at the top of the shell 3, from which it exits by way of the exit connector 17.

[0075] The liquid coolant fluid gathered in the bottom of the shell 3 is made to evaporate by the exchanger tubes 7 of the second group, with a pool boiling operating method.

[0076] In practice it has been found that the invention fully achieves the intended aim and objects, in that, by virtue of the presence of the trays provided with openings for draining and the possibility for the coolant liquid to overflow from them, it makes it possible to take better advantage of the exchange surface of the exchanger tubes with respect to a traditional falling film evaporator, and, by virtue of the openings for draining arranged on the bottom of the trays, it makes it possible to prevent, under partial load conditions, some rows of exchanger tubes from remaining dry, with a consequent improvement of the wettability of the exchanger tubes with respect to a traditional pool boiling evaporator as well.

[0077] Another advantage of the evaporator according to the invention is that it enables a reduction of the quantity of coolant required with respect to a pool boiling evaporator.

[0078] The invention, thus conceived, is susceptible of numerous modifications and variations, provided they are within the scope of the appended claims.

[0079] In practice the materials employed, provided they are compatible with the specific use, and the contingent dimensions and shapes, may be any according to requirements and to the state of the art.

[0080] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. An evaporator comprising an enclosure (2) which is provided with a lateral confinement shell (3) with a substantially horizontal axis, which internally accommodates a dispenser (4) of a coolant fluid and at least one tube bundle (6), which is arranged below said dispenser (4) and comprises a plurality of exchanger tubes (7) which extend substantially parallel to the axis of said shell (3) and are designed to be passed through by a fluid to be cooled, at least one first group of said exchanger tubes (7) being arranged along rows which extend on substantially horizontal and mutually superimposed planes, wherein the exchanger tubes (7) of each one of said rows are arranged in at least one respective tray (11), which is adapted to collect the liquid coolant fluid in order to keep the exchanger tubes (7) of each one of said rows at least partially immersed in said liquid coolant fluid, each one of the trays (11) having, along at least one first longitudinal edge, at least one first containment sidewall (12) which is adapted to allow the liquid coolant fluid contained therein to fall by overflowing into an underlying tray (11) **characterized in that** each tray is provided in its bottom (11a) with a plurality of openings for draining (11b) the liquid coolant fluid, which are arranged at the exchanger tubes (7) of the underlying tray (11) in order to allow the liquid coolant fluid to fall from each tray (11) onto the outer surface of the exchanger tubes (7) of the underlying tray (11).

2. The evaporator according to claim 1, **characterized in that** each tray (11) is provided with a second containment sidewall (13) which extends upward in order to contain at least partially the overlying tray (11).

3. The evaporator according to one or more of the preceding claims, **characterized in that** said second containment sidewall (13) is arranged along a second longitudinal edge of the corresponding tray (11) which lies opposite with respect to said first longitudinal edge.

4. The evaporator according to one or more of the preceding claims, **characterized in that** said second containment sidewall (13) has a portion the extension of which is inclined toward the outside of the corresponding tray (11).

5. The evaporator according to one or more of the preceding claims, **characterized in that** said trays (11) have, in mutual alternation, in succession, said first longitudinal edge directed toward one side of said shell (3) or toward the opposite side.

6. The evaporator according to one or more of the preceding claims, **characterized in that** said openings for draining (11b) have a size that is calibrated to balance the quantity of liquid coolant fluid that enters each tray (11) with the quantity of coolant fluid that exits in vapor form from each tray (11).

7. The evaporator according to one or more of the preceding claims, **characterized in that** the size of said openings for draining (11b) is different from tray to tray.

8. The evaporator according to one or more of the preceding claims, **characterized in that** it comprises, for each tray (11), means of flow control, which can move on command and are adapted to affect at least partially said openings for draining (11b).

9. The evaporator according to one or more of the preceding claims, **characterized in that** each tray (11) is mounted stacked by interlocking on the underlying tray (11) in order to provide a load-bearing structure for at least the exchanger tubes (7) of said first group of exchanger tubes (7).

10. The evaporator according to one or more of the preceding claims, **characterized in that** each tray (1) has at least one supporting partition (16) which defines at least one positioning abutment for the overlying tray (11).

11. The evaporator according to one or more of the preceding claims, **characterized in that** each tray (11) has, at its ends arranged along its longitudinal axis that is parallel to the axis of said shell (3), containment end walls (14) which define receptacles (15) for the respective exchanger tubes (7).

12. The evaporator according to one or more of the preceding claims, **characterized in that** it comprises,

inside said shell (3) and laterally to said tube bundle (6), at least one shielding wall (18) which extends downward and defines, for the vapor of said coolant fluid that exits from said trays (11), at least one first flow channel (18a) which extends downward and is delimited between said tube bundle (6) and said at least one shielding wall (18) and at least one second flow channel (18a) which extends upward and is delimited between said shell (3) and said shielding wall (18).

13. The evaporator according to one or more of the preceding claims, **characterized in that** it comprises, below said first group of exchanger tubes (7), a second group of exchanger tubes (7) which is designed to cause the evaporation of the excess liquid coolant fluid collected in the lower part of said shell (3).

14. The evaporator according to one or more of the preceding claims, **characterized in that** in the lower part of said shell (3) there is at least one discharge outlet (20) for the extraction of oil.

Patentansprüche

1. Ein Verdampfer, der eine Einfassung (2) umfasst, die mit einem seitlichen Einschlussgehäuse (3) mit im Wesentlichen horizontaler Achse ausgestattet ist, das in seinem Inneren einen Spender (4) für ein Kühlfluid und mindestens ein Rohrbündel (6) enthält, welches unterhalb des Spenders (4) angeordnet ist und eine Vielzahl von Tauscherrohren (7) umfasst, welche sich im Wesentlichen parallel zur Achse des Gehäuses (3) erstrecken und konstruiert sind, um von einem zu kühlenden Fluid durchströmt zu werden; wobei mindestens eine erste Gruppe von Tauscherrohren (7) entlang Reihen angeordnet ist, die sich auf im Wesentlichen horizontalen und übereinander angeordneten Ebenen erstrecken; wobei die Tauscherrohre (7) jeder der Reihen in mindestens einem dazugehörigen Behälter (11) angeordnet sind, der ausgebildet ist, um das flüssige Kühlfluid zu sammeln, um die Tauscherrohre (7) jeder der Reihen zumindest teilweise in das flüssige Kühlfluid eingetaucht zu halten; wobei jeder der Behälter (11) entlang mindestens einer ersten Längskante mindestens eine erste Einfassungs-Seitenwand (12) hat, die ausgebildet ist, um das darin enthaltene flüssige Kühlfluid durch Überlaufen in einen darunter liegenden Behälter (11) laufen zu lassen; **dadurch gekennzeichnet, dass** jeder Behälter in seinem Boden (11a) eine Vielzahl von Öffnungen (11b) zum Ablassen des flüssigen Kühlfluids hat, die an den Tauscherrohren (7) des darunter liegenden Behälters (11) angeordnet sind, um das flüssige Kühlfluid von jedem Behälter (11) auf die äußere Oberfläche der Tauscherrohre (7) des darunter liegenden Behälters (11) laufen zu lassen.

2. Der Verdampfer gemäß Anspruch 1, **dadurch gekennzeichnet, dass** jeder Behälter (11) mit einer zweiten Einfassungs-Seitenwand (13) ausgestattet ist, die sich nach oben erstreckt, um den darüber liegenden Behälter (11) zumindest teilweise aufzunehmen.

3. Der Verdampfer gemäß einem oder mehreren der obigen Ansprüche, **dadurch gekennzeichnet, dass** die zweite Einfassungs-Seitenwand (13) entlang einer zweiten Längskante des entsprechenden Behälters (11) angebracht ist, die der ersten Längskante gegenüberliegt.

4. Der Verdampfer gemäß einem oder mehreren der obigen Ansprüche, **dadurch gekennzeichnet, dass** die zweite Einfassungs-Seitenwand (13) einen Abschnitt hat, dessen Erstreckung zur Außenseite des entsprechenden Behälters (11) hin schräg ist.

5. Der Verdampfer gemäß einem oder mehreren der obigen Ansprüche, **dadurch gekennzeichnet, dass** die ersten Längskanten der Behälter (11) abwechselnd zu einer Seite des Gehäuses (3) hin oder zur gegenüberliegenden Seite hin gerichtet sind.

6. Der Verdampfer gemäß einem oder mehreren der obigen Ansprüche, **dadurch gekennzeichnet, dass** die Ablassöffnungen (11b) eine Größe haben, die kalibriert ist, um die Menge an flüssigem Kühlfluid, das in jeden Behälter (11) eintritt, mit der Menge an Kühlfluid abzugleichen, das in Dampfform aus jedem Behälter (11) austritt.

7. Der Verdampfer gemäß einem oder mehreren der obigen Ansprüche, **dadurch gekennzeichnet, dass** die Größe der Ablassöffnungen (11b) sich von Behälter zu Behälter unterscheidet.

8. Der Verdampfer gemäß einem oder mehreren der obigen Ansprüche, **dadurch gekennzeichnet, dass** er für jeden Behälter (11) Mittel zur Durchflussregelung umfasst, die sich auf Befehl bewegen können und ausgebildet sind, um die Ablassöffnungen (11b) zumindest teilweise zu beeinflussen.

9. Der Verdampfer gemäß einem oder mehreren der obigen Ansprüche, **dadurch gekennzeichnet, dass** jeder Behälter (11) durch Verblockung auf den darunter liegenden Behälter (11) gestapelt ist, um zumindest für die Tauscherrohre (7) der ersten Gruppe von Tauscherrohren (7) eine Last tragende Struktur zu bilden.

10. Der Verdampfer gemäß einem oder mehreren der obigen Ansprüche, **dadurch gekennzeichnet,**

dass jeder Behälter (1) mindestens eine tragende Trennvorrichtung (16) hat, die mindestens ein Positionierungs-Widerlager für den darüber liegenden Behälter (11) bestimmt.

11. Der Verdampfer gemäß einem oder mehreren der obigen Ansprüche, **dadurch gekennzeichnet, dass** jeder Behälter (11) an seinen Enden, die entlang seiner Längsachse angeordnet sind, welche parallel zur Achse des Gehäuses (3) ist, Einfassungs-Endwände (14) hat, die Aufnahmevorrichtungen (15) für die entsprechenden Tauscherrohre (7) bestimmen.

12. Der Verdampfer gemäß einem oder mehreren der obigen Ansprüche, **dadurch gekennzeichnet, dass** er, innerhalb des Gehäuses (3) und seitlich des Rohrbündels (6), mindestens eine Schutzwand (18) umfasst, die sich nach unten erstreckt und für den Dampf des Kühlfluids, das aus den Behältern (11) austritt, mindestens einen ersten Strömungskanal (18a) bestimmt, der sich nach unten erstreckt und durch das Rohrbündel (6) und die mindestens eine Schutzwand (18) begrenzt ist, und mindestens einen zweiten Strömungskanal (18a), der sich nach oben erstreckt und durch das Gehäuse (3) sowie die Schutzwand (18) begrenzt ist.

13. Der Verdampfer gemäß einem oder mehreren der obigen Ansprüche, **dadurch gekennzeichnet, dass** er unterhalb der ersten Gruppe von Tauscherrohren (7) eine zweite Gruppe von Tauscherrohren (7) umfasst, die dazu dient, die Verdampfung überschüssigen flüssigen Kühlfluids zu veranlassen, das sich im unteren Teil des Gehäuses (3) angesammelt hat.

14. Der Verdampfer gemäß einem oder mehreren der obigen Ansprüche, **dadurch gekennzeichnet, dass** sich im unteren Teil des Gehäuses (3) mindestens ein Ablass (20) für die Extraktion von Öl befindet.

Revendications

1. Évaporateur comportant une enceinte (2) qui est pourvue d'une enveloppe de confinement latérale (3) avec un axe sensiblement horizontal, qui reçoit intérieurement un distributeur (4) d'un fluide de refroidissement et au moins un faisceau de tubes (6), qui est agencé sous ledit distributeur (4) et comporte une pluralité de tubes d'échangeur (7) qui s'étendent de manière sensiblement parallèle à l'axe de ladite enveloppe (3) et sont conçus pour être traversés par un fluide à refroidir, au moins un premier groupe desdits tubes d'échangeur (7) étant agencé le long de rangées qui s'étendent sur des plans sensiblement horizontaux et mutuellement superposés,
dans lequel les tubes d'échangeur (7) de chacune desdites rangées sont agencés dans au moins un plateau (11) respectif, qui est adapté pour collecter le fluide de refroidissement liquide afin de maintenir les tubes d'échangeur (7) de chacune desdites rangées au moins en partie immergés dans ledit fluide de refroidissement liquide, chacun des plateaux (11) ayant, le long d'au moins un premier bord longitudinal, au moins une première paroi latérale de confinement (12) qui est adaptée pour permettre au fluide de refroidissement liquide contenu dans celui-ci de tomber par débordement dans un plateau (11) sous-jacent, **caractérisé en ce que** chaque plateau est pourvu, dans son fond (11a), d'une pluralité d'ouvertures (11b) pour évacuer le fluide de refroidissement liquide, qui sont agencées sur les tubes d'échangeur (7) du plateau (11) sous-jacent afin de permettre au fluide de refroidissement liquide de tomber à partir de chaque plateau (11) sur la surface extérieure des tubes d'échangeur (7) du plateau (11) sous-jacent.

2. Évaporateur selon la revendication 1, **caractérisé en ce que** chaque plateau (11) est pourvu d'une seconde paroi latérale de confinement (13) qui s'étend vers le haut afin de contenir au moins partiellement le plateau (11) sus-jacent.

3. Évaporateur selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** ladite seconde paroi latérale de confinement (13) est agencée le long d'un second bord longitudinal du plateau (11) correspondant qui se situe à l'opposé par rapport audit premier bord longitudinal.

4. Évaporateur selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** ladite seconde paroi latérale de confinement (13) a une portion dont l'extension est inclinée vers l'extérieur du plateau (11) correspondant.

5. Évaporateur selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** lesdits plateaux (11) ont, en alternance mutuelle, les uns à la suite des autres, ledit premier bord longitudinal dirigé vers un côté de ladite enveloppe (3) ou vers le côté opposé.

6. Évaporateur selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** lesdites ouvertures d'évacuation (11b) ont une taille qui est calibrée pour équilibrer la quantité de fluide de refroidissement liquide qui entre dans chaque plateau (11) avec la quantité de fluide de refroidissement qui sort de chaque plateau (11) sous forme de vapeur.

7. Évaporateur selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** la taille

desdites ouvertures d'évacuation (11b) est différente d'un plateau à un autre.

8. Évaporateur selon une ou plusieurs des revendications précédentes, **caractérisé en ce qu'**il comporte, pour chaque plateau (11), des moyens de commande d'écoulement, qui peuvent se déplacer sur instruction et sont adaptés pour affecter au moins partiellement lesdites ouvertures d'évacuation (11b).

9. Évaporateur selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** chaque plateau (11) est monté empilé par interverrouillage sur le plateau (11) sous-jacent afin de fournir une structure porteuse de charge pour au moins les tubes d'échangeur (7) dudit premier groupe de tubes d'échangeur (7).

10. Évaporateur selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** chaque plateau (11) a au moins une séparation de support (16) qui définit au moins une butée de positionnement pour le plateau (11) sus-jacent.

11. Évaporateur selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** chaque plateau (11) a, au niveau de ses extrémités agencées le long de son axe longitudinal qui est parallèle à l'axe de ladite enveloppe (3), des parois d'extrémité de confinement (14) qui définissent des logements (15) pour les tubes d'échangeur (7) respectifs.

12. Évaporateur selon une ou plusieurs des revendications précédentes, **caractérisé en ce qu'**il comporte, à l'intérieur de ladite enveloppe (3) et latéralement audit faisceau de tubes (6), au moins une paroi de protection (18) qui s'étend vers le bas et définit, pour la vapeur dudit fluide de refroidissement qui sort desdits plateaux (11), au moins un premier canal d'écoulement (18a) qui s'étend vers le bas et est délimité entre ledit faisceau de tubes (6) et ladite au moins une paroi de protection (18) et au moins un second canal d'écoulement (18a) qui s'étend vers le haut et est délimité entre ladite enveloppe (3) et ladite paroi de protection (18).

13. Évaporateur selon une ou plusieurs des revendications précédentes, **caractérisé en ce qu'**il comporte, sous ledit premier groupe de tubes d'échangeur (7), un second groupe de tubes d'échangeur (7) qui est conçu pour entraîner l'évaporation du fluide de refroidissement liquide en excès collecté dans la partie inférieure de ladite enveloppe (3).

14. Évaporateur selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** dans la partie intérieure de ladite enveloppe (3), il y a au moins une sortie d'évacuation (20) pour l'extraction d'huile.

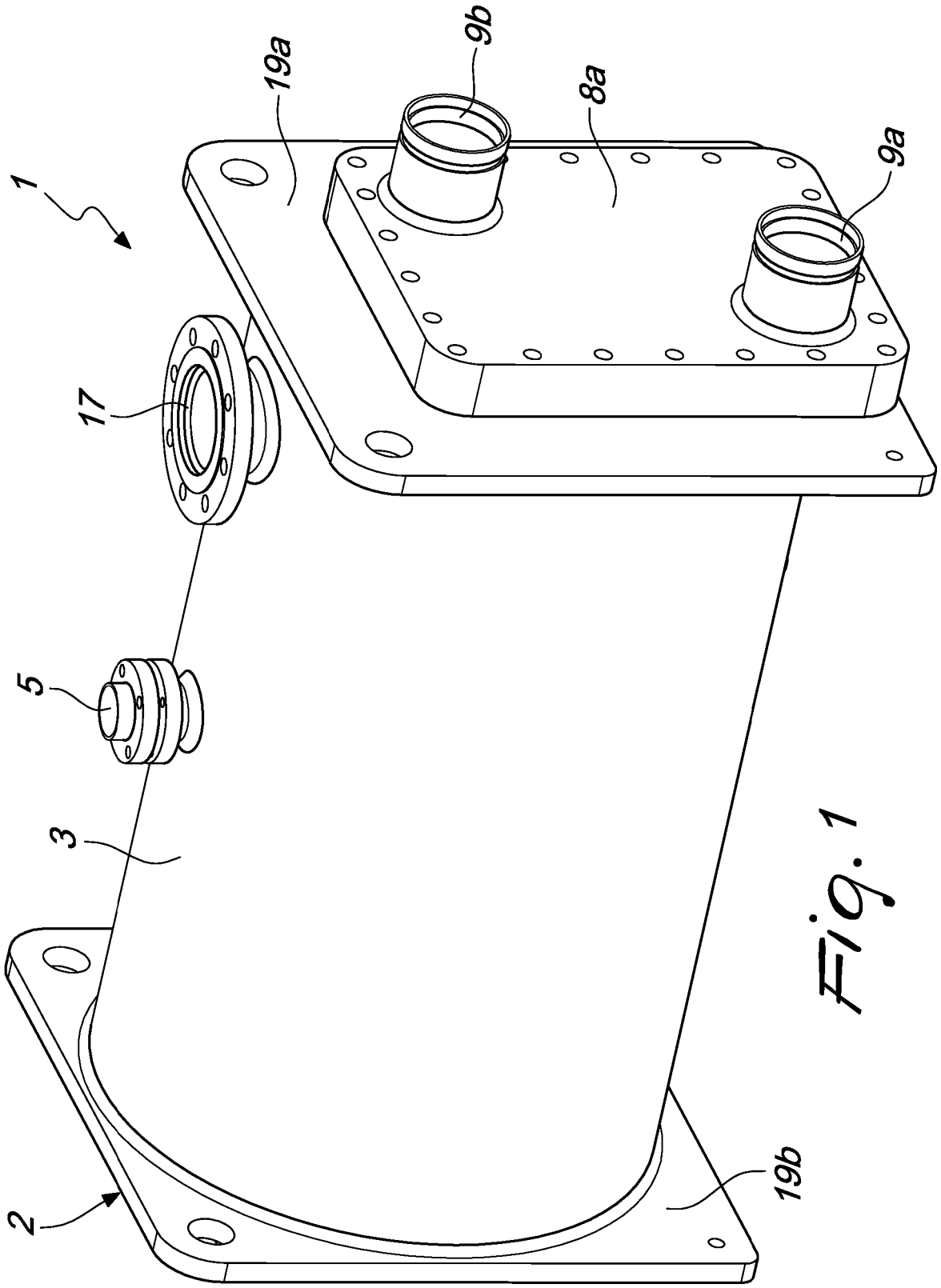

Fig. 1

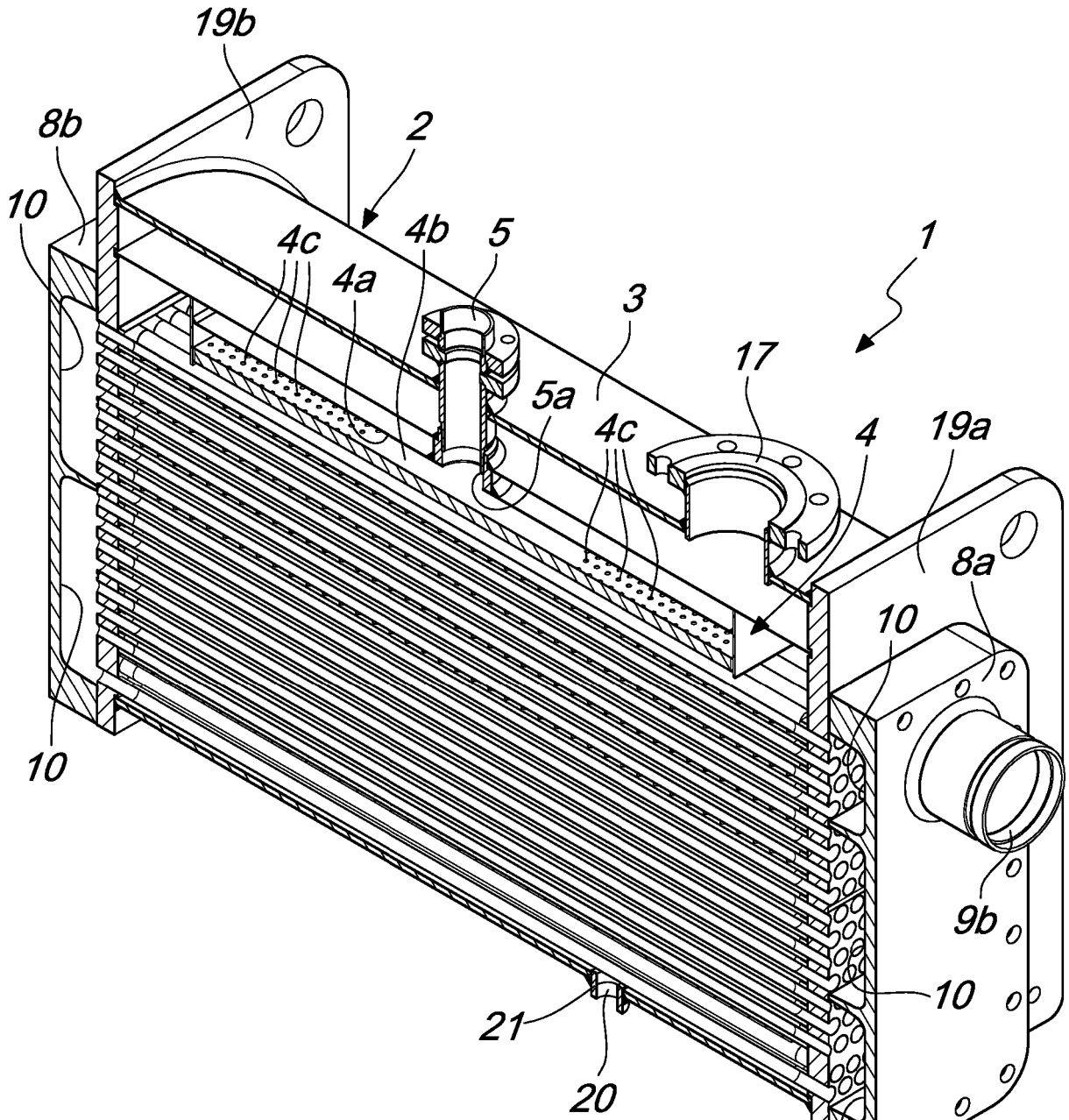

Fig. 2

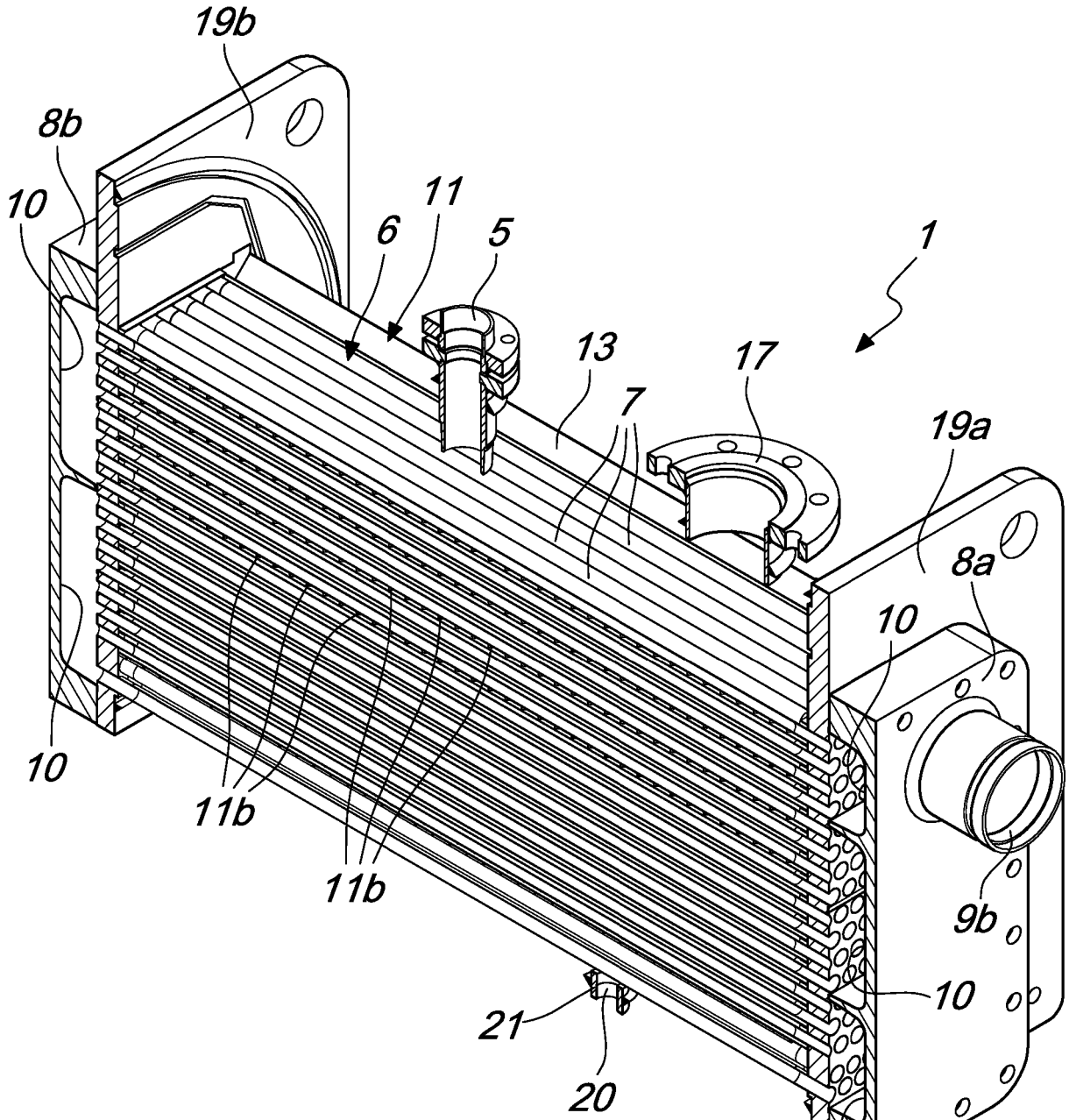

Fig. 3

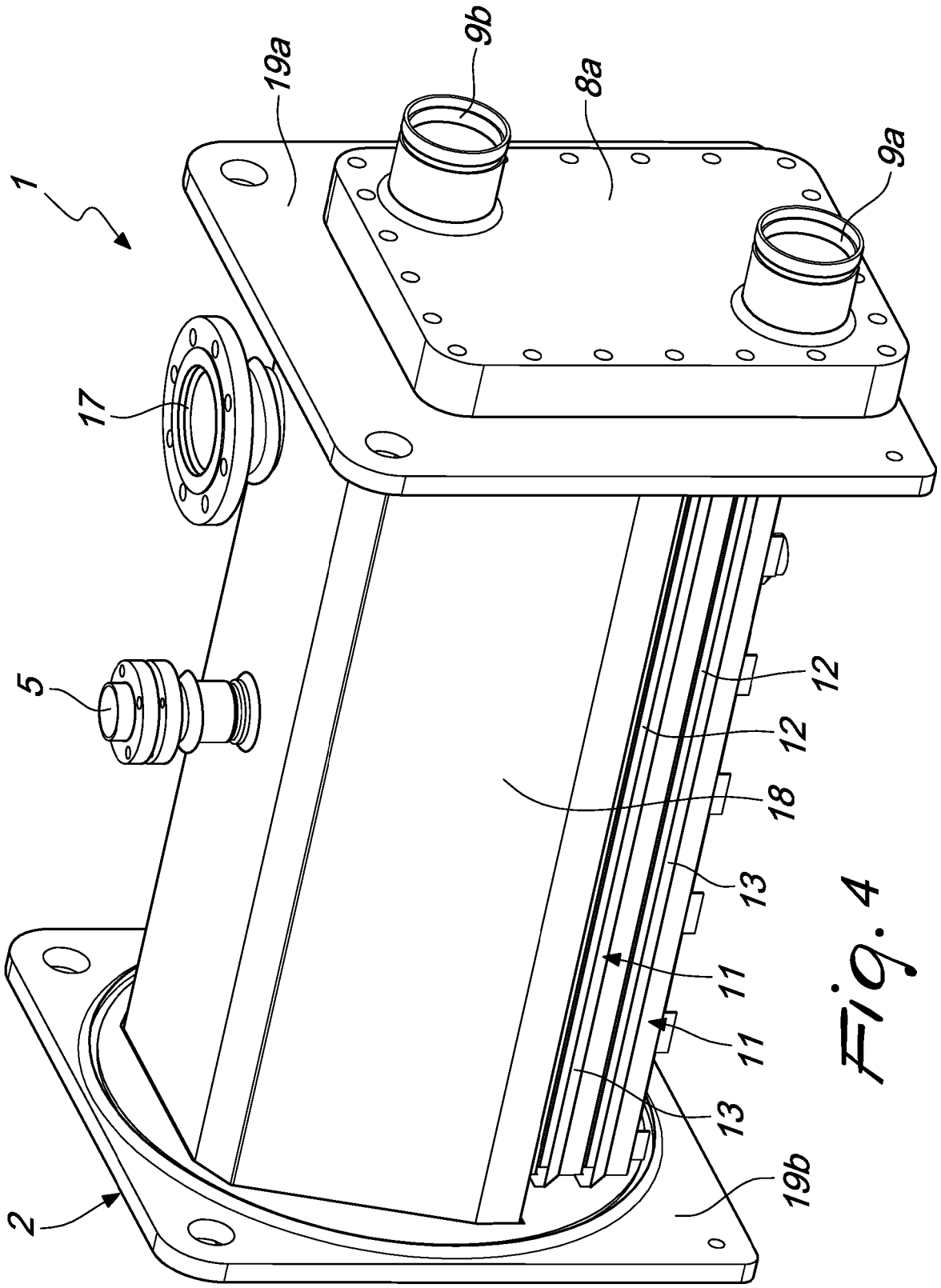

Fig. 4

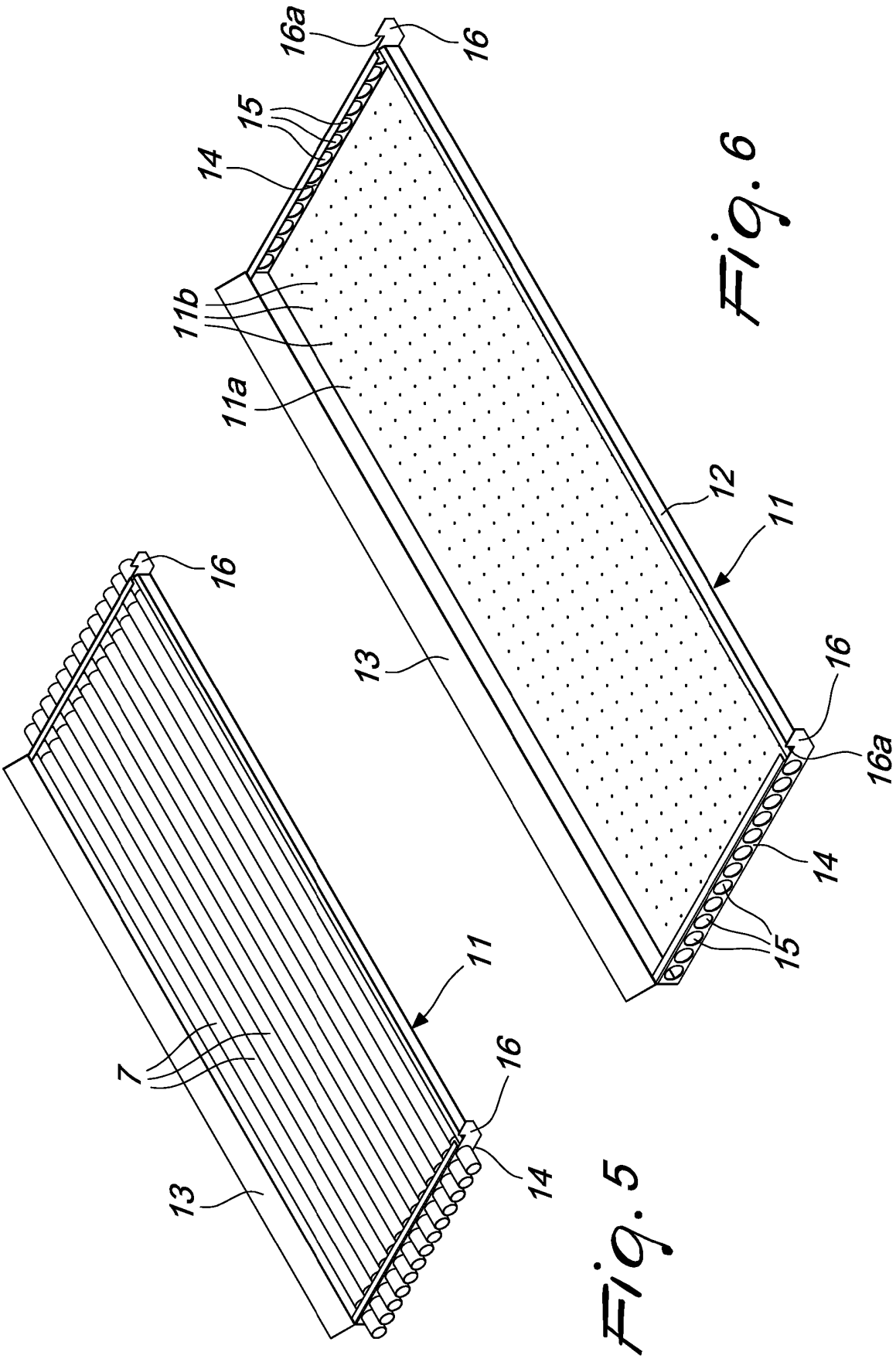

Fig. 6

Fig. 5

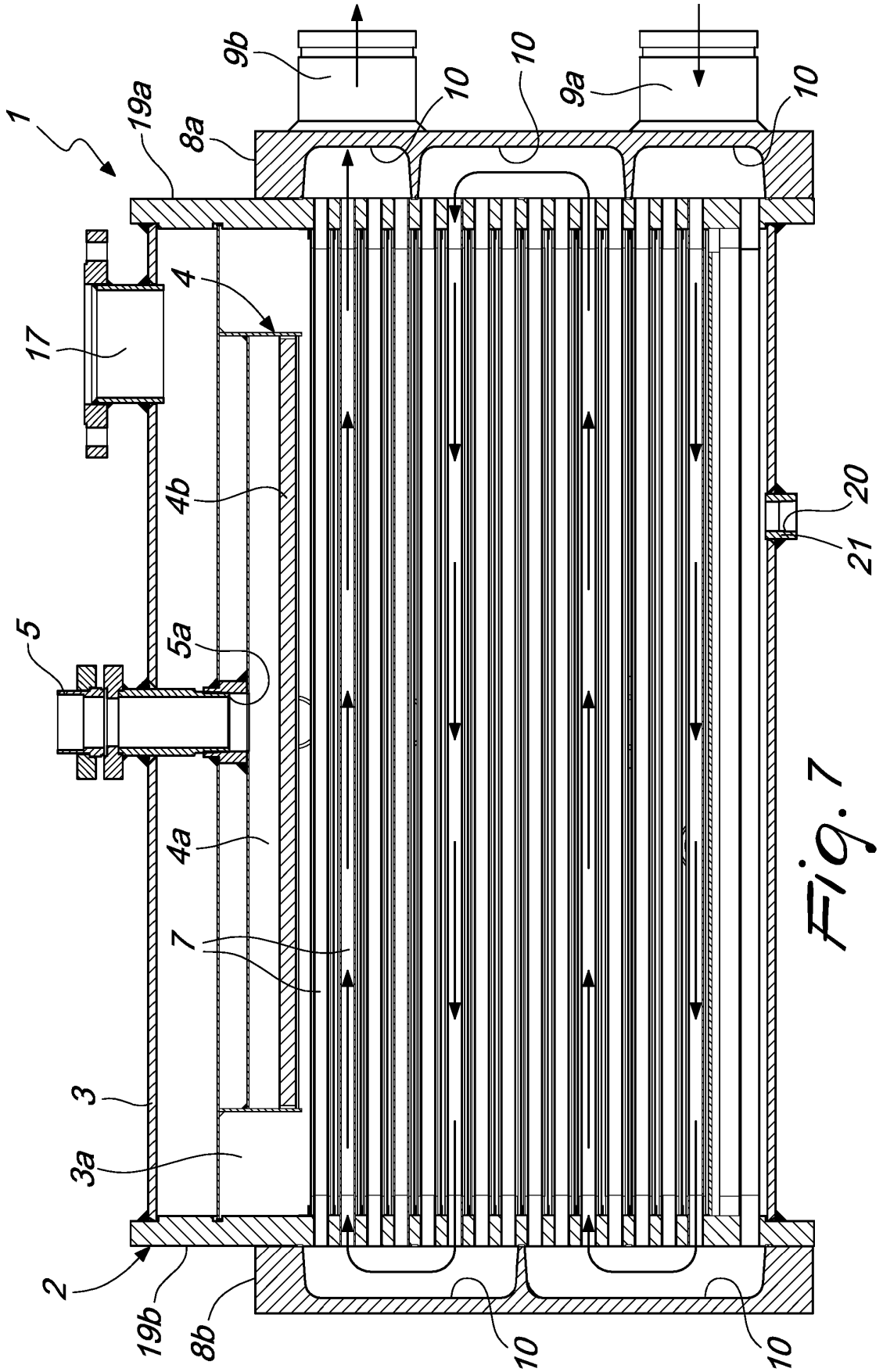

Fig. 7

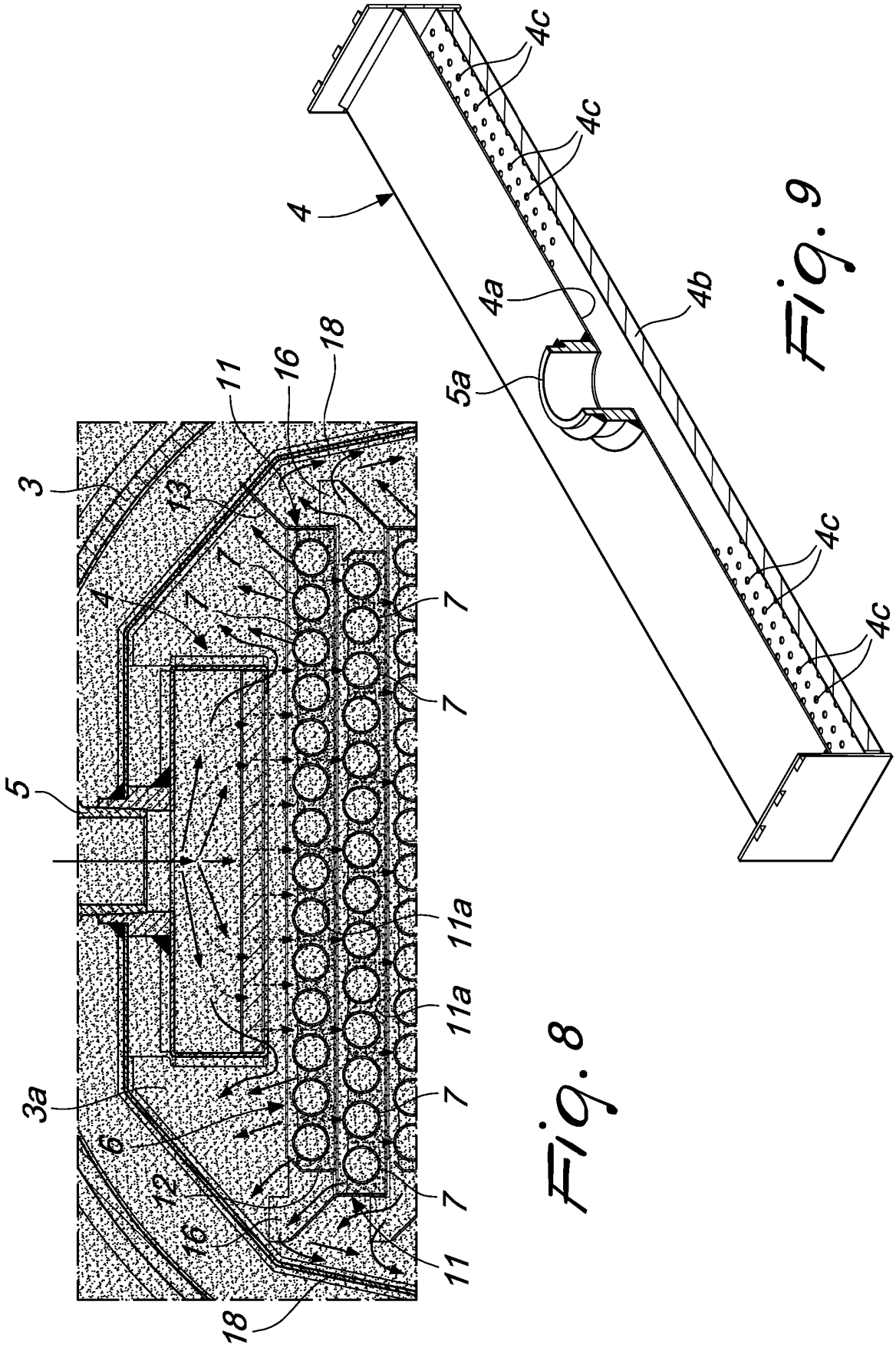

Fig. 8

Fig. 9

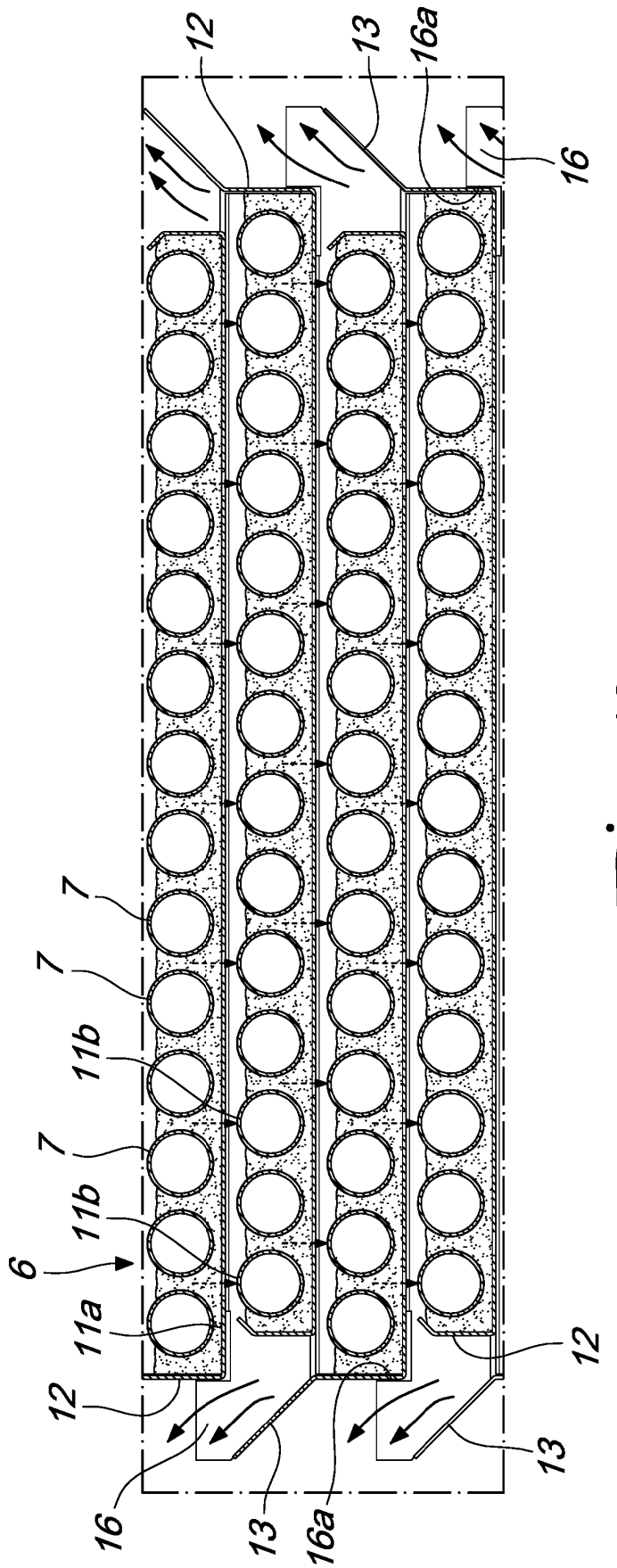

Fig. 10

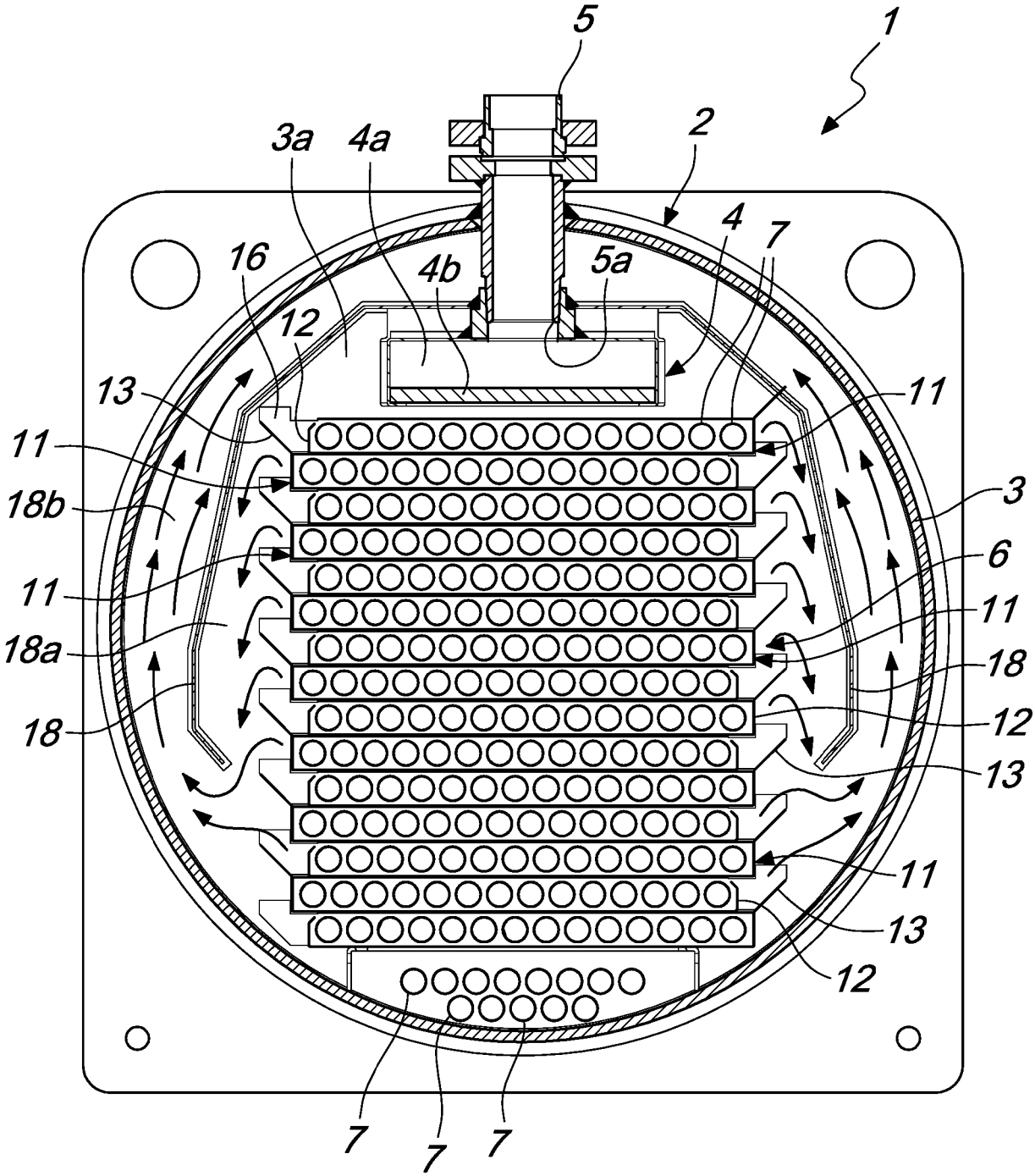
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Fig. 11

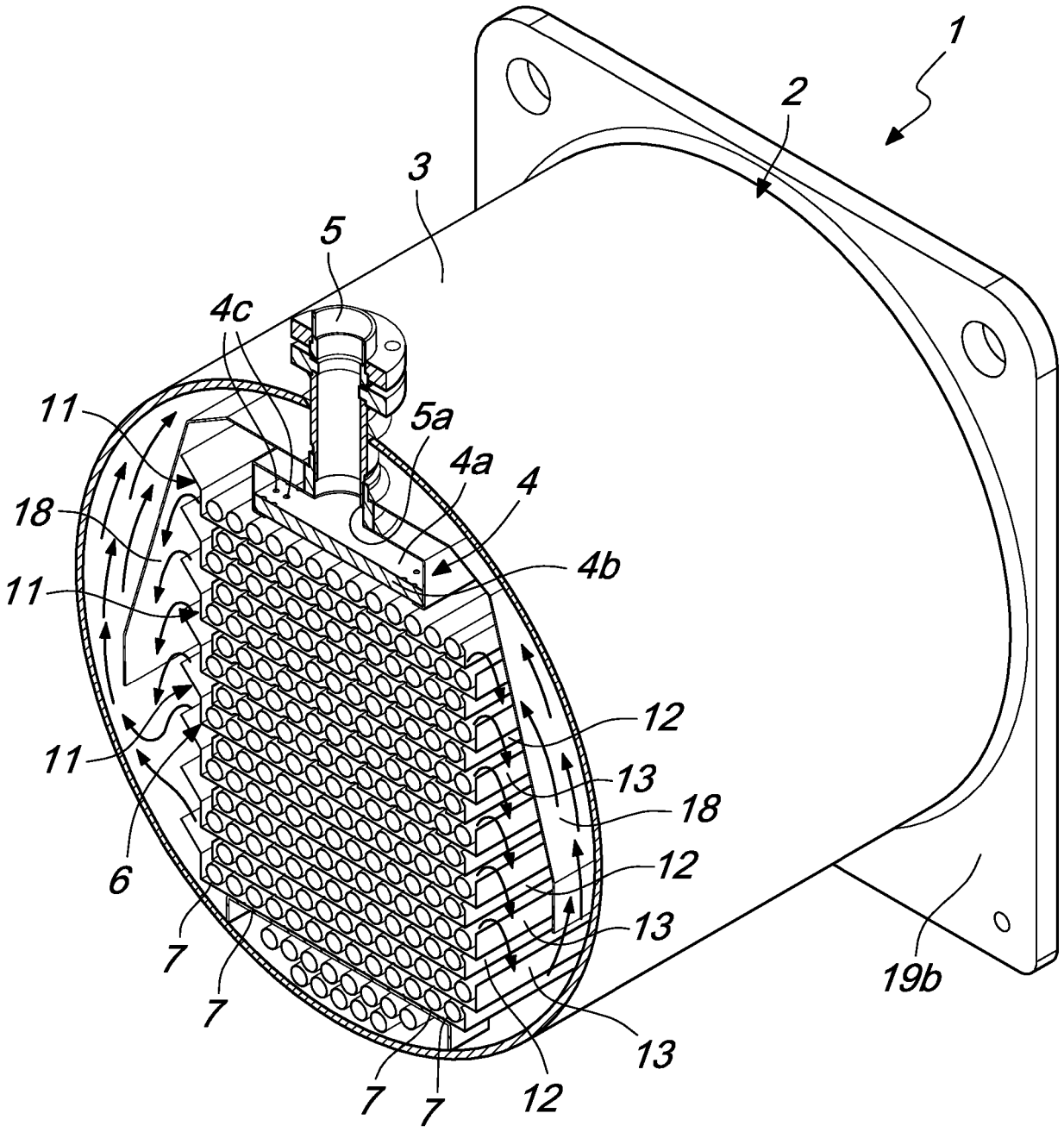

Fig. 12

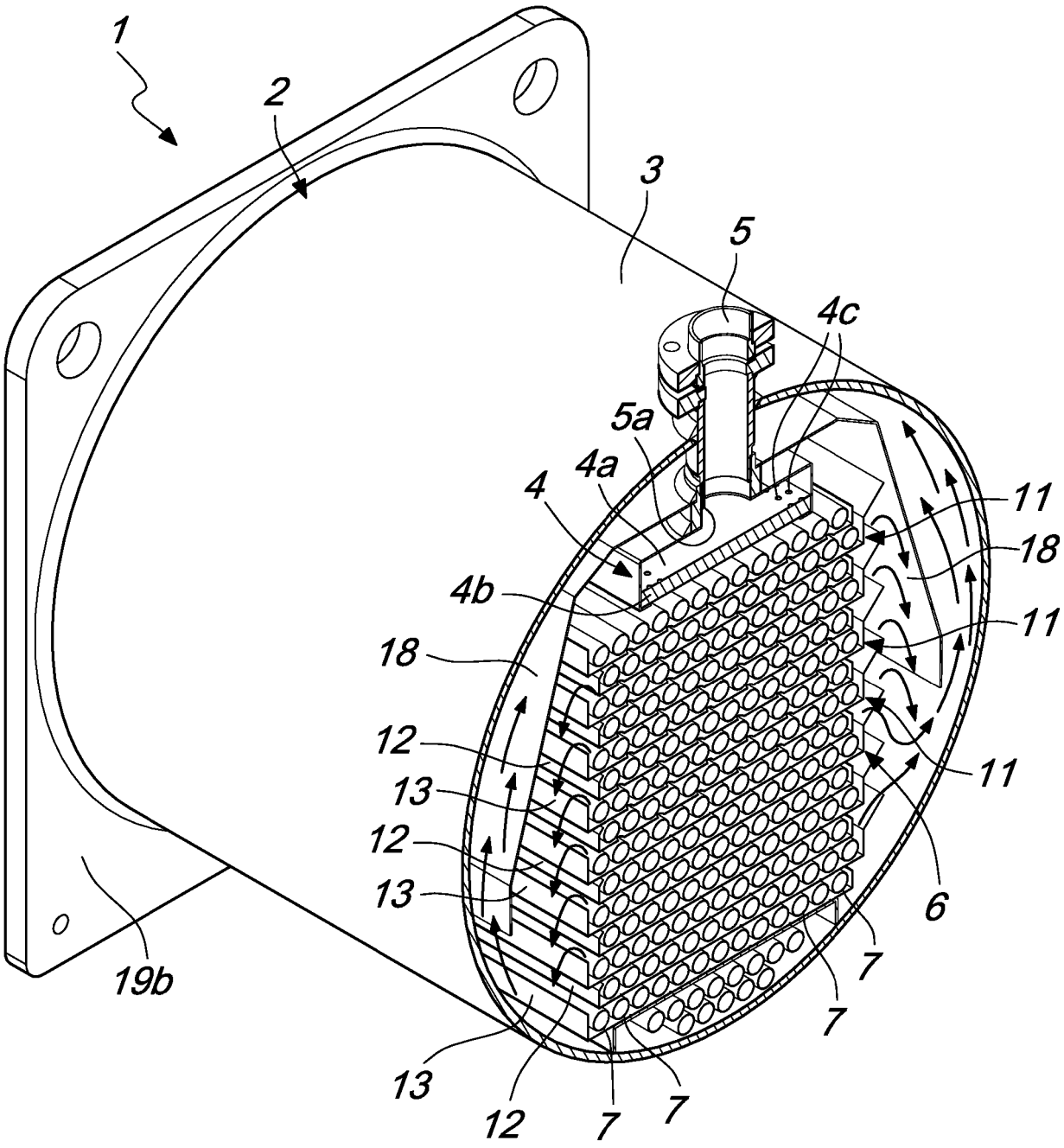

Fig. 13

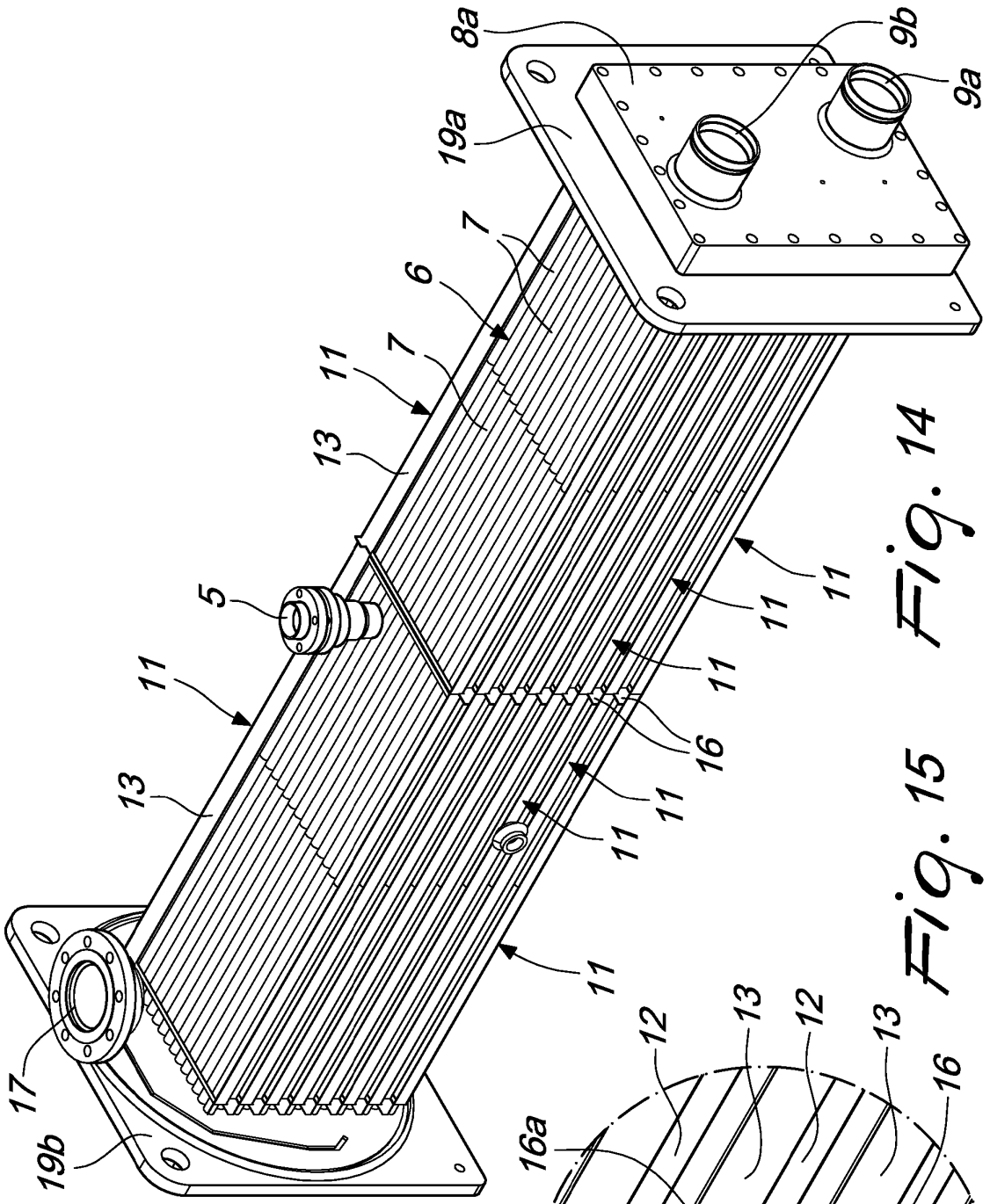
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Fig. 14

Fig. 15

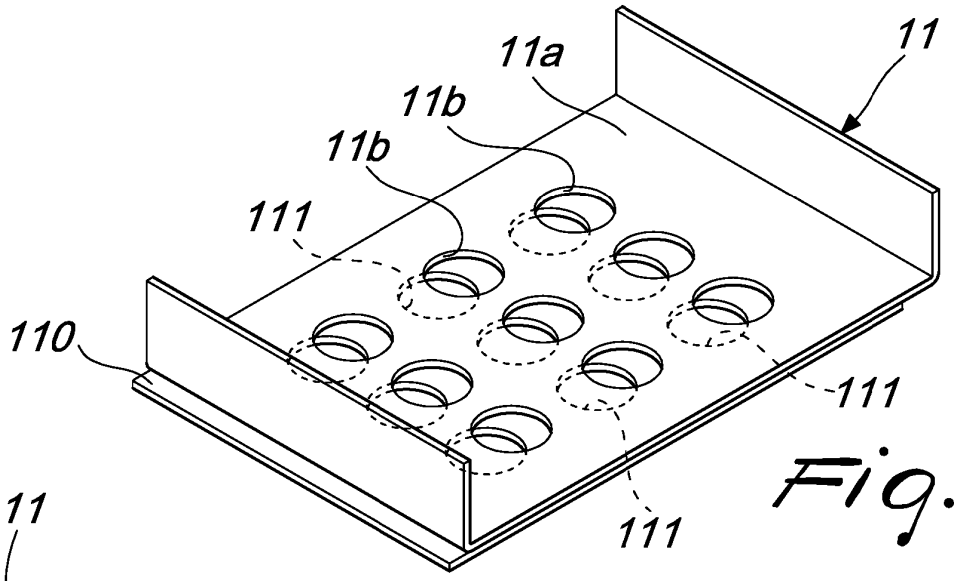

Fig. 16

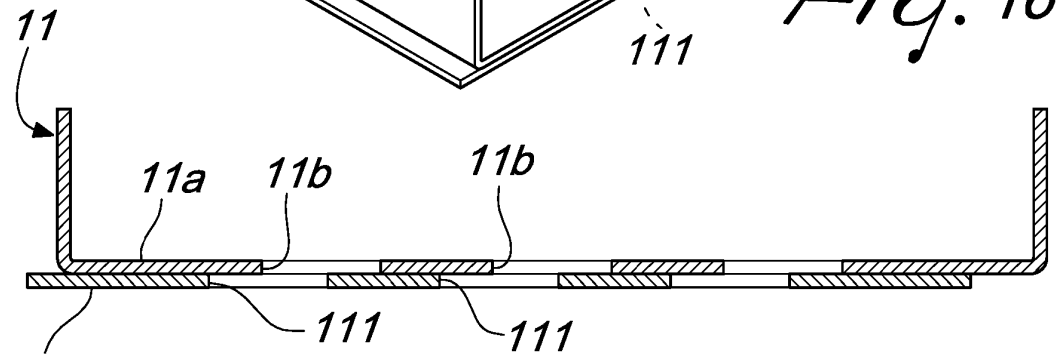

Fig. 17

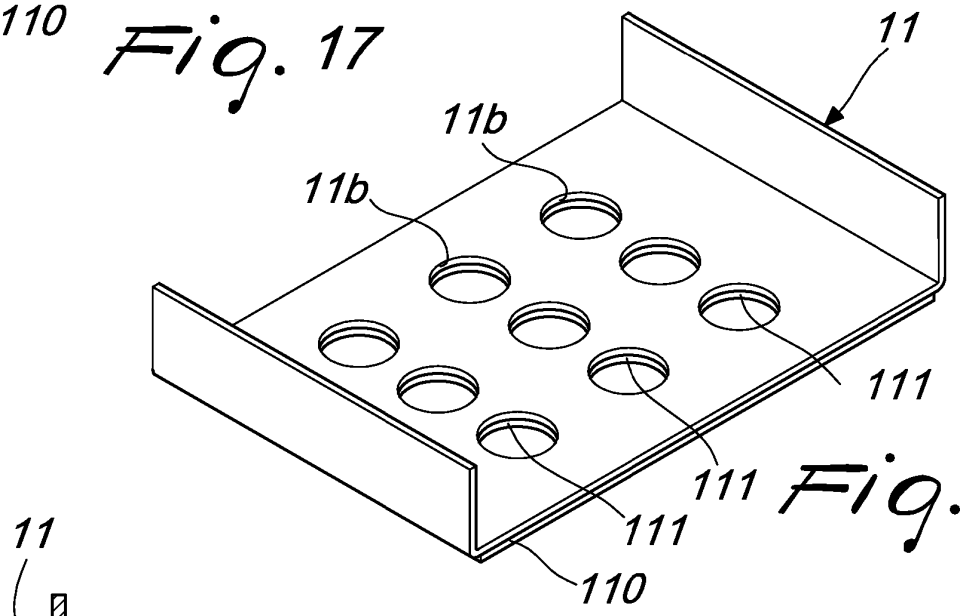

Fig. 18

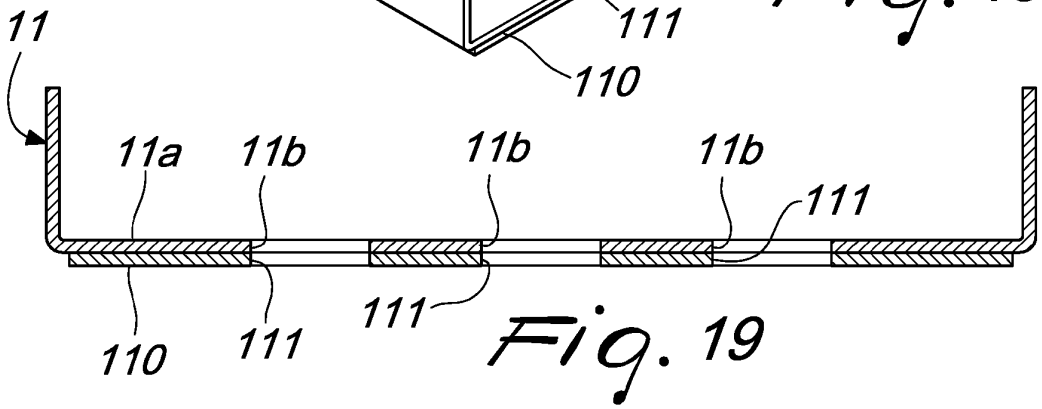

Fig. 19

REFERENCES CITED IN THE DESCRIPTION

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