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(54) **Baffle suitable for evaporators**

(57) The present invention relates to a baffle suitable for evaporators which allows increasing heat transfer in a heat exchanger incorporating a stack of these baffles, since this stack forces the flow of the fluid to be evaporated transverse to the bundle of tubes, particularly according to a helical trajectory with a long path. The helical trajectory of the liquid flow also helps preventing production of stagnation points even in zones where the liquid has not yet evaporated. Baffle manufacture is cost effective because it allows manufacturing by means of stamping. The manufacture of a heat exchanger incorporating a stack of such baffles is also cost effective because of the ease of inserting the baffles within the shell of the exchanger and because there is no need to axially fix the position of each baffle along the tubes through which hot gas, transferring the heat required in the phase change of the fluid to be evaporated, circulates.

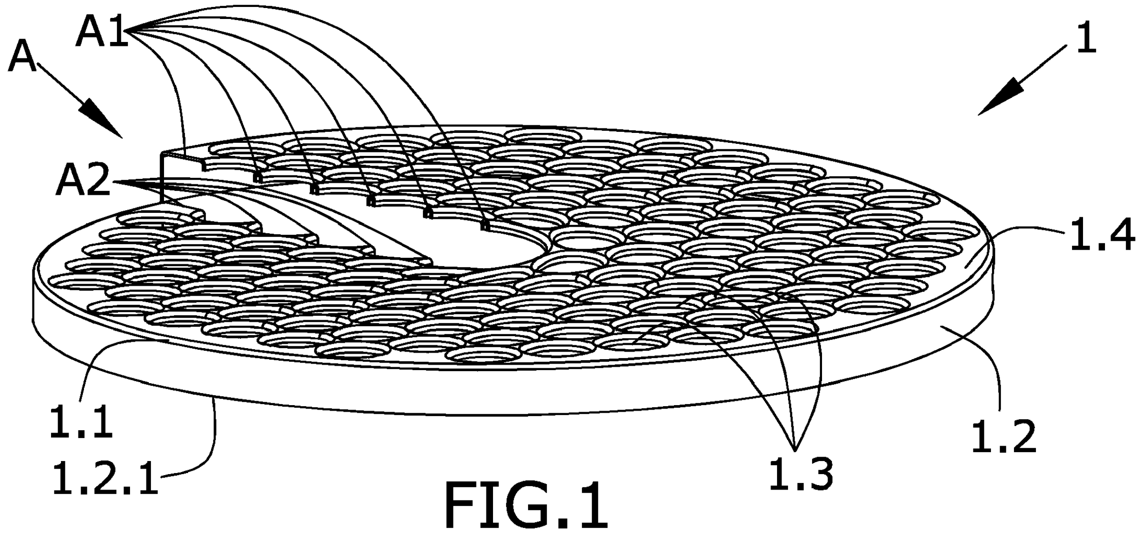

FIG.1

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Description

Object of the Invention

[0001] The present invention relates to a baffle suitable for evaporators which allows increasing heat transfer in a heat exchanger incorporating a stack of these baffles, since this stack forces a flow of the fluid to be evaporated transverse to the bundle of tubes, particularly according to a helical trajectory with a long path.

[0002] The helical trajectory of the liquid flow also helps preventing production of stagnation points even in zones where the liquid has not yet evaporated.

[0003] Baffle manufacture is cost effective because it allows manufacturing by means of stamping. The manufacture of a heat exchanger incorporating a stack of such baffles is also cost effective because of the ease of inserting the baffles within the shell of the exchanger and because there is no need to axially fix the position of each baffle along the tubes through which hot gas, transferring the heat required in the phase change of the fluid to be evaporated, circulates.

Background of the Invention

[0004] One of the most intensively developing fields of technology today is the technology for heat recovery in heat engine vehicles. Heat recovery from exhaust gas is aimed at harnessing the heat from the exhaust gas which would otherwise be discharged into the atmosphere.

[0005] A technique which harnesses said heat from exhaust gases is the technique of incorporating a power cycle where heat transfer from exhaust gases to a specific working fluid is a step within a thermodynamic cycle, the purpose of which is to convert said transferred heat into work.

[0006] Among the particular ways of transferring heat from exhaust gases to a working fluid which is made to follow a thermodynamic cycle include the use of evaporators causing phase change from liquid to vapor in said working fluid.

[0007] The working substance or fluid carrying out the power cycle is usually ethanol. Nevertheless, various fluids can be used as a working fluid, where many of them are organic substances (carbon-based). Other fluids that can also be used as a working fluid can be water or ammonia (NH_3), in this case inorganic substances. The Rankine cycle is an example of performing a thermal cycle applied for converting transferred heat energy into mechanical energy.

[0008] The incorporation of an evaporator in a vehicle has restrictions, such as the space available in the engine compartment for installation or the condition of being a device with a low manufacturing cost. One way to reduce the space occupied by said evaporator and/or the cost is by increasing heat exchange capacity, i.e., increasing turbulence or exchange surface comprised in the evaporator over which hot gas circulates. A bundle of tubes is housed in a shell and immersed in the fluid to which heat is transferred or the fluid to be evaporated. The fluid to which heat is transferred circulates between the tubes of the bundle of tubes and the shell of the heat exchanger housing said bundle of tubes.

[0009] Therefore, to increase efficiency of the heat exchanger and thus reduce the space it occupies, the heat transfer area of the zone through which the working fluid circulates can be increased, such that more heat can be transferred. However, the limitation of the space that can be occupied by the device, and therefore the space available inside the shell, means that the number of tubes cannot be increased to any extent desired.

[0010] To increase the exchange area between a first fluid, i.e., the gas transferring heat, and a second fluid, i.e., the working fluid undergoing phase change, the use of pairs of tubes where each pair of tubes is formed by an inner tube and an outer tube having a larger diameter, arranged coaxially to one another, is also known. A bundle of pairs of tubes thus distributed is housed in a shell such that two possible channels are obtained for the flow of the first fluid. Said two channels are the inside of the inner tubes having a smaller diameter and the space defined between the tubes having a larger diameter and the shell.

[0011] The space defined between the two bundles of tubes allows passage of the working fluid, i.e., the fluid undergoing phase change. The exchange area between the first fluid and the second fluid is therefore the surface of the inner tubes and the surface of the outer tubes.

[0012] Documents DE 102011118164 A1 and DE 102010008175 A1 describe a heat exchanger with this configuration. Additionally, the tubes of the exchanger defined in DE 102010008175 A1 further increase heat transfer between the inner tubes and the outer tubes, because the configuration of the tubes changes along the length thereof.

[0013] It is possible to increase the degree of heat transfer by intercalating baffles in the space existing between the tubes and the inner wall of the shell, for forcing the exchange by increasing convection. These baffles usually incorporate passages in alternating positions, forcing a zig-zag flow. However, one drawback of such baffles is that they require fixing by means of welding at pre-established points of the bundle of tubes, in addition to the production of stagnation zones behind the baffles where the fluid barely reaches or reaches with a very low speed causing very hot points, which increase thermal fatigue and generates structural damage.

[0014] The present invention allows increasing heat exchange by improving convection between the second fluid and the outer surface of the exchange tubes, overcoming the problems identified above by establishing a simple configuration for a baffle which is manufactured by stamping, does not require being welded to the bundle of tubes and considerably increases the degree of heat transfer between the working fluid and the bundle of tubes, while at the same time helps to contain vibrations in the tubular bundle without preventing differential expansions and shrinkages between the shell and the tubes, therefore reducing the level of thermal fatigue of the part.

Description of the Invention

[0015] A first aspect of the present invention relates to a baffle suitable for evaporators. The evaporator for which is the baffle intended comprises a shell housing a bundle of heat exchange tubes. The bundle of tubes allows passage of the first fluid transferring heat, preferably the exhaust gas of an internal combustion engine. The space through which the second fluid or working fluid receiving heat and undergoing a phase change from liquid to vapor flows is arranged between the tubes of the bundle of tubes and the shell. Conventional working fluids are water, coolants, methanol and ethanol. This second fluid has been identified as a working fluid given its main application of being subjected to a thermal cycle for converting the heat absorbed by said second fluid into mechanical work.

[0016] Therefore, the fluid flowing through the bundle of tubes transferring heat will be referred to as the first fluid, and the fluid circulating between the tubes of the bundle of tubes and the shell will be referred to as the second fluid.

[0017] The first aspect of the invention relates to a baffle modifying the trajectory of the second fluid causing it to circulate mainly transverse to the bundle of tubes, increasing convection inside the shell. Considering its structure, the baffle comprises:

- *a main plate having a plurality of perforations for passage of the heat exchange tubes of the evaporator therethrough,*
- *a first support region located on one side of the main plate,*
- *a second support region arranged on the opposite side of the main plate and spaced from the first support region, where the second support region is adapted to allow stacking a second contiguous baffle, being supported on the first support region of the contiguous baffle of the stack; and where the stacking gives rise to a stacking direction,*

and where the main plate has an opening from a central zone to the periphery, having a first edge segment and a second edge segment separated from the first edge segment, configured such that the first edge segment of a baffle is adjacent to the second edge segment of the contiguous baffle in the stack.

[0018] The baffle according to the invention has a configuration which allows it to be stacked together with a contiguous baffle, this stacking giving rise to a duct having a helical trajectory for the working fluid. Each of the baffles allows passage of the bundle of tubes, whereby heat exchange occurs, through the plurality of perforations comprised therein. The first fluid flows according to the direction imposed by the direction of the bundle of tubes and the second fluid follows a mainly transverse trajectory along the helical trajectory configured by the baffles.

[0019] Said helical trajectory is obtained by stacking a plurality of baffles. Each of the baffles has a first support region and a second support region, both regions being spaced from one another. This spacing generates a channel between consecutive baffles. Each baffle contributes to an angular sector of the trajectory of the second fluid. In the embodiments, this angular sector is 360°, assuring continuity between baffles of the helical trajectory along the heat exchanger. Said continuity is established by the edge condition imposed according to the last structural technical feature indicated above, whereby the first edge segment and the second edge segment of the opening are such that they also give rise to the adjacency of the edges in baffles arranged adjacent to one another in the stack. Said condition forces the entire flow to follow the entire helical trajectory, from the inlet until reaching the outlet, with a direction of movement essentially transverse to the tubes.

[0020] Likewise, stagnation points which usually appear behind a baffle are eliminated, since the helical flow circulates parallel to the surface of the main plate. The baffle is not interposed perpendicular to the main flow for deflecting said flow, rather it acts as a guide to impose a flow parallel to it, following the described helical trajectory.

[0021] Stacking of the baffles means that, if the space occupied by the stack is limited at the ends thereof, then it will be unnecessary to fix each of the baffles to the bundle of tubes. In this case, arranging a stop or limiting element maintaining the packing resulting from the compact stack in at least one of the ends of the stack is sufficient. In the embodiments, seat rings are included at both ends, which rings are adapted to the helical configuration with which the stack of baffles finishes, such that the baffles of the stack are kept compact and therefore in contact at all times.

[0022] Therefore, the manufacture of this heat exchanger only requires inserting a plurality of baffles such as those of the present invention, correctly oriented such that the edges of the openings coincide with one another. In this regard, the perforations allowing passage of the tubes of the bundle of tubes serve as guides facilitating assembly and orientation of each of the baffles, thus also facilitating the manufacture of the heat exchanger from these baffles.

Description of the Drawings

[0023] The foregoing and other advantages and features of the invention will be more clearly shown based on the following detailed description of a preferred embodiment given only by way of illustrative and non-limiting example in reference to the attached drawings.

Figure 1 shows a perspective view of an embodiment of the baffle object of the invention.

Figure 2 shows an elevational view of a stack with three baffles according to the embodiment shown in the preceding figure.

Figure 3 shows an exploded perspective view of the components of an embodiment of an evaporator incorporating a stack of baffles such as those shown in the preceding figures.

Figure 4 shows an elevational section view of the evaporator of the preceding figure, where the bundle of tubes has been eliminated to allow observing the stack of baffles as well as its constructive details.

Figure 5 shows the elevational section view of the preceding figure without eliminating the inner components of the evaporator, such as the bundle of tubes.

Figure 6 shows a perspective view of an embodiment of the baffle object of the invention where the surface of the perimetral skirt has grooves to facilitate insertion in the shell.

Detailed Description of the Invention

[0024] According to the first inventive aspect, the present invention relates to a baffle (1) for evaporators. Figure 1 shows a perspective view of an embodiment of the baffle (1), and Figure 2 shows an elevational view of a stack of three baffles such as those shown in Figure 1.

[0025] The evaporator for which the baffle (1) according to the invention, and particularly the baffle (1) according to this embodiment, is suitable comprises, as shown in Figures 3, 4 and 5:

- a shell (2),
- a bundle of heat exchange tubes (3) housed in the shell (2), extending according to a longitudinal direction X-X', provided for the circulation of a first fluid, there being a space between the outer surface of the heat exchange tubes (3) and the shell (2) for passage of a second fluid, intended for being evaporated by heat transfer from the first fluid to the second fluid, and
- a plurality of baffles (1) such as the baffles of the first inventive aspect, distributed such that they form a stack where the stacking direction coincides with the longitudinal direction X-X' and with the bundle of heat exchange tubes (3) going through the baffles through perforations (1.3).

[0026] Said Figures 3 to 5 show an embodiment of the evaporator. The baffles (1) according to the invention are such that the stacking thereof establishes a helical conduit for the second fluid inside the evaporator.

[0027] Considering the configuration details of the baffle (1), Figures 1 and 6 show the perspective views of a baffle (1) according to different embodiments, manufactured in stamped sheet metal. The baffle (1) is formed by a main plate (1.4) comprising a plurality of perforations (1.3) adapted for passage of the tubes (3) of the bundle of tubes of the exchanger.

[0028] The main plate (1.4) has a helical warped surface. The helical surface starts from a first edge segment (A1), which in this embodiment extends according to a radial direction and furthermore extends according to the clockwise direction of rotation, considering the particular orientation shown in Figure 1, until reaching a second edge segment (A2), which also extends according to a radial direction.

[0029] Both the helical shape and the perforations (1.3) of the main plate (1.4) have been obtained by stamping.

[0030] The perimetral edge of the helical surface segment of the main plate (1.4) extends towards the inner portion, also considering the particular orientation of Figures 1 and 2, by means of a skirt-like cylindrical surface (1.2). In other words, it extends parallel to the direction defined by stacking a plurality of baffles (1) and which in this embodiment is essentially perpendicular to the main plate (1.4) given the reduced helical feed of the helical surface. Nevertheless, it is possible to carry out the invention with main plates having greater helical pitch. In these cases, the axis defined by the stack continues to be the longitudinal reference.

[0031] In this embodiment, the cylindrical surface (1.2) extends along the entire perimetral edge of the main plate (1.4) with a constant width. According to other embodiments, the cylindrical surface (1.2) extends according to two or more perimetral edge segments of the main plate (1.4). This cylindrical surface (1.2) is intended for being completely or partially supported in the inner wall of the shell (2) of the evaporator.

[0032] According to another embodiment shown in Figure 6, the cylindrical surface (1.2) shows a plurality of grooves (12) parallel to the direction defined by stacking a plurality of baffles (1) such that there is a tab between consecutive grooves. This configuration facilitates inserting the baffles (1) inside the shell (2) and therefore assembling them. Another technical effect of this configuration is the improved adaptation of the periphery of the baffle (1) to the inner surface of the shell (2) at each point such that better sealing between the baffle (1) and the shell (2) is achieved, preventing passage of fluid between both components.

[0033] The perimetral edge of the main plate (1.4) has a first support region (1.1), which in this embodiment is located on one of the faces of the main plate (1.4). The cylindrical surface (1.2) extends in the opposite direction from the opposite face of the main plate (1.4), such that the free edge of this cylindrical surface (1.2) is the second support region (1.2.1).

[0034] The cylindrical surface (1.2) according to this embodiment establishes a spacing between the first support region (1.1) and the second support region (1.2.1).

[0035] Figure 2 shows a stack of three baffles (1) according to one embodiment. All the baffles (1) in this stack have the same configuration, so it is not necessary to manufacture different types of baffles (1) according to their axial or longitudinal position, axial or longitudinal direction being understood as the direction defined by stacking. This longitudinal direction is identified in Figure 2 by means of axis X-X'.

[0036] Each of the baffles (1) comprises an opening (A). In the embodiment, this opening (A) is a radial cut of the main plate (1.4) traversing some perforations (1.3). For that reason, the radial cut is not a straight cut but rather interrupted segments of cuts in the material located between the perforations (1.3). The radial cut as well as deformation by stamping generate the first and second edge segment (A1, A2). Deformation by stamping separates the edge segments (A1, A2) from one another according to the stacking direction.

[0037] In this example, stacking causes the overlapping of a plurality of baffles (1) such that the orientations of the openings (A), in the embodiment the orientation is determined by the radial cut, coincide with one another according to the projection of axis X-X'. Given that the helical surface formed by the main plate (1.4) extends 360°, the first edge segment (A1) of a baffle (1) coincides with the second edge segment (A2) of the contiguous baffle, establishing surface continuity defining the main plate (1.4) of both baffles (1). Since this condition of continuity occurs between each of the consecutive baffles (1), the plurality of main plates (1.4) forms a continuous helical surface, with the perforations (1.3) in alignment for passage of the bundle of tubes (3) through said perforations (1.3), following the stacking direction.

[0038] The helical surface formed by the stack of baffles (1) establishes a helical path for the second fluid, which is essentially perpendicular to the tubes (3) arranged in the path thereof.

[0039] Both liquid phase and gas phase exist during phase change. The horizontal is the most unfavorable orientation with respect to the direction of the gravitational force, since the liquid phase tends to be at a lower point of the path. Even under these circumstances, the helical movement of the second fluid does not have stagnation points and carries away the condensates accumulated in the lower portions preventing accumulation.

[0040] In this embodiment where there are perforations (1.3) coinciding with the opening (A), the first edge segment (A1) and the second edge segment (A2) are discontinuous. This is the result of generating the opening (A) through a radial cut going through perforations (1.3) during a die-cutting and stamping operation. In this case, the tubes (3) going through the perforations (1.3) are surrounded by the edge generated by half the perforation (1.3) of the main plate (1.4) of a baffle (1), and by the edge generated by half the perforation (1.3) of the main plate (1.4) of the contiguous baffle.

[0041] According to a particular embodiment, the cylindrical surfaces (1.2) also result in a continuous cylindrical surface. Figure 2 shows the resulting continuous cylindrical surface and the support of the first support region (1.1) on the second support region (1.2.1). In this stack, the width of the cylindrical surface (1.2) of each baffle (1) defines the spacing between the baffles (1) and therefore the height of the section of the helical duct generated by stacking. In the particular case of using a baffle (1) with grooves (12), the cylindrical surface (1.2) is still considered a continuous surface with the exception that it has a plurality of grooves (12) on the surface thereof.

[0042] Figure 3 shows an exploded perspective view of the components of an evaporator according to an embodiment where the bundle of tubes (3) goes through a stack of baffles (1) such as the one described. This drawing clearly shows the cylindrical surface generated by stacking a plurality of baffles (1). As shown in Figure 4, this cylindrical surface is supported in the inner wall of the shell (2). The stack of baffles (1) is preferably not welded to the tubes (3) although this may be the case in a particular example. In this particular case, a seat ring (9, 11) has been included at each end of the stack of baffles (1) configured according to the helical perimetral shape.

[0043] The bundle of tubes (3) extends between a first end baffle (4) and a second end baffle (5), both in the shape of a circular plate with a cylindrical seat in the periphery thereof for closing on the inner wall of the shell (2). The bundle of tubes (3) is welded by brazing or any other techniques of attachment, to the end baffles (4, 5).

[0044] Figures 4 and 5 show a gap between the first end baffle (4) and the seat ring (11) such that between the stack of baffles (1) and said end baffle (4) there is a first chamber (C1) which is accessible to the second fluid through an inlet (2.1) located in this embodiment in the shell (2) and with direct access to the bundle of tubes (3). In this first chamber (C1) the second fluid is distributed along the transverse section of the bundle of tubes (3) and is forced to enter the helical duct configured by the stack of baffles (1).

[0045] The access for the entry or exit of the first fluid at this end of the heat exchanger is through a first manifold (10), which in this case is shown with a flange (10.1) for attachment to the duct of the first fluid. Said access will be for the entry or exit depending on if the evaporator works in co-current flow or counter-current flow.

[0046] Considering the opposite end of the exchanger, said end is the end of the trajectory of the second fluid after said second fluid travelled through the helical path imposed by the stack of baffles (1). Said second fluid expands after the phase change it undergoes along the travel thereof through the heat exchanger, so a second chamber (C2) that is larger than the first chamber (C1) is configured for receiving the evaporated second fluid.

[0047] This second chamber (C2) is formed inside a second manifold (8) having a larger diameter than the shell (2). This second manifold (8) is not only adapted for receiving the evaporated second fluid but also for housing a third manifold (7) in the central position according to longitudinal axis X-X', receiving the first fluid at the end of the bundle of tubes (3).

[0048] Given that the shell (2) undergoes size changes due to thermal expansion, which changes are different from the size changes the bundle of tubes (3) undergoes, the core of the heat exchanger formed mainly by the bundle of tubes (3) is connected to the end of the heat exchanger by means of a compressible bellows (6) with axial deformation capacity. The bellows (6) establishes a fluid communication between the end of the third manifold (7) and the end of the second manifold (8). Therefore, one of the ends of the bundle of tubes (3) is in the third manifold (7) and the latter is linked to the second manifold (8) by means of the bellows (6) without there being any fluid communication between the inside of the third manifold (7) and the inside of the second manifold (8) to prevent the two fluids from being in direct contact. The second chamber (C2) is mainly defined as the space between the third manifold (7) arranged inside the second manifold (8), and said second manifold (8).

[0049] In this embodiment, the outlet (8.1) of the second fluid is located in this second manifold (8).

[0050] The first fluid firstly exits through the third manifold (7), then going through the compressible bellows (6) and finally leaving the second manifold (8), which is communicated with the duct of the first fluid of the internal combustion engine by means of a flange (8.2).

[0051] The second fluid is in more direct contact with the shell (2). Heat losses occurring through the shell reduce the effective heat transferred from the first fluid to the second fluid and therefore reduce the overall performance of the heat exchanger. According to one embodiment, the shell (2) is insulated by being surrounded by an insulating material, such as rock wool. According to another embodiment, the shell (2) is located inside a second shell such that there is an air chamber between both shells (2) performing the function of thermal insulation, reducing heat leakage.

Claims

1. A baffle (1) suitable for heat exchangers, particularly of the type provided for the circulation of a first fluid carried through the inside of a plurality of heat exchange tubes and a second fluid circulating through the outside of the heat exchange tubes, to cause the evaporation of the second fluid by heat transfer from the first fluid to the second fluid, wherein said baffle comprises:

- a main plate (1.4) having a plurality of perforations (1.3) for passage of the heat exchange tubes of the evaporator therethrough,
- a first support region (1.1) located on one side of the main plate (1.4),
- a second support region (1.2.1) arranged on the opposite side of the main plate (1.4) and spaced from the first support region (1.1), wherein the second support region (1.2.1) is adapted to allow stacking a second contiguous baffle, being supported on the first support region (1.1) of the contiguous baffle of the stack, and where the stacking gives rise to a stacking direction,

and wherein the main plate (1.4) has an opening (A) from a central zone to the periphery, having a first edge segment (A1) and a second edge segment (A2) separated from the first edge segment (A1), configured such that the first edge segment (A1) of a baffle is adjacent to the second edge segment (A2) of the contiguous baffle in the stack.

2. The baffle (1) according to claim 1, wherein the main plate (1.4) is configured according to a helical surface.

3. The baffle (1) according to any of the preceding claims, wherein the two edge segments (A1, A2) are separated according to the stacking direction.

4. The baffle (1) according to any of the preceding claims, wherein the main plate (1.4) is a circular disk and the opening (A) is configured by means of a radial cut of the main plate (1.4).

5. The baffle (1) according to any of the preceding claims, wherein the opening (A) goes through one or more of the perforations (1.3).

6. The baffle (1) according to any of the preceding claims, wherein the perimetral edge of the main plate (1.4) is prolonged according to a cylindrical surface (1.2) at least in a segment of the periphery thereof, such that the second support region (1.2.1) is the free edge of said cylindrical surface (1.2).

7. The baffle (1) according to claim 6, wherein the cylindrical surface (1.2) has a constant width along the entire periphery of the main plate (1.4).

8. The baffle (1) according to claim 6 or 7, wherein the cylindrical surface (1.2) has grooves, leaving tabs between the grooves (12).

9. An evaporator comprising:

- a shell (2),
- a bundle of heat exchange tubes (3) housed in the shell (2) extending according to a longitudinal direction X-X', provided for the circulation of a first fluid, there being a space between the outer surface of the heat exchange tubes (3) and the shell (2) for passage of a second fluid intended for being evaporated by heat transfer from the first fluid to the second fluid, and
- a plurality of baffles (1) according to any of the preceding claims, distributed such that they form

a stack wherein the stacking direction coincides with the longitudinal direction X-X' and with the bundle of heat exchange tubes (3) going through the perforations (1.3) thereof,

such that the stack of baffles (1) establishes a helical conduit for the second fluid.

10. The evaporator according to claim 9 and any of claims 6 to 8, **characterized in that** the cylindrical surface (1.2) of the stacked baffles (1) configures a surface arranged against the inner wall of the shell (2).

11. The evaporator according to any of claims 9 to 10, wherein the bundle of heat exchange tubes (3) is attached at a first end to a first end baffle (4) integral with the shell and the opposite end of the bundle is attached to a second end baffle (5), wherein this second end baffle (5) is a floating baffle.

12. The evaporator according to claim 11, where the floating end of the bundle of heat exchange tubes (3) is attached to the shell (2) by means of a compressible bellows (6) to compensate for thermal expansion effect.

13. The evaporator according to any of claims 9 to 12, wherein the perforations (1.3) of the baffles (1) are configured for being arranged against the heat exchange tubes (3).

14. The evaporator according to any of claims 9 to 13, wherein at one end of the stack of baffles (1) there is arranged a seat ring (11) adapted to the shape of the baffle (1) on which the support is established for spacing the stack of baffles (1) and the first end baffle (4) to give rise to a chamber.

15. The evaporator according to any of claims 9 to 14, wherein the shell (2) is thermally insulated.

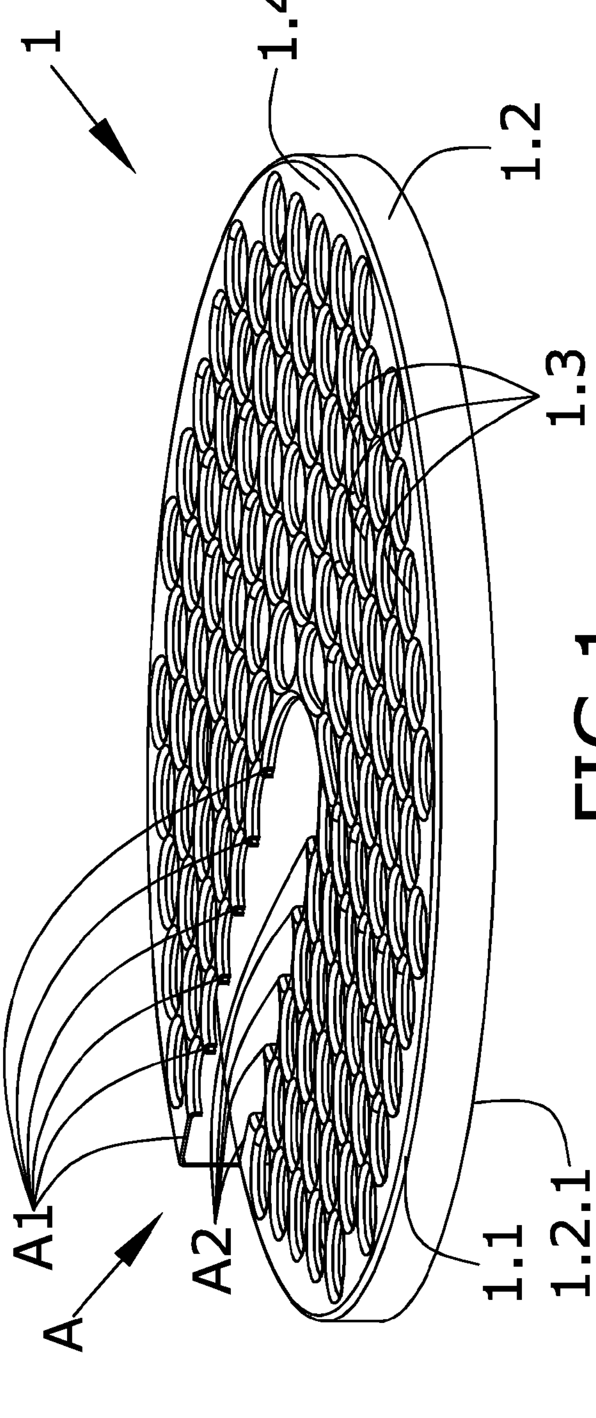

FIG.1

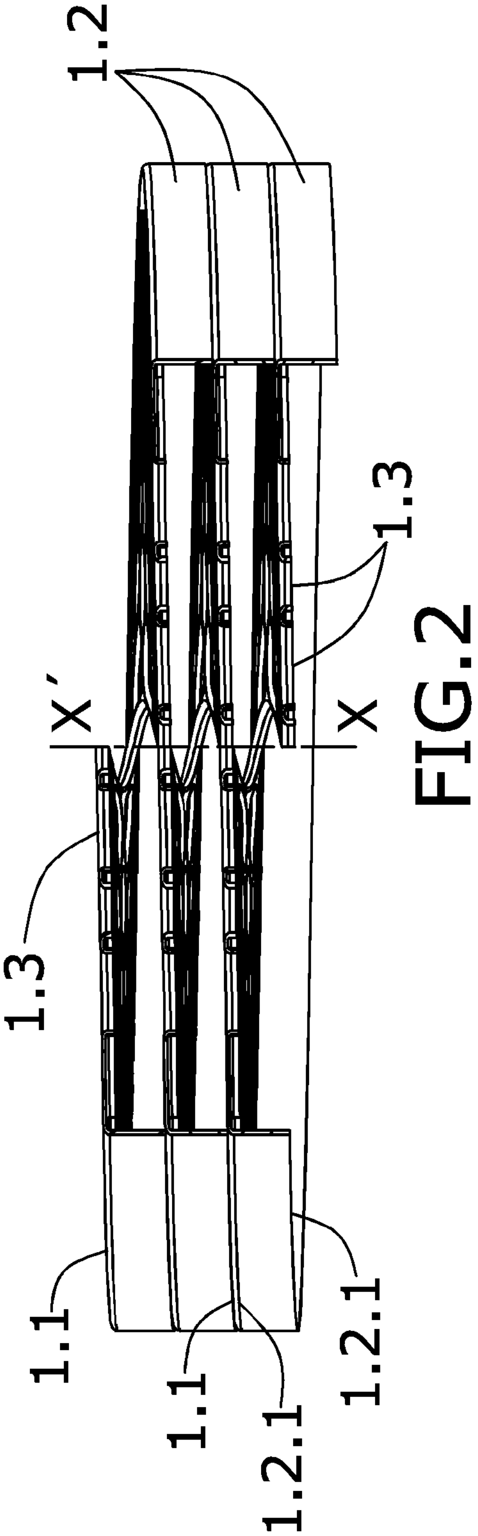

FIG.2

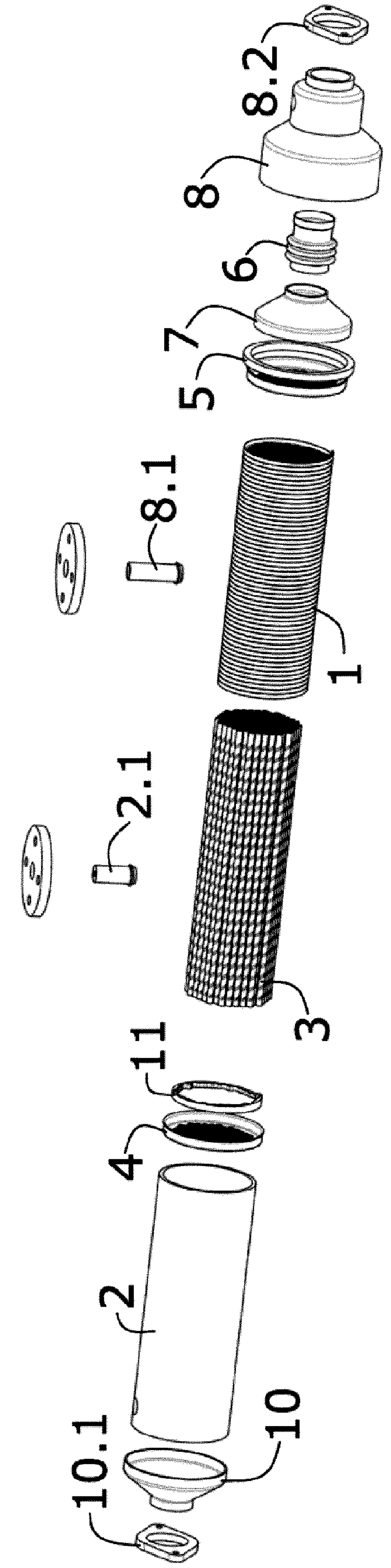

FIG.3

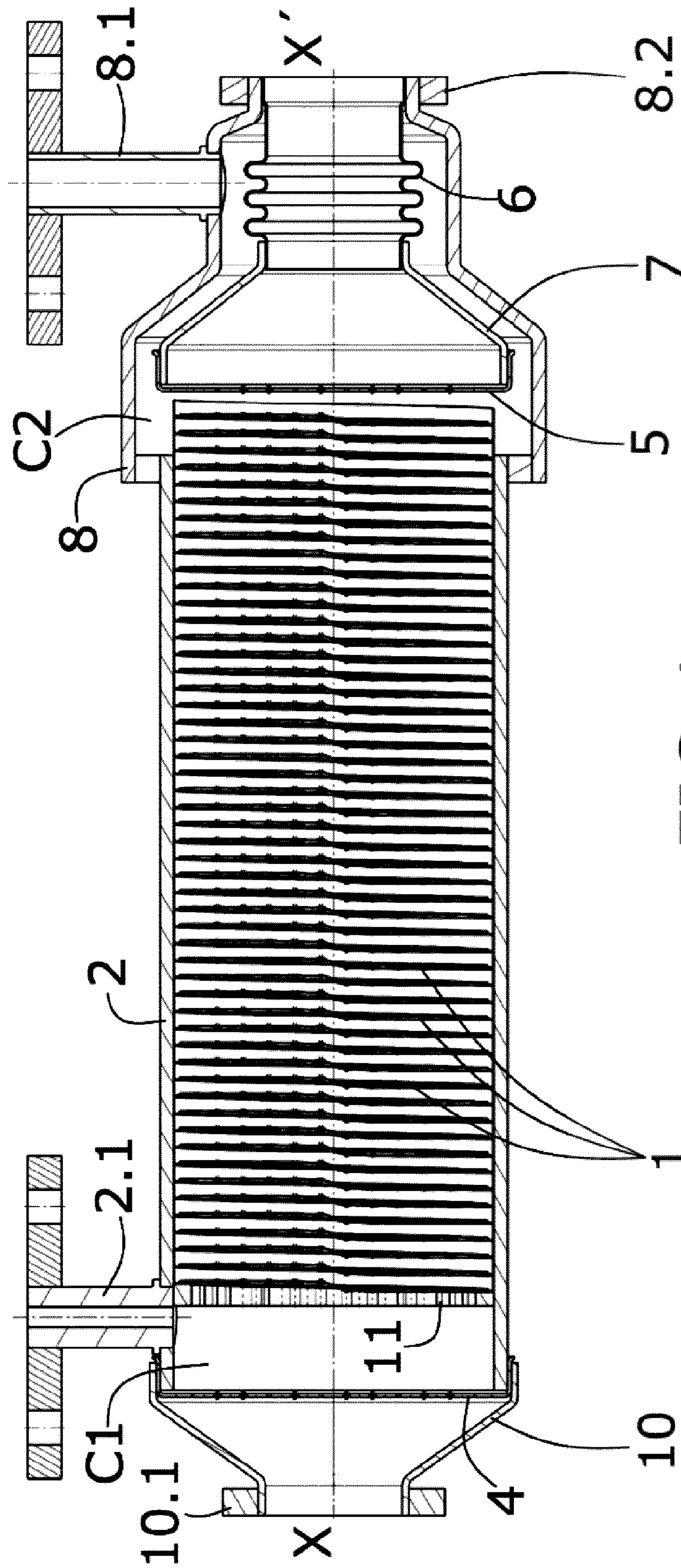

FIG.4

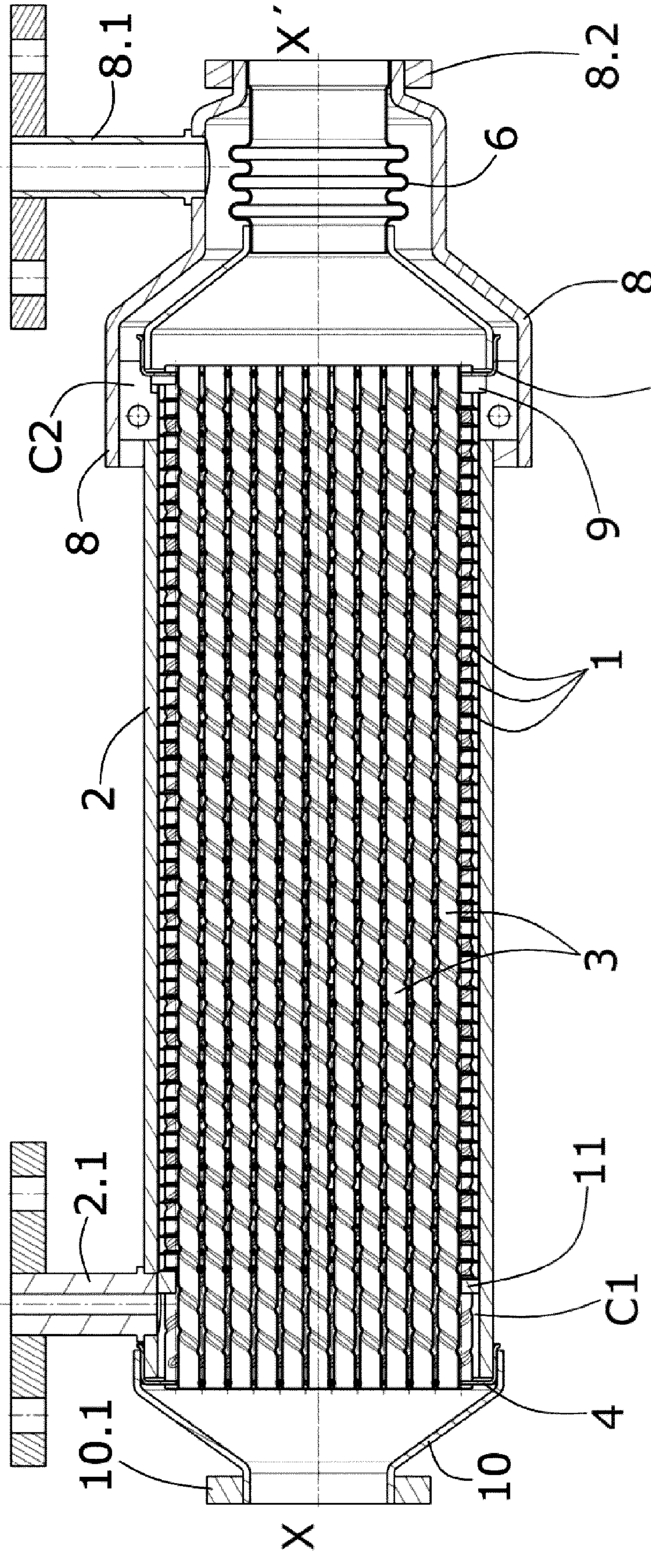

FIG.5

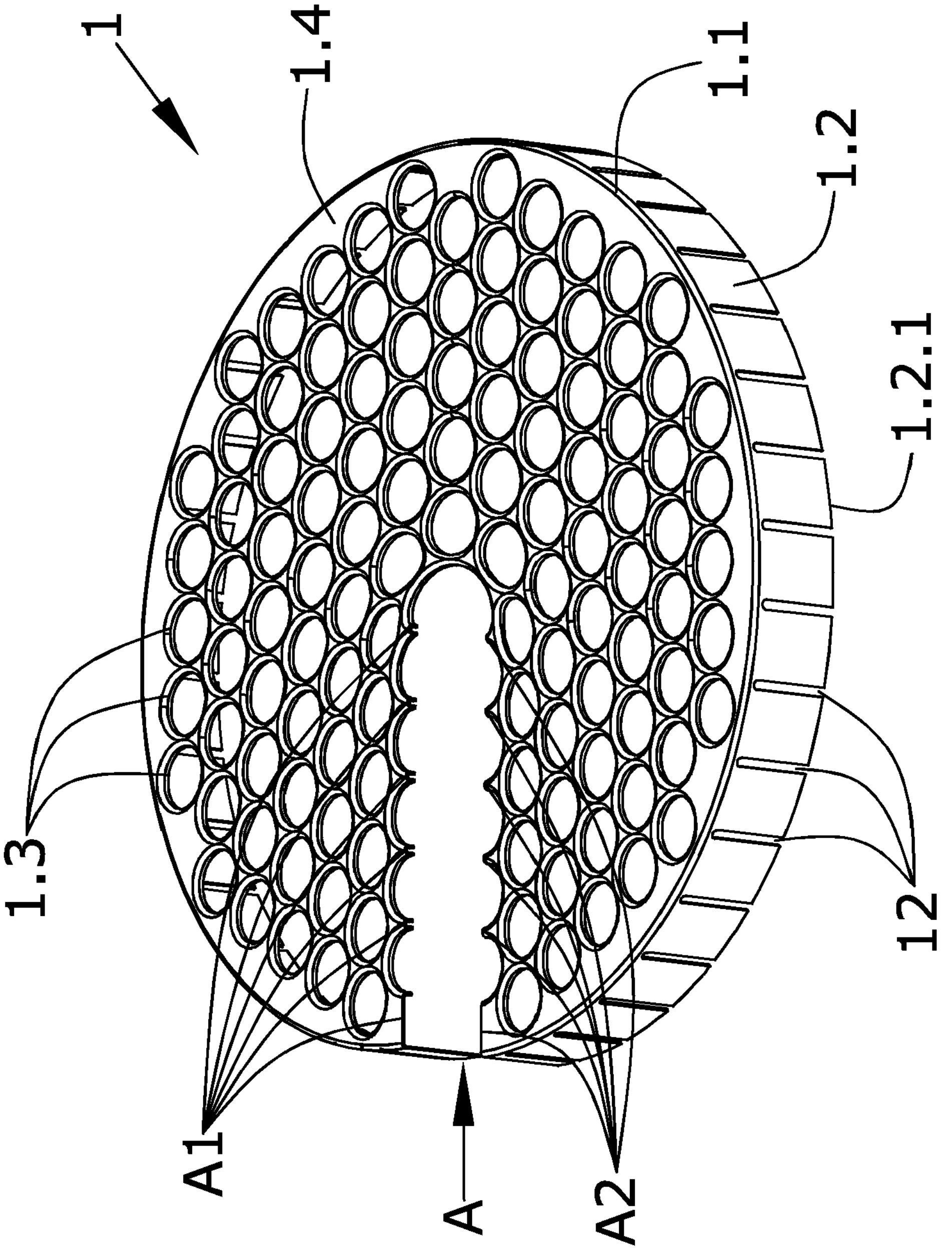

FIG.6

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EUROPEAN SEARCH REPORT

Application Number
EP 14 38 2488

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Place of search	Date of completion of the search	Examiner
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