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(54) **HEAT EXCHANGE DEVICE**

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Description

Object of the Invention

[0001] The present invention is a heat exchange device characterized by a particular configuration of the liquid inlet or outlet manifold wherein a baffle formed from the shell itself is incorporated.

[0002] This configuration allows not only suitably orienting the inflow in regions of the tube bundle of the exchanger where convection must be more intense, but also allows generating a flow suitable for reaching all the regions having a higher convective heat transfer requirement.

[0003] Configuring a baffle from the shell prevents incorporating and manufacturing specific additional parts as well as the additional operations required for their configuration and attachment to the heat exchanger.

[0004] The present invention is useful in the application of environmental protection measures.

Background of the Invention

[0005] One of the technical fields experiencing the most intensive development is that of heat exchangers for vehicles with an internal combustion engine. This is the case of heat exchangers in EGR (Exhaust Gas Recirculation) systems for reducing nitrogen oxide emissions, and also in evaporators for recovering heat from the gases of escape.

[0006] The heat exchange is carried out in a tube bundle in which the configuration of the tubes can be very diverse, for example they can be corrugated tubes, flat tubes or tubes configured by stacking die-cut and stamped plates.

[0007] In any case, typically a hot gas from the combustion chambers of the internal combustion engine circulates inside the tubes, and a liquid suitable for removing the heat from the gas circulates on the outside of said tubes.

[0008] The liquid is either a liquid coolant or else a liquid intended for changing phase, for example, to be part of a thermodynamic cycle that allows obtaining mechanical energy from the thermal energy extracted from the gas.

[0009] Throughout the description, the fluid circulating inside the tube bundle will generically be identified as first fluid, and the fluid circulating in the space defined between the inner wall of the shell and the outside of the tubes of the tube bundle will generically be identified as second fluid.

[0010] The temperature along each tube of the tube bundle will vary along the length thereof since the first fluid, the hot fluid circulating on the inside, interchanges heat through the wall of the tube with the fluid flowing on the outside. Therefore, the end of the tube where the hot fluid enters is the end where the temperature is the highest.

[0011] This temperature distribution is not the same

for all the tubes of the tube bundle. The fluid with which heat is exchanged flows from an inlet into the shell of the exchanger to an outlet from same, and although all the points of the inside of the shell of the heat exchanger are fluidically communicated with the inlet and outlet, the flow line passing through said point is different. There are preferred paths offering less resistance, favoring greater flow of liquid. There are also somewhat inaccessible regions, such as corners, wherein the flow velocity is lower, and therefore the heat exchange with the tubes is reduced due to less convection.

[0012] It is generally necessary for the second fluid to have the highest possible velocity in a region determined as a section that is transverse to the bundle and located as close as possible to the inlet for the first fluid, the hot gas.

[0013] Solutions based on the use of baffles located inside of the shell, modifying the path of the liquid entering through an inlet conduit, are known in the state of the art. This is the case of patent document JP2014194296A, in which the jet inlet flow from the inlet conduit is diverted with a specific baffle to prevent stagnation regions or regions wherein the velocity of the liquid is very low.

[0014] An alternative way to divert the jet inlet flow is to include additional parts inside the conduit through which the liquid enters the shell. These parts redirect part of the liquid jet, which is always at a high velocity, towards those regions of the heat exchanger which, were this baffle not included, would have a lower velocity. This is the case of the solution described in patent document WO 2015121148A1.

[0015] Solutions of this type have two drawbacks, the first being the use of additional parts that must be manufactured, for example, by die-cutting and stamping, and subsequently attached by welding. This second attachment is complex since the baffle has a warped configuration, is located inside a tube and therefore in a somewhat inaccessible area, and requires specific equipment that increases manufacturing costs.

[0016] Other baffles are formed by partial closures of the conduit through which the liquid accesses the shell of the heat exchanger, and comprising perforations generating jets having a higher velocity oriented in a specific direction. Although these jets acquire a higher velocity, they do not have a uniform configuration that can cover the entire inlet section adjacent to the end of the tube bundle where the hot gas enters and cause substantial pressure drops.

[0017] In contrast, the present invention solves these problems without the addition of specific parts, but rather establishes a configuration combining an extension of the shell into the liquid inlet/outlet manifold and a slot. This combination modifies the entry path of the second fluid due to a deflection effect, giving rise to a laminar flow, without important throttling causing pressure drops, throughout a section and with a modulated flow rate at each point of the section according to the application. Heat exchangers according to the preamble of claim 1

are disclosed in patent documents JP 2009 114923 A, WO 2013/022072 A1 and JP 2009 091948 A.

Description of the Invention

[0018] The present invention is a heat exchanger for the heat exchange between a first fluid, which can be a hot gas, for example, and a second fluid, which can be a liquid, for example. Although the preferred application of this invention is a heat exchanger for EGR systems, it also can be applied in other heat exchangers, such as evaporators or condensers.

[0019] The heat exchanger according to the invention comprises:

- a heat exchange tube bundle extending according to a longitudinal direction between an inlet for the first fluid into the tube bundle and an outlet for the first fluid from the tube bundle, wherein the heat exchange tube bundle is intended for driving the flow of the first fluid,
- a shell housing the heat exchange tube bundle and extending according to the longitudinal direction at least between the inlet for the first fluid and the outlet for the first fluid, wherein the shell is intended for driving the second fluid through the space defined between the tubes of the heat exchange tube bundle and the shell,
- a tubular inlet segment for the entry of the second fluid into the shell and a tubular outlet segment for the exit of the second fluid from inside the shell.

[0020] The tube bundle drives the first fluid, for example hot gas, from one end to the other end, allowing the heat exchange along the length thereof with the second fluid in which the tube bundle is immersed.

[0021] The tube bundle is housed in a shell establishing a space between its inner wall and the outside of the tubes of the tube bundle where the second fluid, a liquid, for example, circulates. This inner space is closed by the shell on the sides of the tube bundle. The closure of the inner space at the ends of the tube bundle can be done in several ways.

[0022] According to a first embodiment, it can be seen that the closure is established for a tube bundle of flat tubes by means of the use of baffles.

[0023] According to a second embodiment it can be seen that the closure is established for a tube bundle, wherein the tubes are formed by stacked plates, by means of a configuration of the tubes in the tube bundle in which the ends of the tubes are expanded. On the stacking of the tubes, such tubes are supported on one another in the expanded area and leave in the intermediate area passage channels for the second fluid with which the transfer of heat is established. This second configuration prevents using baffles and maximizes the area for entry into the tubes of the tube bundle.

[0024] In any case, the inlet for the first fluid is formed

by the set of openings of the tube bundle which allow the entry of hot gas, and the outlet for the first fluid is formed by the set of openings of the tube bundle which allow the exit of said hot gas.

[0025] The second fluid entering the shell accesses the inside of same through a tubular inlet segment and exits through a tubular outlet segment. These tubular segments can be, for example, connecting segments (or spigots) with flexible conduits, or they can be the end portion of a conduit reaching the heat exchanger configured for driving the liquid with which heat is exchanged.

[0026] The present invention additionally verifies that:

- the exchanger comprises at least one first manifold located, according to the longitudinal direction, close to either the inlet for the first fluid or else the outlet for the first fluid, and positioned:
 - either between the first tubular inlet segment and the shell,
 - between the second tubular outlet segment and the shell,
 - or else in both locations;
- the shell has a slot for the passage of the second fluid between the inside of the first manifold and the inside of the shell in which the tube bundle of the heat exchanger is housed, this slot being spaced from the corresponding inlet/outlet for the first fluid in which said first manifold is located,
- the shell has an extension into the first manifold such that this extension establishes a partial closure in the fluidic communication between the inside of the first manifold and the inside of the shell in which the tube bundle of the heat exchanger is housed.

[0027] The inlet/outlet for the second fluid in the heat exchanger according to the invention is established by means of a manifold, the one identified as first manifold, located between the shell and the tubular segment which drives the liquid of or from the inlet/outlet.

[0028] Although the invention is valid for both the entry and exit, it has been experimentally proven that the operation is more efficient when it is applied at the inlet for the second fluid into the shell. Although the description that is made below is based on the movement of the flow of the second fluid for an inlet for the second fluid, the reasoning for the outlet would be the opposite with certain variations due to inertial effects.

[0029] The flow velocity in the tubular segment where the second fluid enters is high given that the passage section is much smaller than the section of the space formed between the inner wall of the shell and the tube bundle.

[0030] The manifold allows generating a chamber or inner space that adapts the diameter of the tubular segment to a section having larger dimensions. In the state of the art, the manifolds allow the access of the second

inlet fluid to a much larger region for entry into the shell, the one established by the support base of the manifold in the shell.

[0031] This expansion of the manifold does not allow good distribution of the flow because an adverse pressure gradient generates an unstable flow, with recirculation zones, and therefore is not capable of being suitably distributed reaching stagnation regions inside the shell.

[0032] Nevertheless, according to the invention the opening in the shell through which the second fluid passes does not coincide with the base of the manifold. The opening is a slot having smaller dimensions than the base of the manifold and additionally comprising an extension of the shell into the manifold.

[0033] In the examples described below, the extension of the shell into the manifold covers the restricted area of the base of the manifold not corresponding to the slot.

[0034] According to the examples described below, the slot has a longitudinal configuration and is oriented transverse to the tube bundle to allow generating a laminar flow in which a cross section of the tube bundle is immersed.

[0035] The slot has a variable width along its length depending on the flow rate to be introduced through each point of its length, which allows modulating the flow rate at different points of the section of the tube bundle.

[0036] The inlet for the second fluid meets with an expansion due to the first manifold. Nevertheless, the presence of the slot generates a reduction in the section increasing the flow velocity according to a configuration in the form of a laminar flow which prevents the existence of stagnation regions in entire regions of a section of the tube bundle, the cross section determined by the position of the slot according to the longitudinal direction.

[0037] When the inlet for the second fluid is established close to the inlet for the first fluid, for example the hot gas, the laminar flow allows increasing the convective heat transfer at all the points of the tube bundle where the temperature is higher, reducing thermal fatigue and increasing the service life of the device.

[0038] This restriction of the passage formed by the slot is obtained from an extension of the shell, preventing the need to make specific parts that must be attached to the inside of the manifold.

[0039] A particular embodiment of the invention wherein the extension of the shell is at least partially interposed in the path established by the geometric extension of the tubular segment attached to the first manifold is also of enormous interest.

[0040] If the tubular segment is the inlet, the inflow tends to follow the path established by the geometric extension of the tubular segment due to inertia. This inertia makes the inflow through the tubular segment be non-homogenous when it passes through the manifold and maintain the jet effect without distributing the velocity field along the base of the first manifold and particularly along the slot.

[0041] This unwanted effect is particularly true when

the slot is wide and it is not of interest to make the slot too narrow to raise the velocity of the fluid given that a narrow slot generates pressure drops in the liquid.

[0042] By at least partially interposing the extension of the shell with the geometric path of the tubular segment, the jet inlet flow is deflected so that the outlet velocity of the second fluid through the slot is more homogenous although said slot is wide without having big pressure drops.

[0043] Other examples and particular ways of carrying out the invention are described below in reference to the drawings.

Description of the Drawings

[0044] These and other features and advantages of the invention will be better understood based on the following detailed description of a preferred embodiment, given solely by way of illustrative and non-limiting example in reference to the attached drawings.

Figure 1 shows a perspective view of a first embodiment of the invention where the device is a heat exchanger for an EGR system.

Figure 2 shows the same perspective view of the first embodiment of the invention where the first manifold has been partially sectioned to have visual access to the inside thereof.

Figure 3 shows the same perspective view of the first embodiment of the invention where the section has been extended not only to the first manifold but also to part of the shell and to the inlet manifold of the hot gas to have visual access to the tube bundle.

Figure 4 shows a top view of the first embodiment where a section of the first manifold has been performed to allow observing the extension of the slot in projection.

Figure 5 shows a longitudinal section of the first embodiment.

Figure 6 shows a perspective view of a second embodiment not within the scope of the invention where the device is a condenser for recovering heat.

Figure 7 shows a detail of one of the ends of the second embodiment where the first manifold is seen in an exploded view to allow observing the inside.

Figure 8 shows a longitudinal section of the second embodiment to allow observing the configuration of the tubes of the tube bundle.

Figure 9 shows a front view of a detail of one end of the second embodiment.

Figure 10 shows a longitudinal section coinciding with the tubular inlet/outlet segment of the second fluid.

Figures 11 and 12 show a perspective view of the shell of a new embodiment, with a configuration of the first manifold obtained by extending the shell, which is applicable to any of the preceding examples. Figure 12 shows a cross section which allows having

visual access to the inside of the first manifold.

Figures 13-15 show a perspective view of the shell of a new embodiment, also with a configuration of the first manifold obtained by extending the shell, with larger dimensions such that there is established a communication channel which allows locating the inlet for the second fluid at the same end as the outlet for the second fluid according to the longitudinal direction.

Figures 16-18 show a perspective view of the shell of a new embodiment, also with a configuration of the first manifold obtained by extending the shell, where the region where the extensions of the shell which are overlapping and spaced from one another extends between two adjacent faces of the heat exchanger. Figures 17 and 18 show sections which allow observing the inside of the first manifold with greater detail.

Figures 19-23 show a new embodiment not within the scope of the invention formed by a two-stage exchanger. Figure 19 is a perspective view of the outside of the heat exchanger. Figure 20 is a top section view wherein the slots of each segment of the exchanger can be seen. Figures 21 and 22 are front section views where the plane of section is located in both chambers of the two-stage exchanger, respectively. Figure 23 is a cross section of the heat exchanger.

Detailed Description of the Invention

[0045] The present invention is a heat exchange device for the transfer of a first fluid to a second fluid.

[0046] In a first embodiment shown in Figures 1 to 5, the heat exchanger is a heat exchanger for an EGR system where the first fluid (11) is a hot gas and the second fluid (12) is a liquid coolant.

[0047] Figure 1 shows a heat exchange device formed by a main body comprising a shell (6) housing a tube bundle (5), which can be clearly seen in the sections shown in Figures 3 and 5, for heat exchange. The main body has a prismatic configuration with rectangular bases and extends along a longitudinal direction identified as X-X', as shown in the sections of Figures 3 and 5.

[0048] The tube bundle (5) is formed by flat tubes fixed at their ends to a first baffle (1) and to a second baffle (2). As shown in Figure 5, the inlet (I) for the first fluid is at the access openings into the inside of the flat tubes of the tube bundle (5), and the outlet (O) for the first fluid is at the access openings at the opposite end, wherein in this embodiment the ends of the flat tubes slightly overtakes the surface of the first baffle (1) and of the second baffle (2).

[0049] The shell (6) in this embodiment is made of die-cut and stamped plate configured with reinforcement ribs (6.3). The first baffle (1) and the second baffle (2) are prolonged, perimetally encircling the ends of the shell (6), according to the longitudinal direction X-X', estab-

lishing the closure of the inside of the shell (6) at respective ends.

[0050] In this embodiment, the inlet and outlet (I, O) for the first fluid is guided by means of second manifolds (9, 10), the main body of which is also made of die-cut and stamped plate. The attachment of both second manifolds (9, 10) to the main body of the heat exchanger is established by means of a seating of the second manifold (9, 10) perimetally embracing its corresponding baffle (1, 2).

[0051] Two tubular segments are shown on the shell (6), a first tubular inlet segment (7) and a second tubular outlet segment (8) for the entry and exit of the second fluid (12), respectively.

[0052] The first tubular inlet segment (7) is attached to a first manifold (3), obtained in this embodiment from die-cut and stamped plate, which in turn is attached to the outside of the shell (6) through a base (3.1) configured in the form of a perimetral strip.

[0053] The second tubular outlet segment (8) is attached to the shell (6), without the participation of a manifold, by means of a flaring or conical transition of the same shell (6).

[0054] As commonly occurs in this technical field, the lack of space in the engine compartment determines that the positions and orientations of the conduits of the first fluid (11) and of the second fluid (12) cannot be optimal and are determined by the position of other components which are also housed in the same engine compartment.

[0055] In this embodiment, the inlet for second fluid (12) is located at the end corresponding to the inlet (I) for the first fluid on one side of the upper rectangular surface of the shell (6) and with an oblique access; and the outlet for the second fluid (12) is located in a diagonally opposite position on the same upper rectangular surface of the shell (6), at the end corresponding to the outlet (O) for the first fluid.

[0056] The access of the liquid from one side makes difficult a suitable cooling of the cross section of the tubes of the tube bundle (5) located close to the inlet (I) for the first fluid, the hot gas, and the first baffle (1) where the highest temperatures are reached. Even bigger is the difficulty of cooling on the side opposite the inlet for the liquid coolant.

[0057] In this embodiment of the invention, the first manifold (3) has a base (3.1) having a configuration that is elongated and rounded at the ends which sits on the outer surface of the shell (6). Although the shell (6) has reinforcement ribs, in this support zone of the first manifold (3) the configuration is flat to make the also flat seating of the base (3.1) of the first manifold (3) easier.

[0058] The shell (6) has an opening in the form of slot (6.2) spaced from the inlet (I) for the first fluid to allow the base (3.1) of the manifold to surround the slot (6.2), which is elongated and arranged transverse to the tube bundle (5) extending according to the longitudinal direction X-X'.

[0059] The width of the slot (6.2) is decreasing, having a greater width at the end near the inlet for the second

fluid (12) and a smaller width at the opposite end. The zone having a smaller width increases the velocity of the second fluid (12) going through said slot (6.2), favoring said second fluid (12), the liquid coolant, from going through the tube bundle (5) in this section near the inlet (I) for the first fluid, hot gas.

[0060] The width of the slot (6.2) allows regulating the velocity and the passage section of the second fluid (12) regardless of the shape of the seating of the first manifold (3).

[0061] Additionally, Figure 4 allows observing that the shell (6) is extended internally according to an extension (6.1) which is what interferes with the flow passing through the inner chamber formed by the first manifold (3). This extension (6.1) allows modifying the path of the flow before going through the slot (6.2) generating a more homogenous outflow of the second fluid (12).

[0062] Figures 6 to 10 show a second embodiment not within the scope of the invention, a condenser for recovering heat from a fluid in the gas phase. This condenser is a heat exchanger that transfers heat from the first fluid (11), a fluid in vapor phase such as ethanol, for example, to the second fluid (12), a liquid, for the purpose of bringing about the change of phase in the first fluid (11).

[0063] In this second embodiment, the heat exchanger is configured according to a prismatic main body with rectangular bases comprising a tube bundle (5) housed in a shell (6) made of die-cut and stamped plate.

[0064] The tube bundle (5) extends along a longitudinal direction which will be identified as X-X', like in the first embodiment.

[0065] In this embodiment, the tube bundle (5) is formed by stacking flat tubes configured from pairs of stamped and die-cut plates. Each of the tubes of the tube bundle (5) has an expansion (5.1) of their ends with a rectangular configuration according to their section, such that it is in this expansion (5.1) where the consecutive tubes are supported in the stack.

[0066] The expansion (5.1) has two effects, the first is the spacing between consecutive tubes for defining the passage channels of the second fluid (12), and the second effect, i.e. the entry and exit of the first fluid (11), occurs through the openings defined with the expansion (5.1), maximizing the entry area into the tube bundle (5) with respect to the front area of said tube bundle (5). In this particular case, the expansion (5.1) is also responsible for closing the inner space defined by the shell (6) at the ends according to the longitudinal direction X-X'.

[0067] Figure 8 shows a longitudinal section of the second embodiment, wherein this section transversely sections each of the tubes of the tube bundle (5). Due to the particular application of the condenser of this second embodiment, the tubes are flat and very narrow, leaving an also very narrow space between tubes. The section of Figure 10 does not explicitly show the configuration of the tube bundle since there is a folded sheet between tubes for configuring fins for improving the heat exchange and another similar sheet inside the tubes, generating

both of them an excessive amount of lines that would hinder seeing the section.

[0068] Both the inlet (I) for the first fluid through the openings of the expansions (5.1) of the tubes of the tube bundle (5) and the outlet (O) for the first fluid in the expansions (5.1) of the opposite end are identified in said Figure 8. In this case, due to the configuration of the openings the inlet and outlet (I, O) for the first fluid cover the entire transverse area except the thicknesses of the tubes of the expansion (5.1).

[0069] In this embodiment, the configuration of the device is symmetrical with respect to a central transverse plane, hence in Figures 7, 9 and 10 showing a detail of one end of the device, two reference numbers referring to the same component, regardless of if it is of one end or the other, are indicated.

[0070] Going back to Figure 6, this figure shows the main body of the heat exchanger located between two second manifolds (9, 10) intended for the entry and exit, respectively, of the first fluid (11).

[0071] The fluid in vapor phase enters through the second inlet manifold (9) of the first fluid (11), gains access to the inside of the stacked tubes of the tube bundle (5) through the inlet (I) for the first fluid; and after going through the tube bundle (5) it exits through the outlet (O) for the first fluid into the second outlet manifold (10) to gain access, once it has changed to the liquid phase, to the next component of the heat recovery system.

[0072] Now the entry of the second fluid (12) will be described; nevertheless, the configuration of the entry is symmetrical to the configuration of the exit. For that reason, dual numbering of the components and parts of both ends of the device, the one corresponding to the entry and also to the exit, will be included.

[0073] The second fluid (12) enters through a first tubular inlet segment (7, 8) which is attached to a first inlet manifold (3, 4). According to the longitudinal direction (X-X'), the first manifold (3, 4) is located close to the inlet (I, O) for the first fluid and positioned between the tubular inlet segment (7, 8) and the shell (6).

[0074] As shown in Figure 9, the first manifold (3, 4) has a support base (3.1, 4.1) configured in the form of a triangle with rounded vertexes, with a larger side and two smaller sides having equal dimensions. The larger side of the base (3.1) is arranged adjacent to the end comprising the inlet (I) for the first fluid, and the opposite vertex, the vertex where the two smaller sides converge, is positioned on the side pointing towards the center of the device.

[0075] The front projection view in Figure 9 shows how the first tubular inlet segment (7) is located on the side of this same vertex.

[0076] The first manifold (3, 4) internally configures a chamber for access into the tube bundle (5); nevertheless, an extension (6.1) of the shell (6) establishes a partial closure of this fluidic communication between the internal chamber formed by the first manifold (3, 4) and the inside of the shell (6).

[0077] The fluidic communication between the first manifold (3, 4) and the inside of the shell (6) is through a slot (6.2), which in this case is elongated, having a constant width, oriented transverse to the longitudinal direction X-X'.

[0078] The spacing between the slot (6.2) and the inlet (1, 0) for the first fluid allows the base (3.1, 4.1) to sit in the shell (6.1) surrounding the slot (6.2). The base (3.1, 4.1) not only surrounds the slot (6.2) but also leaves space inside the first manifold (3, 4) to house the extension (6.1) of the shell (6).

[0079] In this same Figure 9, it can be seen that the first tubular inlet segment (7, 8) has an orientation perpendicular to the surface of the shell (6) where the first manifold (3, 4) is fixed. For that reason, the front view allows seeing the projection of the first tubular inlet segment (7, 8) following a direction coinciding with the path of the flow in the operating mode. This projection allows seeing how the extension (6.1) of the shell (6) is interposed at least partially, in this case almost in its entirety, in this path of the flow.

[0080] With this configuration, the inflow through the first tubular inlet segment (7, 8) is deflected by the extension (6.1) of the shell (6) and distributed homogeneously along the entire length of the slot (6.2). This flow thus diverted allows generating through the slot (6.2) a back flow after surpassing the slot (6.2) with a greater velocity and with a configuration in the form of a laminar flow that sweeps the entire section of the tube bundle (5) preventing stagnation regions and therefore reducing locations where there may be thermal fatigue.

[0081] The baffle formed by the extension (6.1) of the shell (6) does not require manufacturing additional parts that must first be die-cut and stamped and then welded in complex positions, but rather it is enough to suitably design the position and shape of the slot (6.1), the base (3.1, 4.1) for the seating of the first manifold (3, 4) and the orientation of the first manifold (7, 8).

[0082] An inclined position of the first/second tubular segments (7, 8) oriented, for example, towards the baffle formed by the extension (6.1) of the shell (6) allows more complex situations where it is necessary for this inflow to be more homogenous.

[0083] In any of the embodiments of the invention, the first/second tubular inlet/outlet segment (7, 8), or both, can be inclined with respect to the surface of the shell (6) on which it is fixed by means of the first manifold (3, 4). Particularly, said first/second tubular inlet/outlet segment (7, 8), or both, can be inclined towards the vertex opposite the larger side of the triangular configuration where the extension (6.1) of the shell (6) is located.

[0084] In this embodiment, the seating of the first manifold (3, 4) is located on an expansion (6.4) of the shell (6). Generated inside this expansion (6.4) there is a chamber which allows distributing the flow of the second fluid through the channels between tubes of the tube bundle (5) coinciding with said expansion (6.4).

[0085] Though not depicted in the drawings, in any of

the embodiments of the invention it is possible to obtain the main body of the first manifold (3, 4) and the main body of the second manifold (9, 10) which are located at the same end of the heat exchanger in a single part.

[0086] In the described embodiments, one manifold (3, 4) and the other manifold (9, 10) are configured by die-cutting and stamping. In the described embodiment where both manifolds (3, 4; 9, 10) are configured in a single part, a possible method of manufacturing comprises: die-cutting the plate including the plate corresponding to one manifold (3, 4) and the other manifold (9, 10) plus a plate connecting portion between both manifolds (3, 4; 9, 10); and carrying out an operation of bending this plate connecting portion at a right angle.

[0087] The bases of one manifold (3, 4) and the other manifold (9, 10) thereby are oriented perpendicular to one another and sit on the wall of the shell (6) and at the inlet/outlet (1, 0) for the first fluid simultaneously.

[0088] An object of this invention is also an EGR system for a vehicle with an internal combustion engine comprising a heat exchanger according to any of the described configurations.

[0089] An object of this invention is also a heat recovery system for a vehicle with an internal combustion engine comprising an evaporator or a condenser according to any of the described configurations.

[0090] Figures 11 to 15 show two additional embodiments of the invention which allow building a heat exchange device with a smaller number of parts. Both embodiments show only the shell, the rest of the components of the heat exchanger having been removed to make visual access of the inside of the device easier.

[0091] Figure 11 shows an embodiment where the shell (6) is configured in two parts, a first part with a U-shaped cross section and a second part also with a U-shaped cross section but with one of the arms of the U being considerably shorter. Although in section the extensions of both parts are identified with the term "arms," the same elements, when not referred to by means of their section configuration, will be identified as extensions.

[0092] According to this embodiment, the attachment between both parts of the shell (6) is carried out by overlapping the extensions of both parts at least along a strip according to the longitudinal direction X-X'.

[0093] In the case of the attachment between the extensions corresponding to a long arm and a short arm, shown in the lower part of the drawings, the attachment is along a strip according to the longitudinal direction X-X' wherein the end of the extension corresponding to the short arm is stepped towards the inside of the shell (6).

[0094] In the particular case of the attachment between the extensions corresponding to the two long arms of both parts, said extensions are overlapping in a more extensive region. The embodiment shows that the first manifold (3) is configured by means of a bulging zone in the extension of one of the parts of the shell (6), the one located on the outside, in the region overlapping the ex-

tension of the other part of the shell (6), such that this second extension is located on the inside.

[0095] The configuration of the first manifold (3) by means of the extension of the shell (6) is carried out through a deep-drawing operation giving rise to a bulging zone. In this embodiment, the bulging zone is flat with a plane parallel to the extension (6.1) located inside the first manifold (3). In this particular case, the extension (6.1) of the shell (6) is configured as part of the extension located inside the overlap going into the cavity of the first manifold (3).

[0096] The shell (6) thereby comprises on the outside an extension containing the first manifold (3) and on the inside the extension (6.1) of the inner extension overlapping the outer extension and acting as a baffle for the flow of the second fluid (12).

[0097] Both the outer and inner extensions are overlapping and attached, for example by means of brazing, in the area where the first manifold (3) is not located. Other examples of welding applicable to this attachment are: laser, resistance or TIG welding.

[0098] Figure 12 shows the same embodiment but in this view a section has been applied according to two perpendicular planes, one parallel to the longitudinal axis X-X' and the other one transverse, to allow observing the inside of the first manifold (3) formed by overlapping two extensions of the shell (6), as well as the presence of the slot (6.2) establishing the fluidic communication between the inside of the first manifold (3, 4) and the inside of the shell (6).

[0099] This particular configuration allows configuring the first manifold (3), the second manifold (4) or both (3, 4) from the plate of the shell (6), this solution being applicable to any of the embodiments described up until now. With this configuration, the support base (3.1) of the first manifold (3) can be identified with the perimetral region of the first manifold (3) where there is overlap between the plate of the extension of the shell (6) located on the outside and the plate of the extension of the shell (6) located on the inside.

[0100] The embodiment shown in Figures 11 and 12 comprises the inlet for the second fluid (12) at opposite ends according to the longitudinal direction X-X'. The second fluid (12) thus flows through the inside of the shell (6) along the entire length of the tube bundle (5).

[0101] Nevertheless, there are situations in which the space limitations in the engine compartment prevent locating the conduits of the second fluid (12) at both ends. This is the case of the following embodiment shown in Figures 13 to 15.

[0102] In this embodiment, the inlet for the second fluid (12) is located at the same end, according to the longitudinal direction X-X', where the inlet for the second fluid (12) is located. The configuration of the extensions of the two U-shaped parts configuring the shell (6) are like those of the preceding embodiment, but the first manifold (3) has a bulged region with a larger extension covering virtually the entire flat surface of the shell (6) where the inlet

for the second fluid (12) is located.

[0103] The first manifold (3) configured this way also increases the dimensions of the extension (6.1) such that a circulation channel having a flat configuration is established inside of the first manifold (3).

[0104] The circulation channel goes from the inlet for the second fluid (12) through the tubular inlet segment (7) to the access slot (6.2) of the second fluid (12) into the shell (6) in which the tube bundle of the heat exchanger (5) is housed.

[0105] Although in this embodiment the base of the first manifold (3) has a rectangular configuration, the configuration of the channel can be narrower forming a conduit between the plate of the extension located on the outer side and the plate of the inner extension (6.1). Nevertheless, the larger dimensions of the channel like that shown in Figures 13 to 15 establish a larger passage section and therefore smaller pressure drops.

[0106] The larger area of the plate of the inner extension (6.1) allows including more than one slot (6.2) for allowing the passage of the second fluid (12), for example to zones which would otherwise be stagnation regions.

[0107] Figure 14 shows a cross section which allows seeing the transverse slot (6.2) located inside the first manifold (3). Figure 15 is a section having larger dimensions which allows seeing the channel formed by the inside of the first manifold (3). The direction in which the second fluid can flow has been identified by means of arrows.

[0108] Therefore, in this embodiment access of the tubular segment (7, 8) in fluidic communication with the first manifold (3) is spaced from the slot (6.2) according to the longitudinal direction X-X' such that the extension (6.1) and the first manifold (3) define a channel for the passage of the second fluid (12).

[0109] In the embodiments shown in Figures 11 to 15, the first manifold (3) is configured by means of overlapping two extensions of the shell (6) wherein it is the outer extension that is bulged such that both extensions are spaced from one another.

[0110] Another alternative configuration establishes that the inner extension is bulged inwardly to allow for the two spaced extensions. In this particular case, the region bulged towards the inside of the shell (6) is what comprises both the deflecting extension (6.1) and the slot (6.2).

[0111] Another intermediate configuration not shown in the drawings either establishes both bulged extensions, such that the first manifold (3) is configured inside both bulges.

[0112] In any of these cases, in the perimetral region of the first manifold (3) the two extensions of the shell (6) are attached to one another and the first tubular inlet segment (7) or the second tubular outlet segment (8) is in fluidic communication with the first manifold (3).

[0113] Figures 16, 17 and 18 show another embodiment where the tubular inlet segment (7) is located on one side of the shell (6). The passage channel formed

between the extensions of the two U-shaped parts which are overlapping and spaced from the shell (6) are laterally extended from the face on which the slot (6.2) is located, such that it allows access of the second fluid (12) into heat exchanger from this side through the tubular inlet segment (7). That is, the region of the two extensions that are overlapping and spaced from one another extends between two adjacent faces of the shell (6).

[0114] Figure 17 is a partial section which allows showing the position of the slot (6.2), located at one end of the heat exchanger and arranged transverse to the longitudinal direction (X-X'), and also allows showing the extension of the flat channel towards the side of the heat exchanger where the tubular inlet segment (7) is located. Figure 18 shows a section having larger dimensions for seeing the larger dimensions of the flat channel formed between the extensions of the shell (6) which are overlapping and spaced from one another to give rise to said flat channel.

[0115] Figures 19 to 23 show a new embodiment of a two-stage exchanger not within the scope of the invention. Two-stage exchangers reduce the length of the tube bundle by splitting it into two segments arranged essentially parallel to one another, an outgoing segment and another return segment. The embodiment uses this two-stage configuration to incorporate an embodiment of the invention, in which the first fluid (11) exiting from the outgoing segment changes direction through a direction-changing manifold (13).

[0116] This embodiment incorporates various solutions that have been previously described and some solutions that are also applicable to embodiments that have already been described.

[0117] With respect to the structure of the heat exchanger, the tube bundle is differentiated in two groups separated by a wall (6.5), a first group of tubes for the outgoing segment for the first fluid (11) and a second group of tubes for the return segment for the first fluid (11) through which said first fluid (11) flows after changing direction through the direction-changing manifold (13). This direction-changing manifold (13) redirects the first fluid (11) from the outlet of the first outgoing segment to the inlet of the second return segment.

[0118] Figure 20 is a top view of a section which allows seeing the upper face of the shell. Figure 20 shows arrows indicating the direction of flow of both the first fluid (11) and the second fluid (12). It has already been indicated that the first fluid (11) has a first path through a first segment and a second path through a second segment. These segments are the two defined inside the chambers existing inside the shell (6) separated by the wall (6.5). The change in direction is depicted in this drawing by means of a hollow, two-way arrow since the circulation direction depends on if the heat exchanger works in co-current or on if it works in counter-current. The rest of the arrows show the path of the second fluid (12).

[0119] In this embodiment, the first inlet manifold (3) and the first outlet manifold (4) are longitudinally extend-

ed along most of the length of the heat exchanger such that they generate a flat channel. Figure 20 shows, by means of a circle with a dashed line, the inlet (I) and the outlet (O) given that they are not seen due to the section.

[0120] The second fluid (12) enters through the tubular inlet segment (7), being deflected by the extension of the shell (6.1) to be driven through the flat channel to the other end of the heat exchanger. The slot (6.2) is located at the end of the first inlet manifold (3). Given that the path is parallel to the longitudinal direction (X-X') of the heat exchanger, the second fluid tends to maintain a parallel path. In this case, the slot (6.2) is U-shaped, giving rise to a tab (6.2.1) which is bent towards the inside of the shell (6) housing the tube bundle.

[0121] The curvature of the tab (6.2.1), which is part of the extension (6.1) of the shell (6), makes deflection of the path of the second fluid (12) easier.

[0122] The mainly longitudinal path of the second fluid (12) into the first inlet manifold (3) is indicated with a continuous arrow. Once inside the shell (6), it extends through the entire group of tubes of the tube bundle until passing to the other group of tubes of the tube bundle. In this embodiment, the passage from one of the chambers defined by the wall (6.5) to the other chamber occurs at the longitudinal ends of the wall (6.5) given that said wall (6.5) does not reach the end. The spacing with the end baffles establishes a passage window (6.5.1) which can be enlarged, as occurs at one of the ends depending on the flow that is to be allowed in each of said ends.

[0123] Once the second fluid (12) has reached the second group of tubes of the tube bundle, after said second group of tubes has been immersed, it reaches the other slot (6.2), the one of the first outlet manifold (4).

[0124] From this slot (6.2), through which the second fluid (12) exits after absorbing the heat given off by the first fluid (11), to the outlet through the tubular outlet segment (8), identified in the projection view by (O), there is a long path guided by the extension (6.1). It has been experimentally tested that this path allows the bubbles generated by the boiling effect to collapse, or at least for their size to be considerably smaller, preventing damage to devices located downstream.

[0125] Figure 21 is a front section view coinciding with the second slot (6.2) which shows the path of the second fluid (12) through the first manifold (3) until exiting through the tubular outlet segment (8). This figure shows the window (6.5.1) facilitating the passage from one of the chambers defined by the separation wall (6.5) to the other chamber, as well as the passage established at the opposite end since the wall (6.5) does not reach said end.

[0126] Figure 22 is a section view like that of Figure 21, but the plane of section passes through the first slot (6.2). In this case, the circulation direction of the second fluid (12) is the opposite shown by the arrows. This section shows the curvature of the tab (6.2.1) towards the inside of the chamber defined by the wall (6.5) on the inside of the shell (6).

[0127] Figure 23 is a cross-section view of the embod-

iment showing the central arrangement of the wall (6.5), the tab (6.2.1) formed by means of the slot (6.2) with the curvature towards the inside of the chamber, the other outlet slot (6.2) for the second fluid (12) and the flat channels established by the first inlet manifold (3) and the first outlet manifold (4).

[0128] The solution of establishing a deformation, for example by deep-drawing, in the plate of the extension (6.1) of the shell (6) around the slot (6.2) to achieve deflection of the flow passing through the slot (6.2) is applicable to any of the embodiments described above, and particularly by using a U-shaped slot to obtain a tab (6.2.1).

[0129] Establishing a long flat channel between the outlet slot (6.2) for the second fluid (12) and the tubular outlet segment (8) is also applicable to the preceding embodiments to reduce or eliminate bubbles due to the existence of possible boiling processes.

[0130] Likewise, although the drawings show the shell as having a tubular configuration, it can be manufactured using two U-shaped parts with overlapping extensions, both for the attachment of the two U-shaped parts and for the formation of the first manifolds (3, 4).

Claims

1. A heat exchanger for the transfer of heat between a first fluid (11), a hot fluid, and a second fluid (12), a cold fluid, wherein said heat exchanger comprises:

- a heat exchange tube bundle (5) extending according to a longitudinal direction (X-X') between an inlet (I) for the first fluid into the tube bundle and an outlet (O) for the first fluid from the tube bundle, wherein the heat exchange tube bundle (5) is intended for driving the flow of the first fluid (11),
- a shell (6) housing the heat exchange tube bundle (5) and extending according to the longitudinal direction (X-X') at least between the inlet (I) for the first fluid and the outlet (O) for the first fluid, wherein the shell (6) is intended for driving the second fluid (12) through the space defined between the tubes of the heat exchange tube bundle (5) and the shell (6),
- a tubular inlet segment (7) for the entry of the second fluid (12) into the shell (6) and a tubular outlet segment (8) for the exit of the second fluid (12) from inside the shell (6),

wherein

- the exchanger comprises at least one first manifold (3, 4) located, according to the longitudinal direction (X-X'), close to either the inlet (I) for the first fluid or else the outlet (O) for the first fluid, and positioned:

- either between the first tubular inlet segment (7) and the shell (6),
- between the second tubular outlet segment (8) and the shell (6),
- or else in both locations;

- the shell (6) has a slot (6.2) for the passage of the second fluid (12) between the inside of the first manifold (3, 4) and the inside of the shell (6) in which the tube bundle of the heat exchanger (5) is housed, this slot (6.2) being spaced from the corresponding inlet/outlet (I, O) for the first fluid in which said first manifold (3, 4) is located,
- the shell (6) has an extension (6.1) into the first manifold (3, 4) such that this prolongation (6.1) establishes a partial closure in the fluidic communication between the inside of the first manifold (3, 4) and the inside of the shell (6) in which the tube bundle of the heat exchanger (5) is housed, **characterized in that**
- the slot (6.2) has an essentially elongated configuration according to a main direction and has a variable width.

2. The heat exchanger according to claim 1, wherein the extension (6.1) is positioned such that is at least partially interposed in the path of the flow driven in the operating mode through the tubular inlet/outlet segment (7, 8) attached to the first manifold (3, 4).

3. The heat exchanger according to claim 1 or 2, wherein the first manifold (3, 4) has a base (3.1, 4.1) intended for being supported on the shell (6), wherein said base (3.1, 4.1) has:

- an essentially triangular configuration with a larger side and two smaller sides, with the vertexes of the triangular configuration being rounded,
- the larger side is perpendicular to the longitudinal direction (X-X') and is located on the side corresponding to the inlet/outlet (I, O) for the first fluid in which the at least one first manifold (3, 4) is located, and
- the vertex opposite this larger side is where at least the extension (6.1) of the shell (6) into the first manifold (3, 4) is located.

4. The heat exchanger according to claim 1 or 2, wherein the first manifold (3, 4) has a base (3.1, 4.1) intended for being supported on the shell (6), wherein said base (3.1, 4.1):

- has an essentially elongated configuration according to a main direction,
- has rounded ends, and
- the main direction along which it extends is essentially perpendicular to the longitudinal di-

rection (X-X').

5. The heat exchanger according to any of the preceding claims, wherein the slot (6.2) has an essentially elongated configuration according to a main direction and has a width decreasing from one end to the opposite end. 5
6. The heat exchanger according to any of the preceding claims, wherein the first tubular segment (7), the second tubular segment (8) or both tubular inlet/out segments (7, 8) are inclined with respect to the surface of the shell (6) on which they are fixed by means of the first manifold (3, 4). 10
7. The heat exchanger according to any of the preceding claims and claims 4 to 6, wherein the first tubular segment (7), the second tubular segment (8) or both tubular inlet/out segments (7, 8) are inclined towards the end of the wider slot. 20
8. The heat exchanger according to any of the preceding claims, wherein the first tubular segment (7) and the second tubular segment (8) are located off-center with respect to the central longitudinal axis and on opposite sides, and wherein at least the tubular segment (7, 8) located in the first manifold (3, 4) internally provided with a slot (6.2) having a variable width is off-center towards the end of the wider slot. 25
9. The heat exchanger according to any of the preceding claims, wherein the region of the shell (6) on which the second manifold (9, 10) is supported and forms the extension (6.1) is in the form of an expansion (6.4), increasing the space inside the shell (6). 30
10. The heat exchanger according to any of the preceding claims, wherein the first manifold (3, 4) has a base (3.1, 4.1) intended for being supported on the shell (6) formed either by means of a perimetral flange or else by means of a supporting edge. 40
11. The heat exchanger according to any of the preceding claims, additionally comprising: 45
 - a second inlet manifold (9) for the first fluid (11) located on the side of the inlet (I) for the entry of the first fluid into the tube bundle and configured such that in the operating mode, the first fluid (11) entering through an inlet opening (9.1) of said manifold (9) is driven into the tubes of the heat exchange tube bundle (5),
 - a second outlet manifold (10) for the first fluid (11) located on the side of the outlet (O) for the exit of the first fluid from the tube bundle and configured such that, in the operating mode, the first fluid (11) exiting from the inside of the tubes of the heat exchange tube bundle (5) is driven

to an outlet opening (4.1) of said manifold (4).

12. The heat exchanger according to any of the preceding claims and according to claim 11, wherein the first manifold (3, 4) and the second manifold (9, 10) arranged at the same end according to the longitudinal direction (X-X') are configured in a single part.
13. The heat exchanger according to any of the preceding claims, wherein the shell (6) is configured in at least two U-shaped parts and attached to one another through the legs of the U.
14. The heat exchanger according to any of the preceding claims, wherein the shell (6) shows two extensions overlapping one another wherein:
 - the outer extension, the inner extension or both is/are configured such that both extensions are spaced from one another configuring the first manifold (3),
 - at least in the perimetral region of the first manifold (3) the two extensions of the shell (6) are attached to one another; and
 - the first tubular inlet segment (7) or the second tubular outlet segment (8) is in fluidic communication with the first manifold (3).
15. The heat exchanger according to claim 14, wherein the region of the two extensions overlapping and spaced from one another extends between two adjacent faces of the shell (6).
16. The heat exchanger according to claim 14 or 15, wherein the access:
 - either of the tubular inlet segment (7) in fluidic communication with the first manifold (3),
 - or else of the tubular outlet segment (8) in fluidic communication with the first manifold (4),
 - or both,
 are spaced from their corresponding slot (6.2) according to the longitudinal direction X-X' such that the extension (6.1) and the first manifold (3) define a channel for the passage of the second fluid (12).
17. The heat exchanger according to any of the preceding claims, wherein a region of the extension (6.1) surrounding the slot (6.2) shows a deformation to deflect the flow of the second fluid (12) passing through said slot (6.2).
18. The heat exchanger according to any of the preceding claims, configured in two passages additionally comprising:
 - a wall (6.5) for establishing two chambers sep-

arating the tubes of the tube bundle into two groups, wherein the slot (6.2) of the first inlet manifold (3) is in fluidic communication with one of the chambers and the slot (6.2) of the first outlet manifold (4) is in fluidic communication with the other chamber; 5

- a direction-changing manifold (13) for putting the outlet of the tubes of the first group of tubes in fluidic communication with the inlet of the tubes of the second group of tubes. 10

19. An EGR or energy recovery system for a vehicle with an internal combustion engine comprising a heat exchanger according to any of the preceding claims. 15

Patentansprüche

1. Wärmetauscher für die Übertragung von Wärme zwischen einem ersten Fluid (11), einem warmen Fluid, und einem zweiten Fluid (12), einem kalten Fluid, wobei der Wärmetauscher umfasst: 20

ein Wärmeaustausch-Rohrbündel (5), das sich in einer Längsrichtung (X-X') zwischen einem Einlass (I) für das erste Fluid in das Rohrbündel und einem Auslass (O) für das erste Fluid aus dem Rohrbündel erstreckt, wobei das Wärmeaustausch-Rohrbündel (5) dazu bestimmt ist, den Strom des ersten Fluids (11) zu leiten, 25

ein Gehäuse (6), das das Wärmeaustausch-Rohrbündel (5) aufnimmt und sich wenigstens zwischen dem Einlass (I) für das erste Fluid und dem Auslass (O) für das erste Fluid in der Längsrichtung (X-X') erstreckt, wobei das Gehäuse (6) dazu bestimmt ist, das zweite Fluid (12) durch den zwischen den Rohren des Wärmeaustausch-Rohrbündels (5) und dem Gehäuse (6) gebildeten Raum zu leiten, 30

ein röhrenförmiges Einlass-Segment (7) für den Eintritt des zweiten Fluids (12) in das Gehäuse (6) und ein röhrenförmiges Auslass-Segment (8) für den Austritt des zweiten Fluids (12) aus dem Inneren des Gehäuses (6), 35

wobei 40

der Wärmetauscher wenigstens einen ersten Verteiler (3, 4) umfasst, der in der Längsrichtung (X-X') entweder in der Nähe des Einlasses (I) für das erste Fluid oder des Auslasses (O) für das erste Fluid angeordnet und wie folgt positioniert ist: 45

entweder zwischen dem ersten röhrenförmigen Einlass-Segment (7) und dem Gehäuse (6), 50

zwischen dem zweiten röhrenförmigen Auslass-Segment (8) und dem Gehäuse (6), 55

oder an beiden Stellen;

das Gehäuse (6) einen Schlitz (6.2) für den Durchgang des zweiten Fluids (12) zwischen dem Innenraum des ersten Verteilers (3, 4) und dem Innenraum des Gehäuses (6) aufweist, in dem das Rohrbündel des Wärmetauschers (5) aufgenommen ist, wobei dieser Schlitz (6.2) von dem entsprechenden Einlass/Auslass (I, O) für das erste Fluid beabstandet ist, in dem sich der erste Verteiler (3, 4) befindet,

das Gehäuse (6) eine Erweiterung (6.1) in den ersten Verteiler (3, 4) hinein derart aufweist, dass diese Verlängerung (6.1) einen teilweisen Verschluss in der Fluid-Verbindung zwischen dem Innenraum des ersten Verteilers (3, 4) und dem Innenraum des Gehäuses (6) bildet, in dem das Rohrbündel des Wärmetauschers (5) aufgenommen ist,

dadurch gekennzeichnet, dass

der Schlitz (6.2) einen im Wesentlichen länglichen Aufbau in einer Hauptrichtung hat und eine variable Breite hat.

2. Wärmetauscher nach Anspruch 1, wobei die Erweiterung (6.1) so positioniert ist, dass sie wenigstens teilweise in den Weg des in dem Betriebsmodus geleiteten Stroms durch das an dem ersten Verteiler (3, 4) angebrachte röhrenförmige Einlass-/Auslass-Segment (7, 8) eingefügt ist.
3. Wärmetauscher nach Anspruch 1 oder 2, wobei der erste Verteiler (3, 4) einen Sockel (3.1, 4.1) aufweist, der zum Aufsetzen auf das Gehäuse (6) bestimmt ist, und wobei der Sockel (3.1, 4.1) aufweist:

- einen im Wesentlichen dreieckigen Aufbau mit einer größeren Seite und zwei kleineren Seiten, wobei die Ecken des dreieckigen Aufbaus abgerundet sind

- die größere Seite senkrecht zu der Längsrichtung (X-X') ist und sich an der dem Einlass/Auslass (I, O) für das erste Fluid entsprechenden Seite befindet, an der sich der wenigstens eine erste Verteiler (3, 4) befindet, und

- die dieser größeren Seite gegenüberliegende Ecke dort liegt, wo wenigstens die Erweiterung (6.1) des Gehäuses (6) in den ersten Verteiler (3, 4) hinein angeordnet ist.

4. Wärmetauscher nach Anspruch 1 oder 2, wobei der erste Verteiler (3, 4) einen Sockel (3.1, 4.1) aufweist, der zum Aufsetzen auf das Gehäuse (6) bestimmt ist, und wobei der Sockel (3.1, 4.1)

- einen im Wesentlichen länglichen Aufbau in einer Hauptrichtung hat,

- abgerundete Enden aufweist, und
 - die Hauptrichtung, in der er sich erstreckt, im Wesentlichen senkrecht zu der Längsrichtung (X-X') ist.
- 5
5. Wärmetauscher nach einem der vorangehenden Ansprüche, wobei der Schlitz (6.2) einen im Wesentlichen länglichen Aufbau in einer Hauptrichtung hat und eine Breite hat, die von einem Ende zu dem gegenüberliegenden Ende abnimmt.
- 10
6. Wärmetauscher nach einem der vorangehenden Ansprüche, wobei das erste röhrenförmige Segment (7), das zweite röhrenförmige Segment (8) oder beide röhrenförmigen Einlass-/Auslass-Segmente (7, 8) in Bezug auf die Fläche des Gehäuses (6) geneigt sind, an der sie mittels des ersten Verteilers (3, 4) befestigt sind.
- 15
7. Wärmetauscher nach einem der vorangehenden Ansprüche und den Ansprüchen 4 bis 6, wobei das erste röhrenförmige Segment (7), das zweite röhrenförmige Segment (8) oder beide röhrenförmigen Einlass-/Auslass-Segmente (7, 8) zum Ende des breiteren Schlitzes hin geneigt sind.
- 20
8. Wärmetauscher nach einem der vorangehenden Ansprüche, wobei das erste röhrenförmige Segment (7) und das zweite röhrenförmige Segment (8) exzentrisch in Bezug auf die Längs-Mittelachse versetzt und an gegenüberliegenden Seiten angeordnet sind, und wobei wenigstens das röhrenförmige Segment (7, 8), das sich in dem ersten Verteiler (3, 4) befindet, der an seiner Innenseite mit einem Schlitz (6.2) mit einer variablen Breite versehen ist, exzentrisch zu dem Ende des breiteren Schlitzes hin versetzt ist.
- 30
9. Wärmetauscher nach einem der vorangehenden Ansprüche, wobei der Bereich des Gehäuses (6), an dem der zweite Verteiler (9, 10) aufsitzt und der die Erweiterung (6.1) bildet, die Form einer Aufweitung (6.4) hat, die den Raum innerhalb des Gehäuses (6) vergrößert.
- 35
10. Wärmetauscher nach einem der vorangehenden Ansprüche, wobei der erste Verteiler (3, 4) einen Sockel (3.1, 4.1) aufweist, der zum Aufsetzen auf das Gehäuse (6) bestimmt ist und entweder durch einen Umfangsflansch oder durch eine aufsitzende Kante gebildet wird.
- 40
11. Wärmetauscher nach einem der vorangehenden Ansprüche, der zusätzlich umfasst:
- 45
- einen zweiten Einlass-Verteiler (9) für das erste Fluid (11), der sich an der Seite des Einlasses (I) für den Eintritt des ersten Fluids in das Rohr-
- 50
- bündel befindet und so eingerichtet ist, dass in dem Betriebsmodus das über eine Einlassöffnung (9.1) des Verteilers (9) eintretende erste Fluid (11) in die Rohre des Wärmeaustausch-Rohrbündels (5) eingeleitet wird,
- 55
- einen zweiten Auslass-Verteiler (10) für das erste Fluid (11), der sich an der Seite des Auslasses (O) für den Austritt des ersten Fluids aus dem Rohrbündel befindet und so eingerichtet ist, dass in dem Betriebsmodus das aus dem Inneren der Rohre des Wärmeaustausch-Rohrbündels (5) austretende erste Fluid (11) zu einer Auslassöffnung (4.1) des Verteilers (4) geleitet wird.
12. Wärmetauscher nach einem der vorangehenden Ansprüche und nach Anspruch 11, wobei der erste Verteiler (3, 4) und der zweite Verteiler (9, 10), die an dem gleichen Ende in der Längsrichtung (X-X') angeordnet sind, als ein Teil ausgeführt sind.
13. Wärmetauscher nach einem der vorangehenden Ansprüche, wobei das Gehäuse (6) in wenigstens zwei U-förmigen Teilen ausgeführt ist, die über die Schenkel des U miteinander verbunden sind.
14. Wärmetauscher nach einem der vorangehenden Ansprüche, wobei das Gehäuse (6) zwei Erweiterungen aufweist, die einander überlappen, und wobei:
- die äußere Erweiterung, die innere Erweiterung oder beide so ausgeführt ist/sind, dass beide Erweiterungen voneinander beabstandet sind und den ersten Verteiler (3) bilden,
 - wenigstens in dem Umfangsbereich des ersten Verteilers (3) die zwei Erweiterungen des Gehäuses (6) aneinander angebracht sind; und
 - das erste röhrenförmige Einlass-Segment (7) oder das zweite röhrenförmige Auslass-Segment (8) in Fluid-Verbindung mit dem ersten Verteiler (3) steht.
15. Wärmetauscher nach Anspruch 14, wobei sich der Bereich der einander überlappenden und voneinander beabstandeten zwei Erweiterungen zwischen zwei benachbarten Flächen des Gehäuses (6) erstreckt.
16. Wärmetauscher nach Anspruch 14 oder 15, wobei der Zugang entweder des röhrenförmigen Einlass-Segments (7), das in Fluid-Verbindung mit dem ersten Verteiler (3) steht, oder des röhrenförmigen Auslass-Segments (8), das in Fluidverbindung mit dem ersten Verteiler (4) steht, oder beide in der Längsrichtung X-X' von ihrem entsprechenden

Schlitz (6.2) so beabstandet sind, dass die Erweiterung (6.1) und der erste Verteiler (3) einen Kanal für den Durchgang des zweiten Fluids (12) bilden.

17. Wärmetauscher nach einem der vorangehenden Ansprüche, wobei ein Bereich der Erweiterung (6.1), der den Schlitz (6.2) umgibt, eine Verformung aufweist, durch die der Strom des zweiten Fluids (12) abgelenkt wird, der durch den Schlitz (6.2) hindurchtritt. 5
18. Wärmetauscher nach einem der vorangehenden Ansprüche, der in zwei Kanälen ausgeführt ist und zusätzlich umfasst: 10
- eine Wand (6.5), durch die zwei Kammern gebildet werden, die die Rohre des Rohrbündels in zwei Gruppen trennen, wobei der Schlitz (6.2) des ersten Einlass-Verteilers (3) in Fluid-Verbindung mit einer der Kammern steht und der Schlitz (6.2) des ersten Auslass-Verteilers (4) in Fluid-Verbindung mit der anderen Kammer steht; 20
 - einen Richtungsänderungs-Verteiler (13), der den Auslass der Rohre der ersten Gruppe von Rohren in Fluid-Verbindung mit dem Einlass der Rohre der zweiten Gruppe von Rohren bringt. 25
19. AGR- oder Energierückgewinnungs-System für ein Fahrzeug mit einem Verbrennungsmotor, das einen Wärmetauscher nach einem der vorangehenden Ansprüche umfasst. 30

Revendications 35

1. Échangeur de chaleur pour le transfert de chaleur entre un premier fluide (11), un fluide chaud, et un second fluide (12), un fluide froid, dans lequel ledit échangeur de chaleur comprend : 40
- un faisceau de tubes d'échange de chaleur (5) s'étendant selon une direction longitudinale (X-X') entre une entrée (I) pour le premier fluide dans le faisceau de tubes et une sortie (O) pour le premier fluide du faisceau de tubes, dans lequel le faisceau de tubes d'échange de chaleur (5) est prévu pour entraîner l'écoulement du premier fluide (11), 45
 - une coque (6) logeant le faisceau de tubes d'échange de chaleur (5) et s'étendant selon la direction longitudinale (X-X') au moins entre l'entrée (I) pour le premier fluide et la sortie (O) pour le premier fluide, dans lequel la coque (6) est prévue pour entraîner le second fluide (12) à travers l'espace défini entre les tubes du faisceau de tubes d'échange de chaleur (5) et la coque (6), 50 55

- un segment d'entrée tubulaire (7) pour l'entrée du second fluide (12) dans la coque (6) et un segment de sortie tubulaire (8) pour la sortie du second fluide (12) de l'intérieur de la coque (6), dans lequel :

- l'échangeur de chaleur comprend au moins un premier collecteur (3, 4) positionné, selon la direction longitudinale (X-X'), à proximité de l'entrée (I) pour le premier fluide ou bien la sortie (O) pour le premier fluide, et positionné :

- soit entre le premier segment d'entrée tubulaire (7) et la coque (6),
- soit entre le second segment de sortie tubulaire (8) et la coque (6),
- ou bien aux deux emplacements ;

- la coque (6) a une fente (6.2) pour le passage du second fluide (12) entre l'intérieur du premier collecteur (3, 4) et l'intérieur de la coque (6) dans laquelle le faisceau de tubes de l'échangeur de chaleur (5) est logé, cette fente (6.2) étant espacée de l'entrée/sortie (I, O) correspondante pour le premier fluide dans laquelle ledit premier collecteur (3, 4) est positionné,

- la coque (6) a une extension (6.1) dans le premier collecteur (3, 4) de sorte que ce prolongement (6.1) établit une fermeture partielle dans la communication fluidique entre l'intérieur du premier collecteur (3, 4) et l'intérieur de la coque (6) dans laquelle le faisceau de tubes de l'échangeur de chaleur (5) est logé,

caractérisé en ce que : 35

- la fente (6.2) a une configuration essentiellement allongée selon une direction principale et a une largeur variable.

2. Échangeur de chaleur selon la revendication 1, dans lequel l'extension (6.1) est positionnée de sorte qu'elle est au moins partiellement intercalée dans la trajectoire de l'écoulement entraîné dans le mode opératoire par le segment tubulaire d'entrée/sortie (7, 8) fixé sur le premier collecteur (3, 4). 45

3. Échangeur de chaleur selon la revendication 1 ou 2, dans lequel le premier collecteur (3, 4) a une base (3.1, 4.1) prévue pour être supportée sur la coque (6), dans lequel ladite base (3.1, 4.1) a : 50

- une configuration essentiellement triangulaire avec un grand côté et deux petits côtés, avec les sommets de la configuration triangulaire qui sont arrondis,
- le grand côté est perpendiculaire à la direction longitudinale (X-X') et est positionné sur le côté correspondant à l'entrée/sortie (I, O) pour le pre-

- mier fluide dans laquelle le au moins un premier collecteur (3, 4) est positionné, et
 - le sommet opposé à ce grand côté est à l'endroit où au moins l'extension (6.1) de la coque (6) dans le premier collecteur (3, 4) est positionnée. 5
4. Échangeur de chaleur selon la revendication 1 ou 2, dans lequel le premier collecteur (3, 4) a une base (3.1, 4.1) prévue pour être supportée sur la coque (6), dans lequel ladite base (3.1, 4.1) : 10
- a une configuration essentiellement allongée selon une direction principale,
 - a des extrémités arrondies, et 15
 - la direction principale le long de laquelle elle s'étend, est essentiellement perpendiculaire à la direction longitudinale (X-X').
5. Échangeur de chaleur selon l'une quelconque des revendications précédentes, dans lequel la fente (6.2) a une configuration essentiellement allongée selon une direction principale et a une largeur diminuant d'une extrémité à l'extrémité opposée. 20
6. Échangeur de chaleur selon l'une quelconque des revendications précédentes, dans lequel le premier segment tubulaire (7), le second segment tubulaire (8) ou à la fois les segments tubulaires d'entrée/sortie (7, 8) sont inclinés par rapport à la surface de la coque (6) sur laquelle ils sont fixés au moyen du premier collecteur (3, 4). 25
7. Échangeur de chaleur selon l'une quelconque des revendications précédentes et selon les revendications 4 à 6, dans lequel le premier segment tubulaire (7), le second segment tubulaire (8) ou à la fois les segments tubulaires d'entrée/sortie (7, 8) sont inclinés vers l'extrémité de la fente plus large. 30
8. Échangeur de chaleur selon l'une quelconque des revendications précédentes, dans lequel le premier segment tubulaire (7) et le second segment tubulaire (8) sont décentrés par rapport à l'axe longitudinal central et sur les côtés opposés, et dans lequel au moins le segment tubulaire (7, 8) positionné dans le premier collecteur (3, 4) intérieurement prévu avec une fente (6.2) ayant une largeur variable est décentré vers l'extrémité de la fente plus large. 35
9. Échangeur de chaleur selon l'une quelconque des revendications précédentes, dans lequel la région de la coque (6) sur laquelle le second collecteur (9, 10) est supporté et forme l'extension (6.1) se présente sous la forme d'une expansion (6.4), augmentant l'espace à l'intérieur de la coque (6). 40
10. Échangeur de chaleur selon l'une quelconque des revendications précédentes, dans lequel le premier collecteur (3, 4) a une base (3.1, 4.1) prévue pour être supportée sur la coque (6) formée au moyen d'une bride périmétrale ou bien au moyen d'un bord de support. 45
11. Échangeur de chaleur selon l'une quelconque des revendications précédentes, comprenant en outre : 50
- un second collecteur d'entrée (9) pour le premier fluide (11) positionné sur le côté de l'entrée (I) pour l'entrée du premier fluide dans le faisceau de tubes et configuré de sorte que dans le mode opératoire, le premier fluide (11) entrant par une ouverture d'entrée (9.1) dudit collecteur (9) est entraîné dans les tubes du faisceau de tubes d'échange de chaleur (5),
 - un second collecteur de sortie (10) pour le premier fluide (11) positionné sur le côté de la sortie (O) pour la sortie du premier fluide du faisceau de tubes et configuré de sorte que, dans le mode opératoire, le premier fluide (11) sortant de l'intérieur des tubes du faisceau de tubes d'échange de chaleur (5) est entraîné vers une ouverture de sortie (4.1) dudit collecteur (4). 55
12. Échangeur de chaleur selon l'une quelconque des revendications précédentes et selon la revendication 11, dans lequel le premier collecteur (3, 4) et le second collecteur (9, 10) agencés au niveau de la même extrémité selon la direction longitudinale (X-X') sont configurés en une seule pièce.
13. Échangeur de chaleur selon l'une quelconque des revendications précédentes, dans lequel la coque (6) est configurée en au moins deux parties en forme de U et fixées entre elles par le biais des pattes du U.
14. Échangeur de chaleur selon l'une quelconque des revendications précédentes, dans lequel la coque (6) représente deux extensions se chevauchant, dans lequel : 60
- l'extension externe, l'extension interne ou les deux est/sont configurée(s) de sorte que les deux extensions sont espacées l'une de l'autre, configurant le premier collecteur (3),
 - au moins dans la région périmétrale du premier collecteur (3), les deux extensions de la coque (6) sont fixées entre elles ; et
 - le premier segment d'entrée tubulaire (7) ou le second segment de sortie tubulaire (8) est en communication fluidique avec le premier collecteur (3). 65
15. Échangeur de chaleur la revendication 14, dans lequel la région des deux extensions qui se chevauchent et espacées l'une de l'autre s'étend entre deux

faces adjacentes de la coque (6).

16. Échangeur de chaleur selon la revendication 14 ou 15, dans lequel l'accès :

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- soit du segment d'entrée tubulaire (7) en communication fluïdique avec le premier collecteur (3),
- ou bien du segment de sortie tubulaire (8) en communication fluïdique avec le premier collecteur (4),
- ou bien des deux,

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sont espacés de leur fente (6.2) correspondante selon la direction longitudinale X-X' de sorte que l'extension (6.1) et le premier collecteur (3) définissent un canal pour le passage du second fluïde (12).

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17. Échangeur de chaleur selon l'une quelconque des revendications précédentes, dans lequel une région de l'extension (6.1) entourant la fente (6.2) représente une déformation pour dévier l'écoulement du second fluïde (12) passant par ladite fente (6.2).

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18. Échangeur de chaleur selon l'une quelconque des revendications précédentes, configuré dans deux passages comprenant en outre :

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- une paroi (6.5) pour établir deux chambres séparant les tubes du faisceau de tubes en deux groupes, dans lequel la fente (6.2) du premier collecteur d'entrée (3) est en communication fluïdique avec l'une des chambres et la fente (6.2) du premier collecteur de sortie (4) est en communication fluïdique avec l'autre chambre ;
- un collecteur de changement de direction (13) pour placer la sortie des tubes du premier groupe de tubes en communication fluïdique avec l'entrée des tubes du second groupe de tubes.

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19. Système de EGR ou à récupération d'énergie pour un véhicule avec un moteur à combustion interne comprenant un échangeur de chaleur selon l'une quelconque des revendications précédentes.

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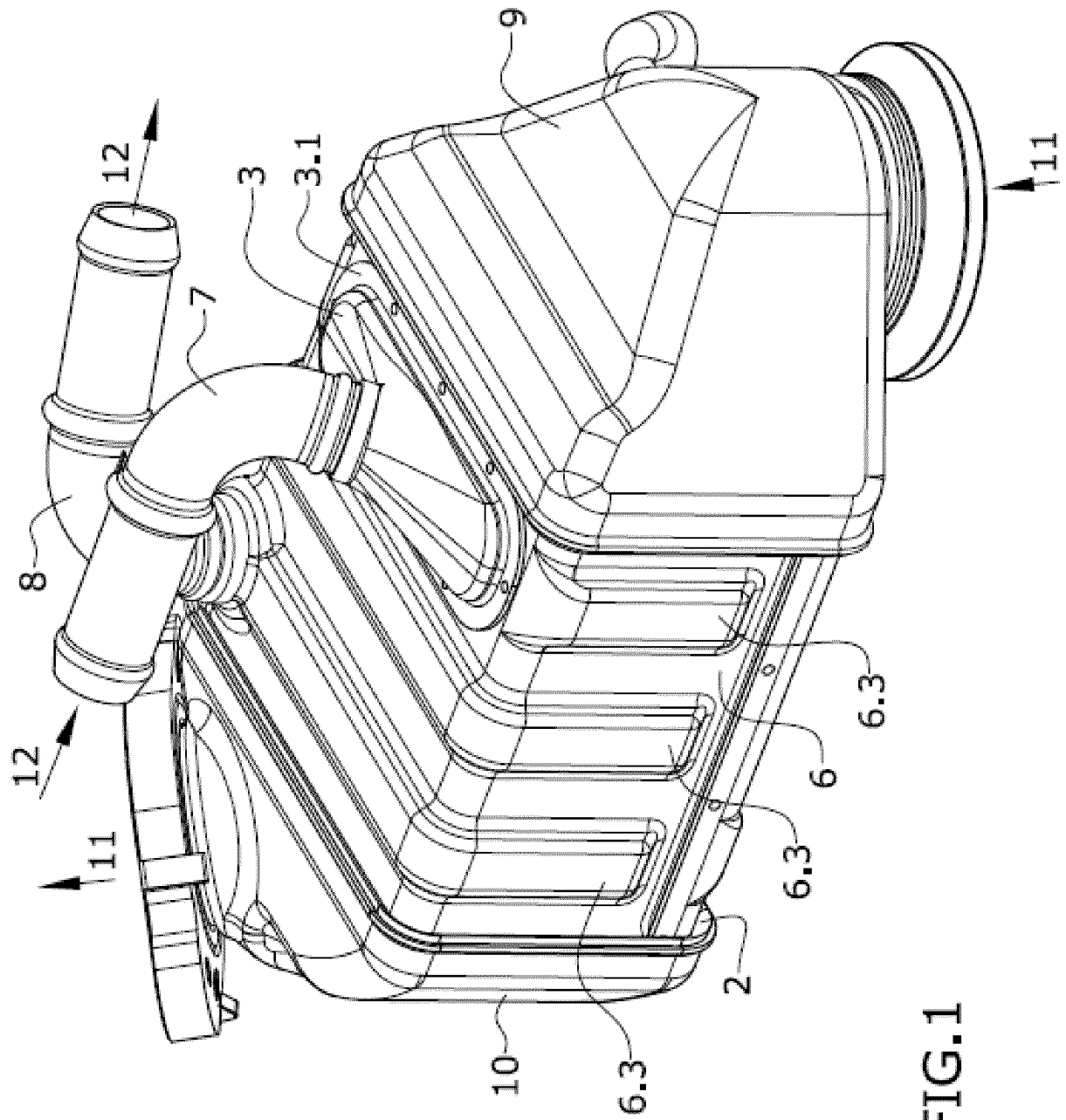


FIG.1

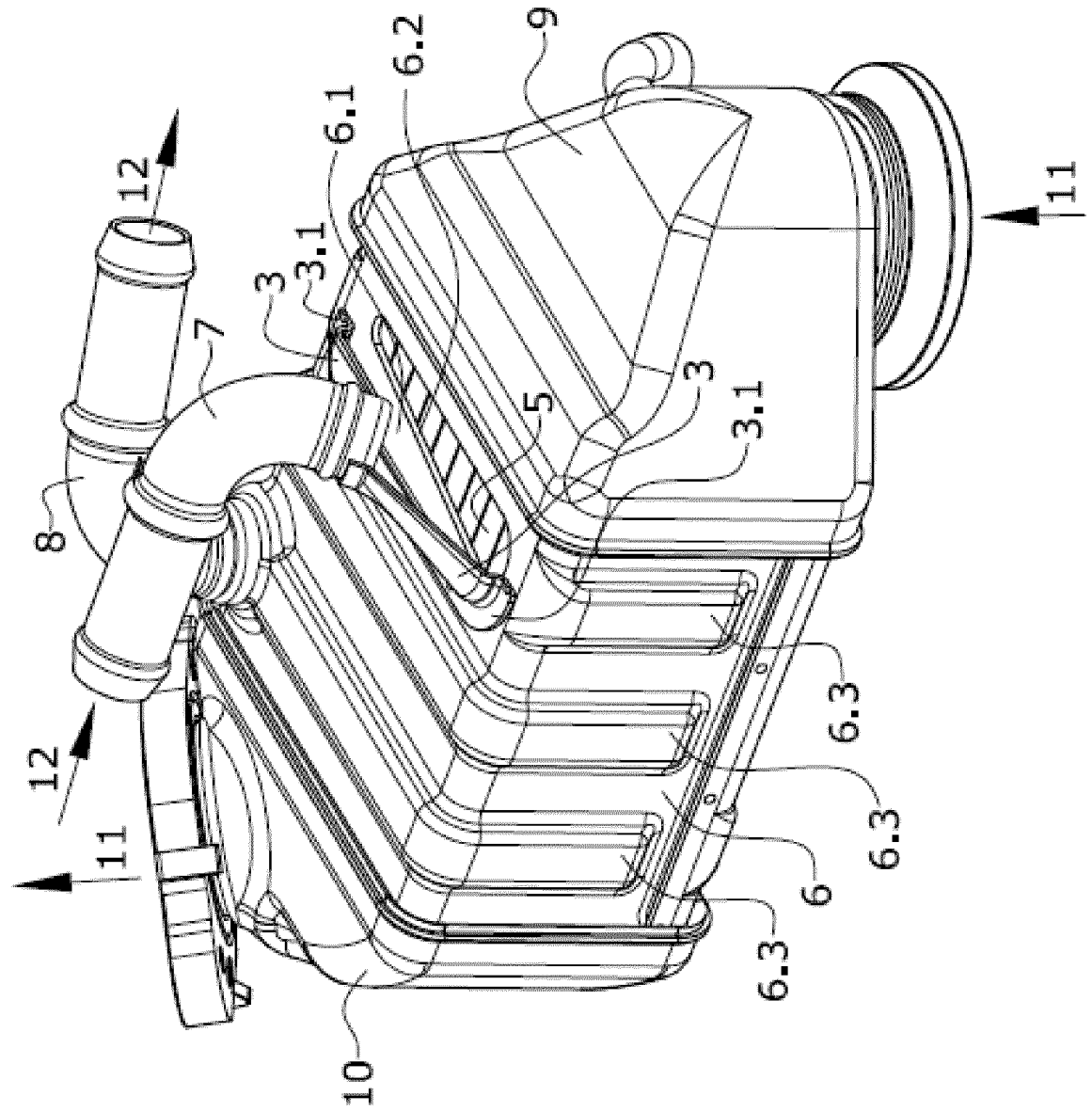
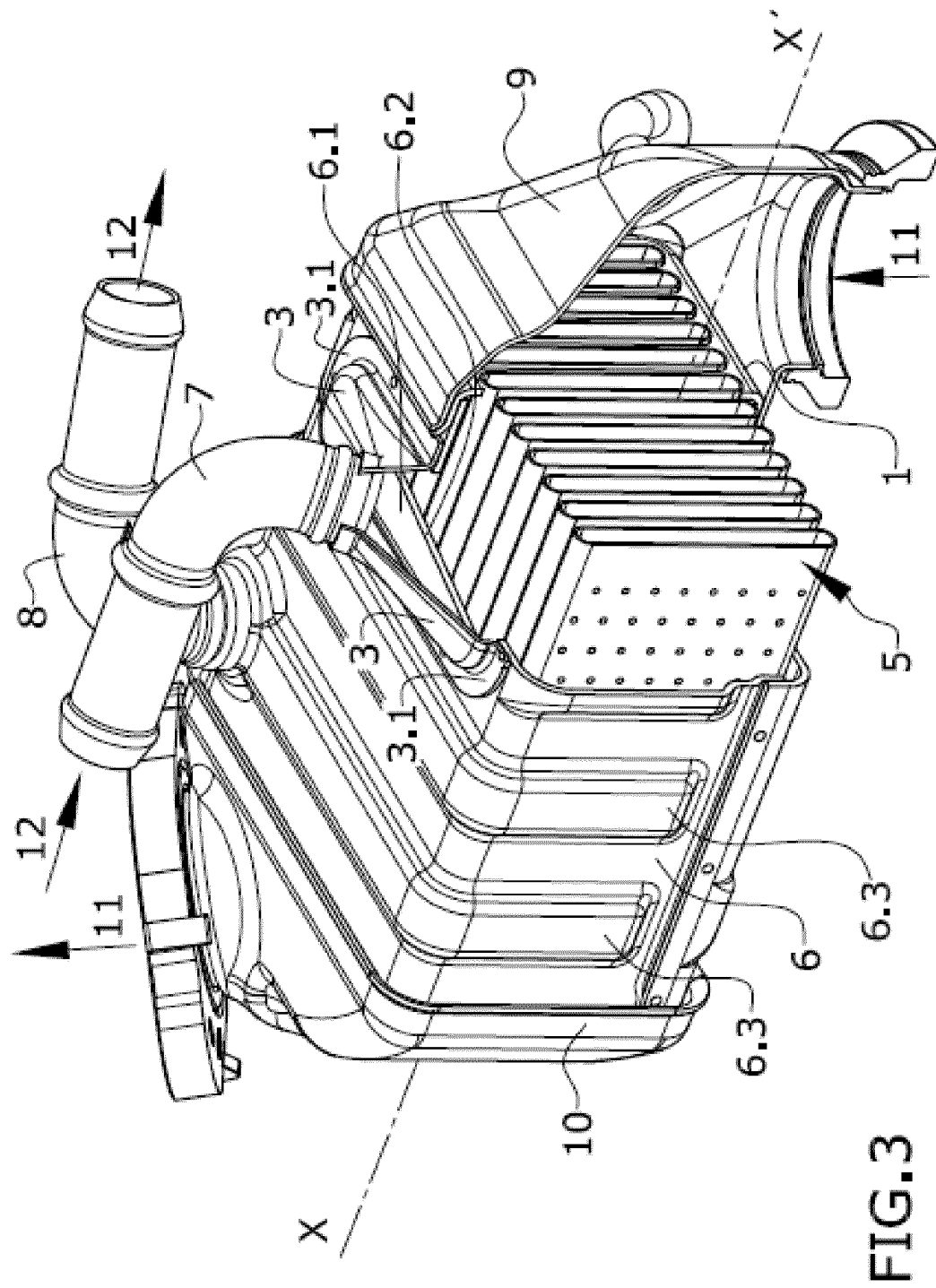


FIG. 2



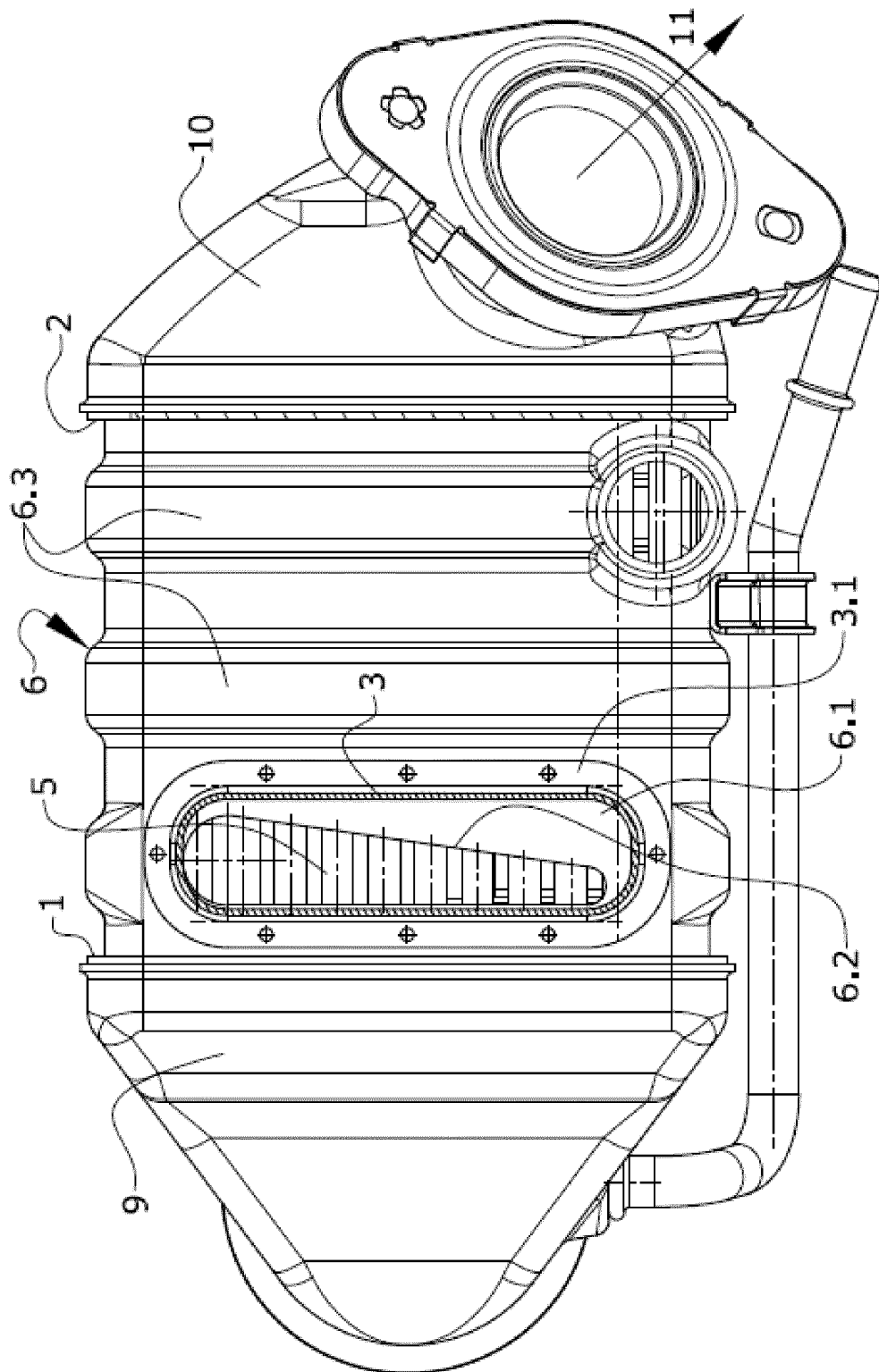


FIG.4

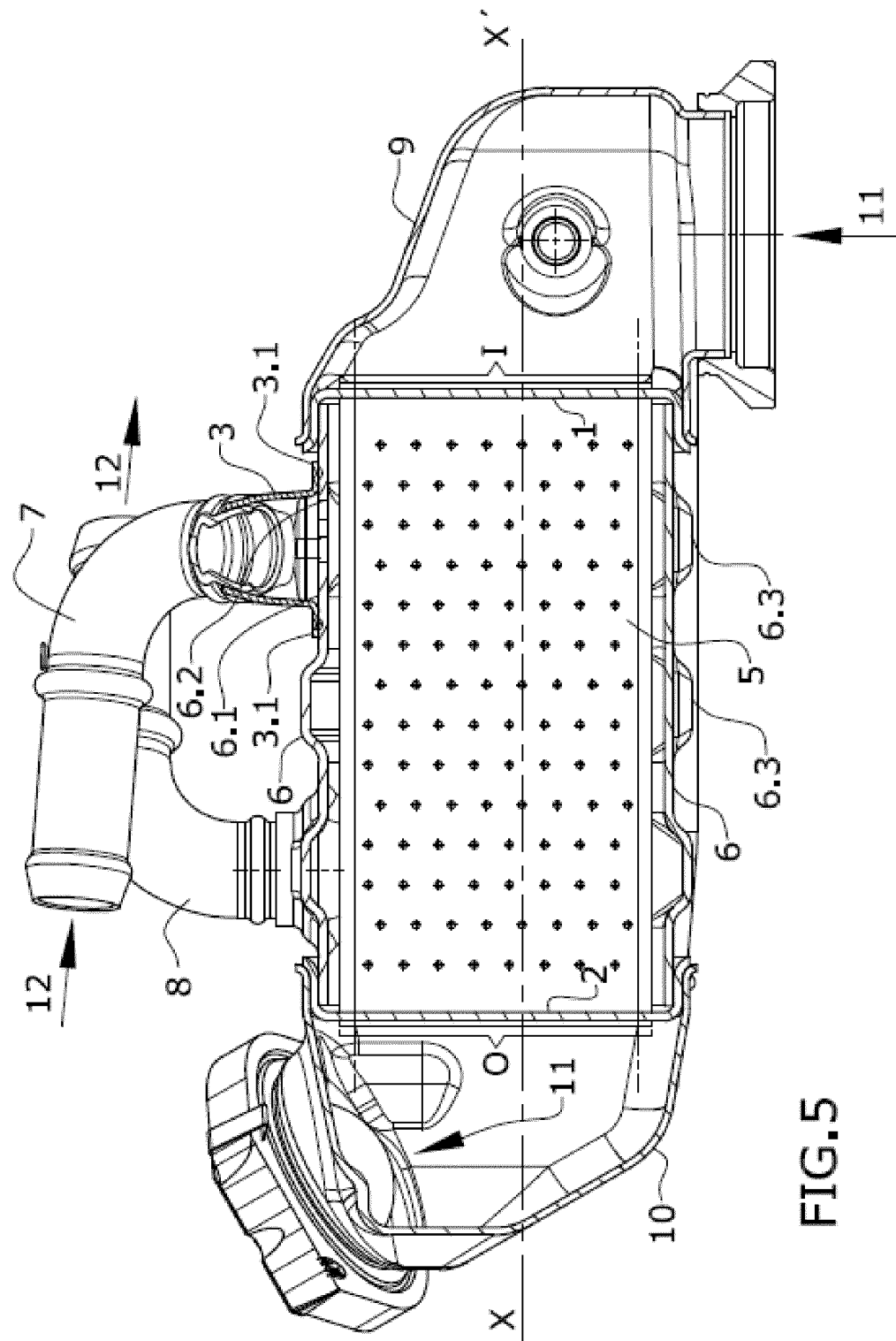


FIG. 5

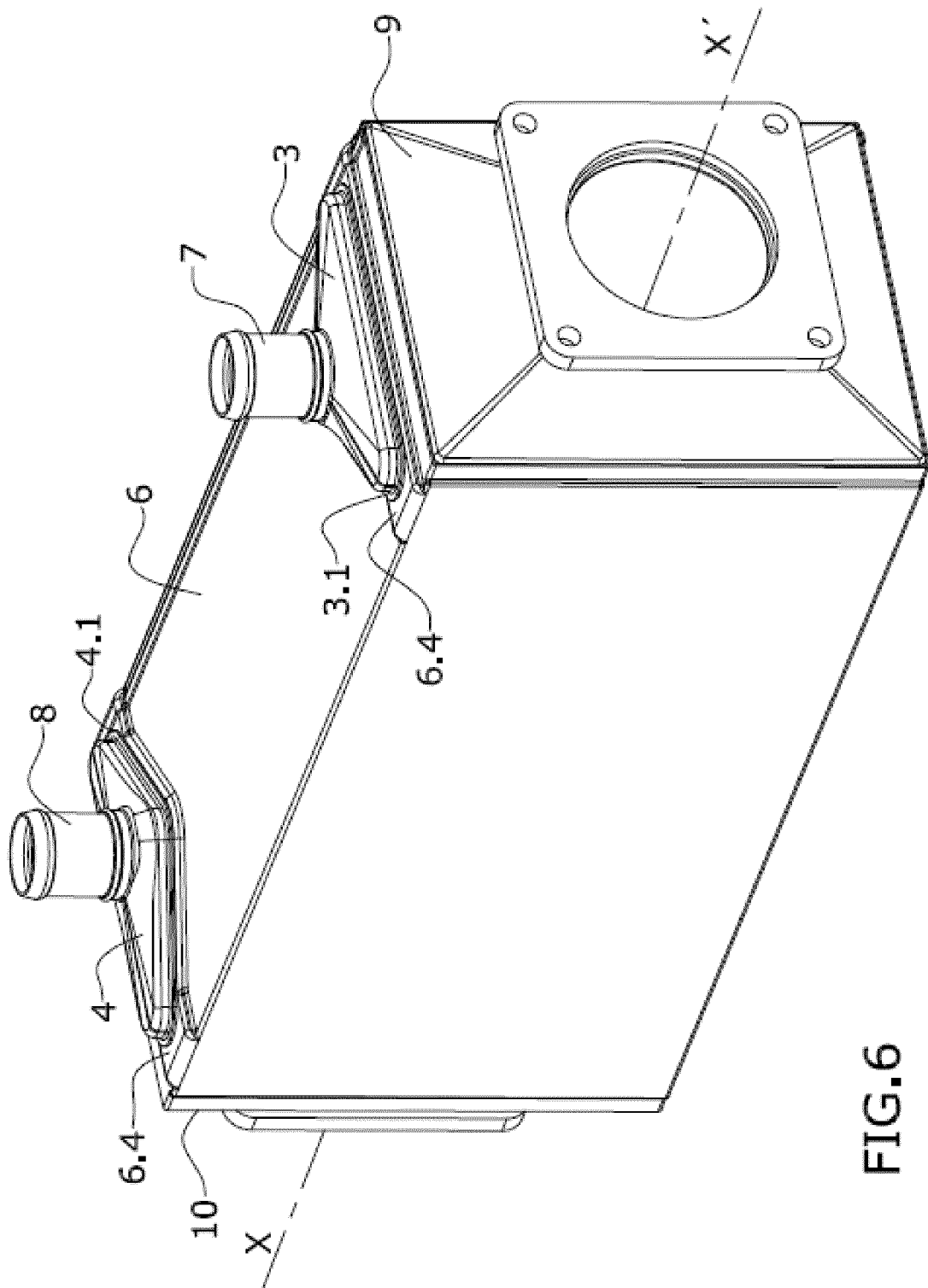


FIG.6

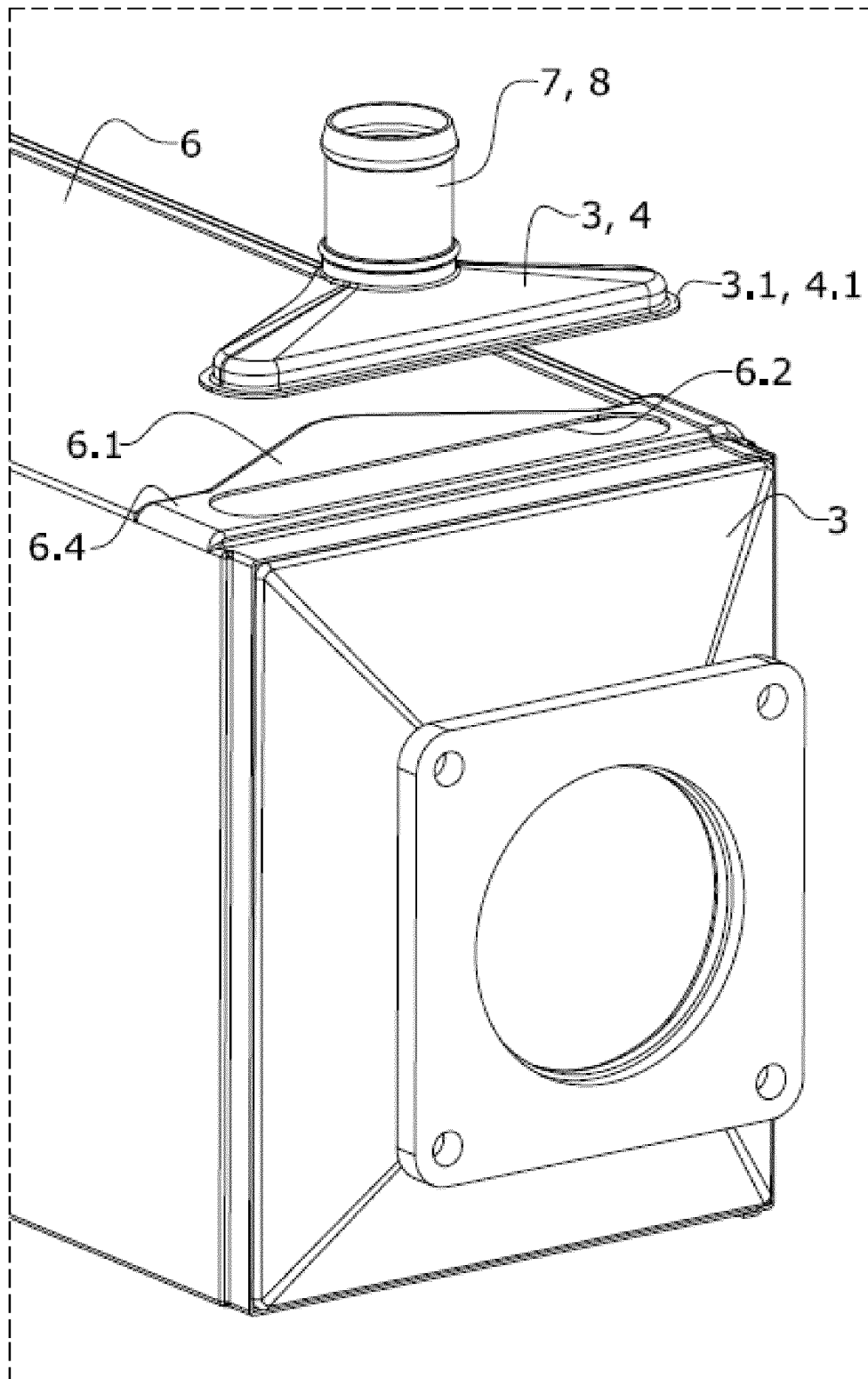


FIG.7

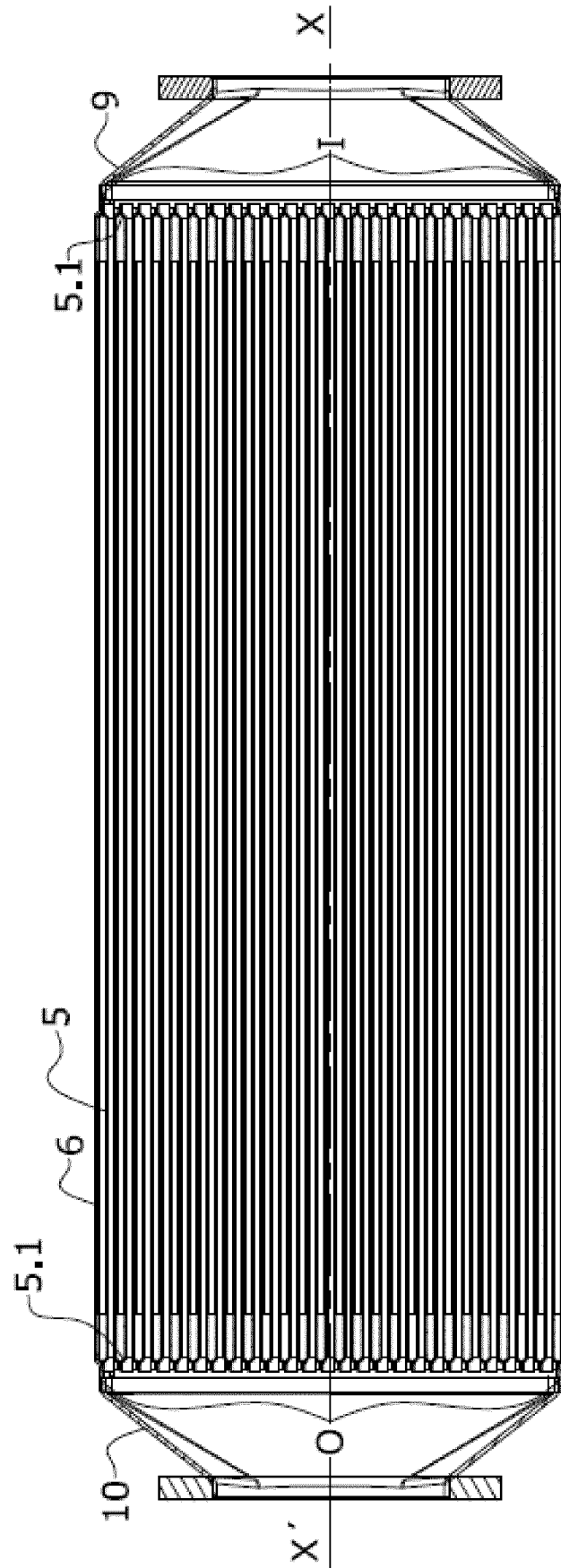


FIG. 8

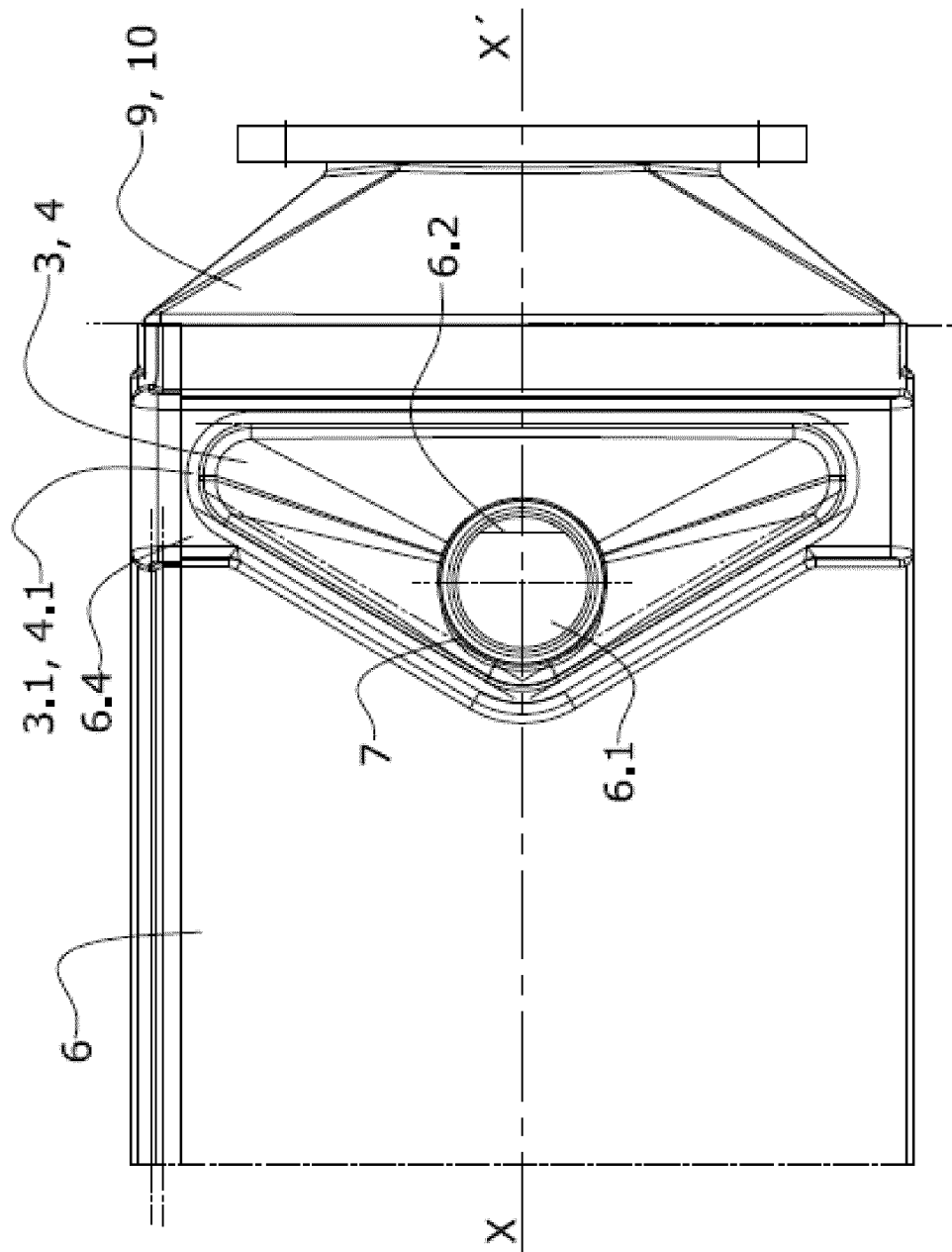


FIG. 9

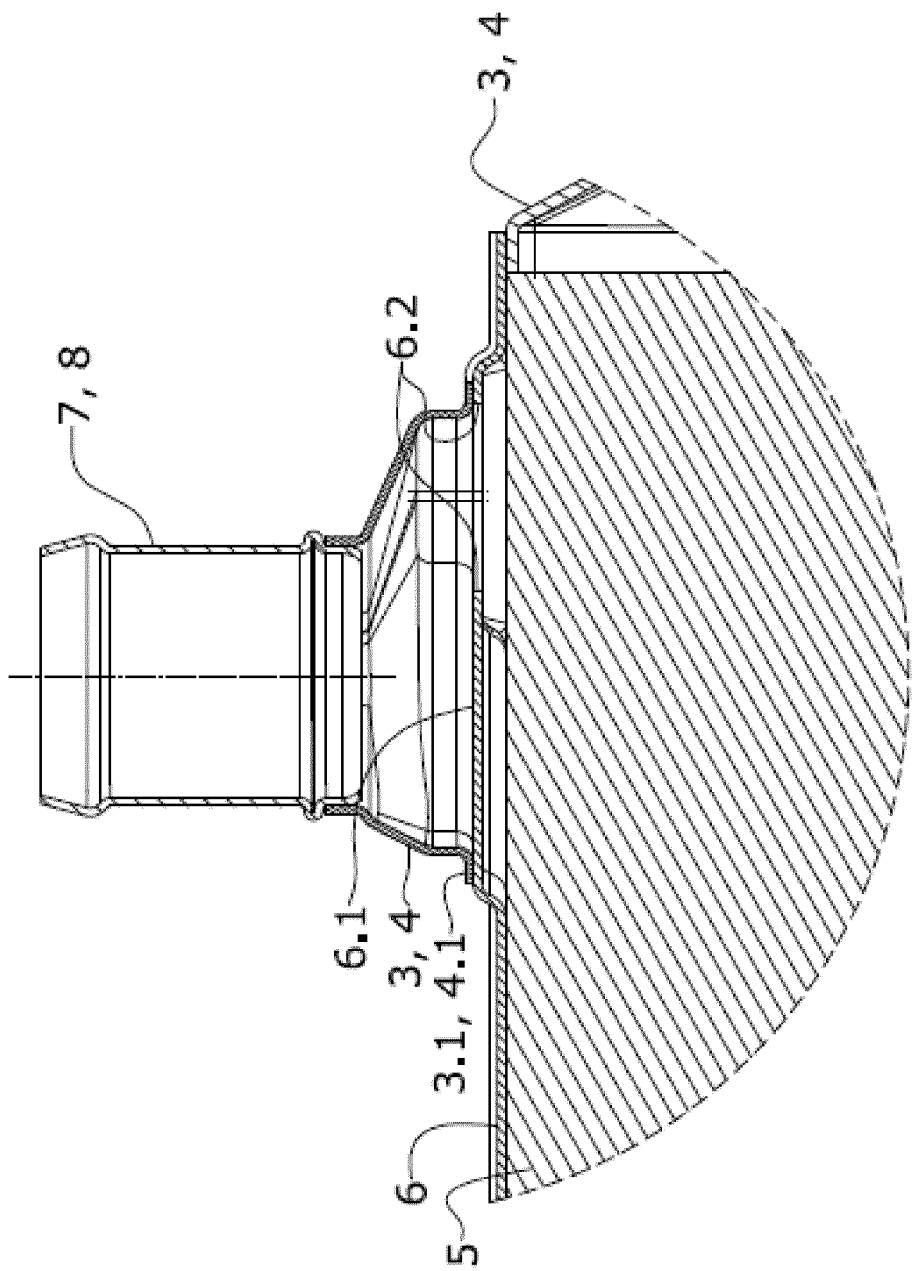


FIG.10

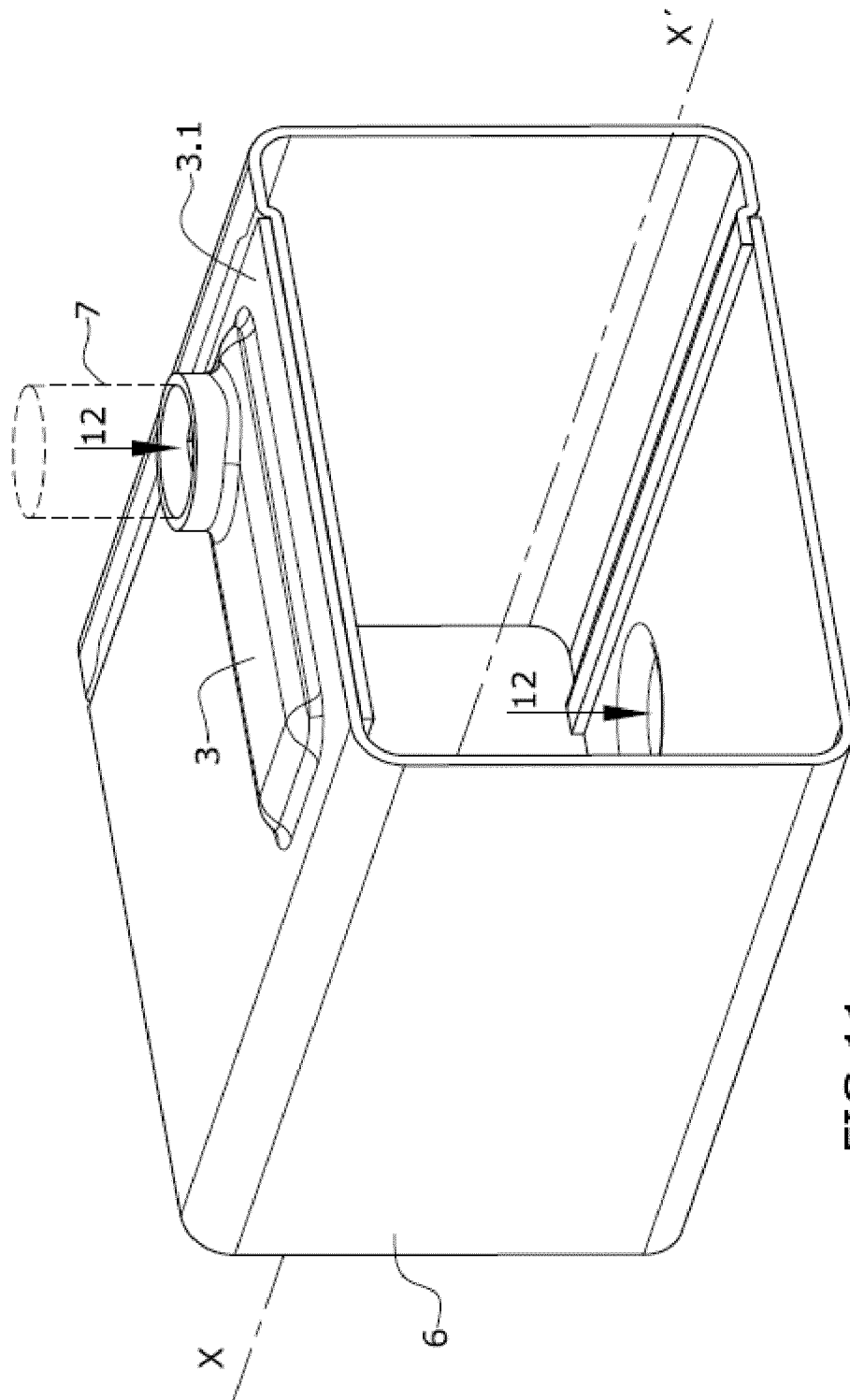


FIG.11

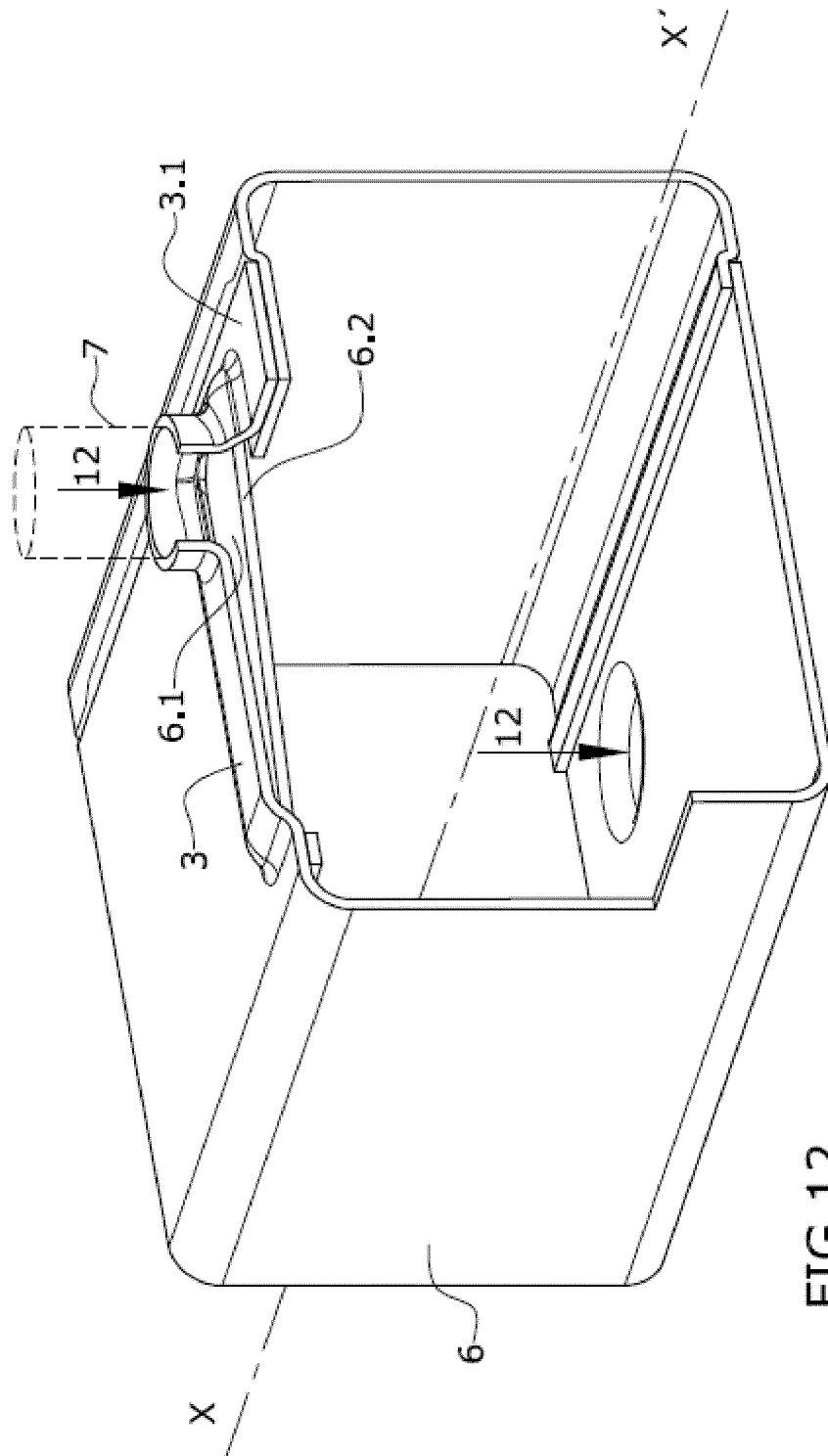


FIG. 12

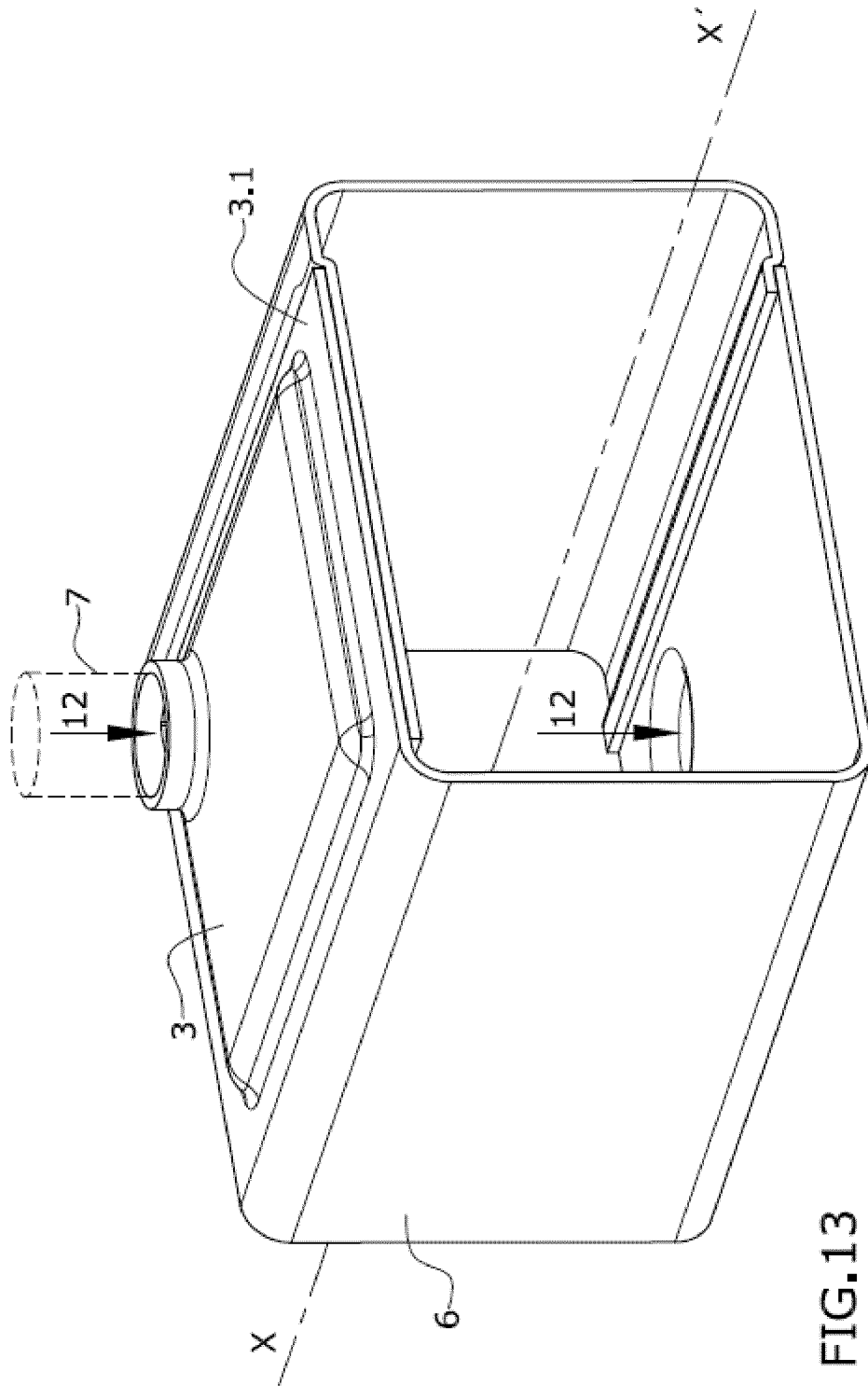


FIG. 13

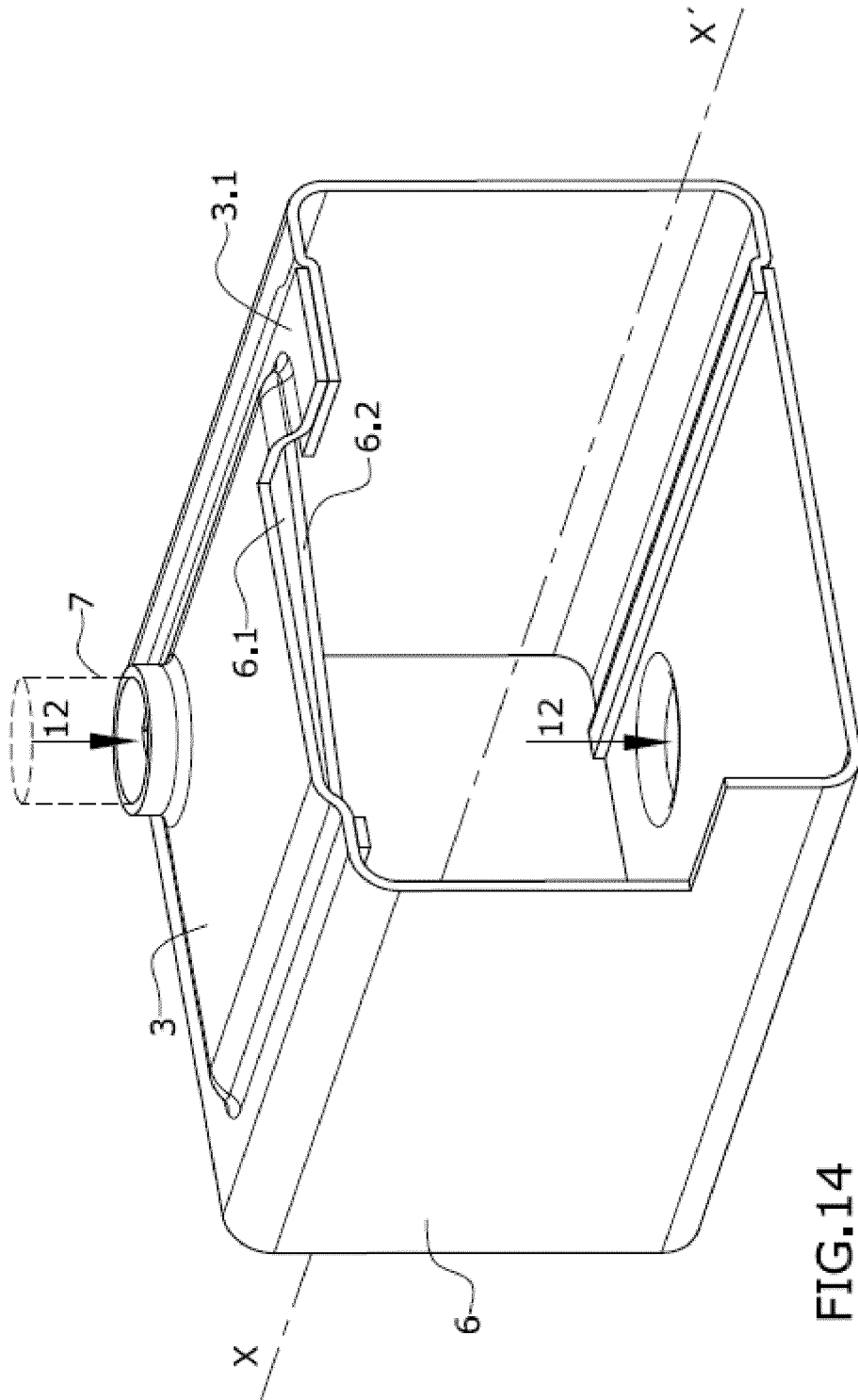


FIG. 14

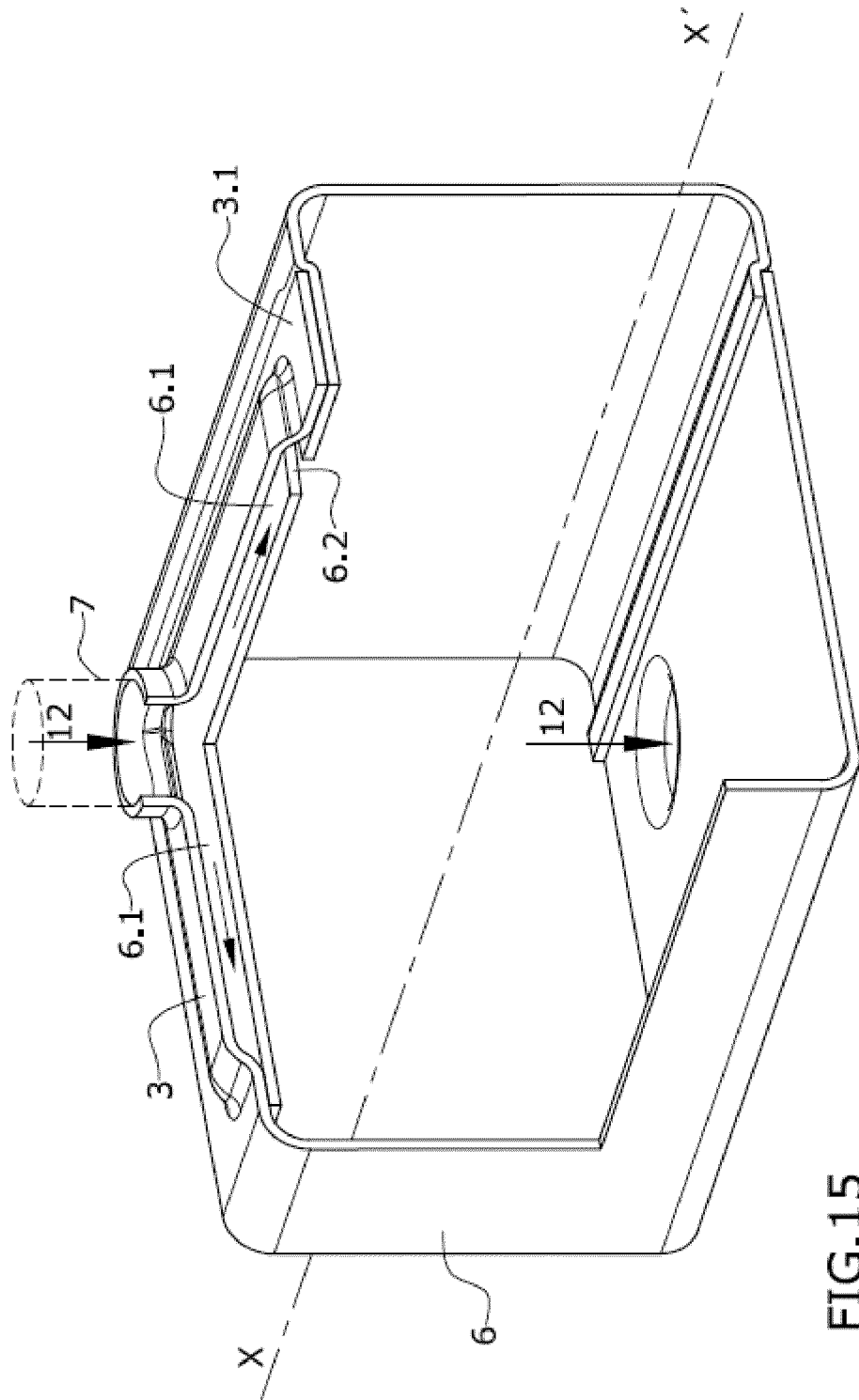


FIG. 15

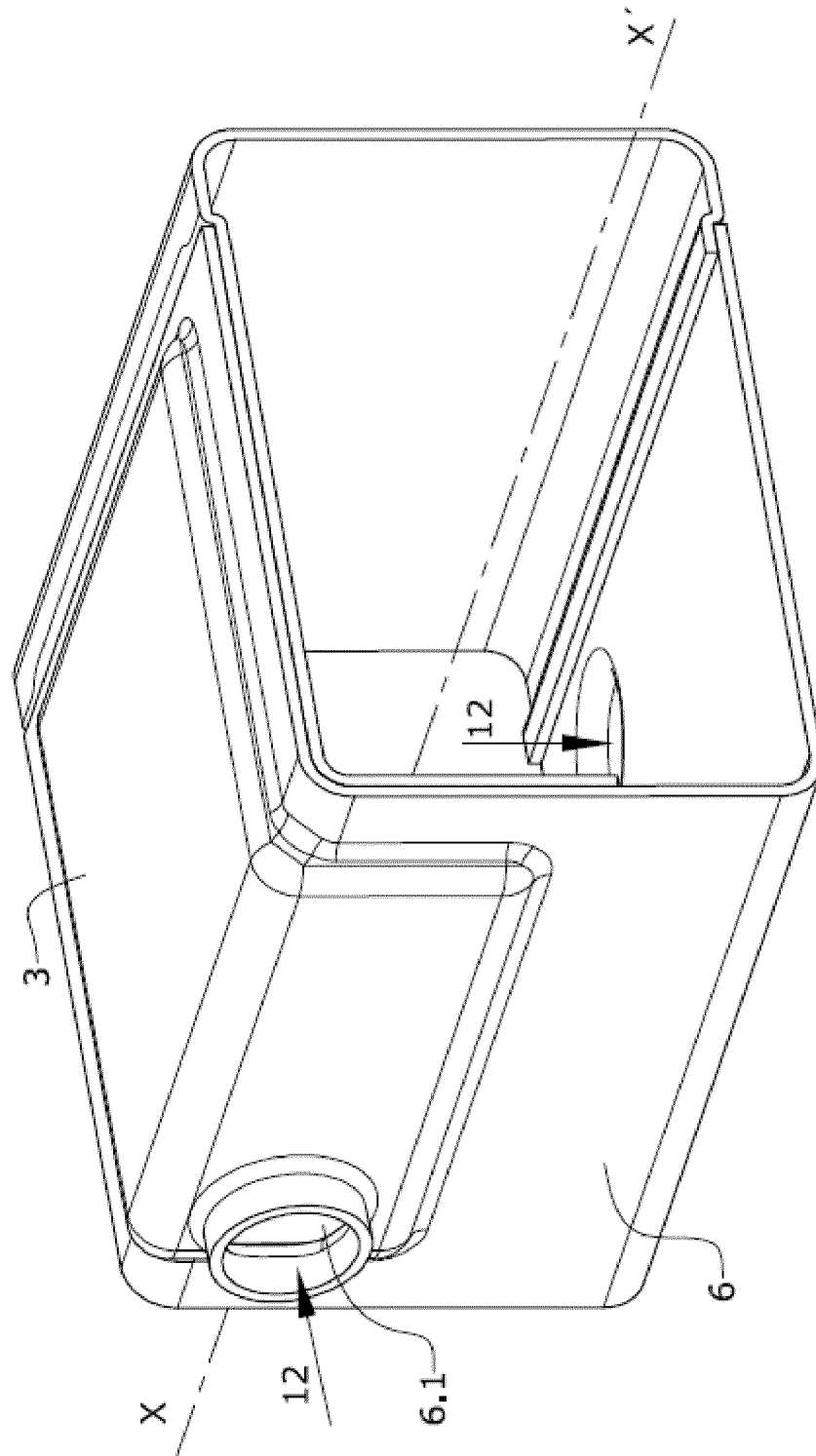


FIG.16

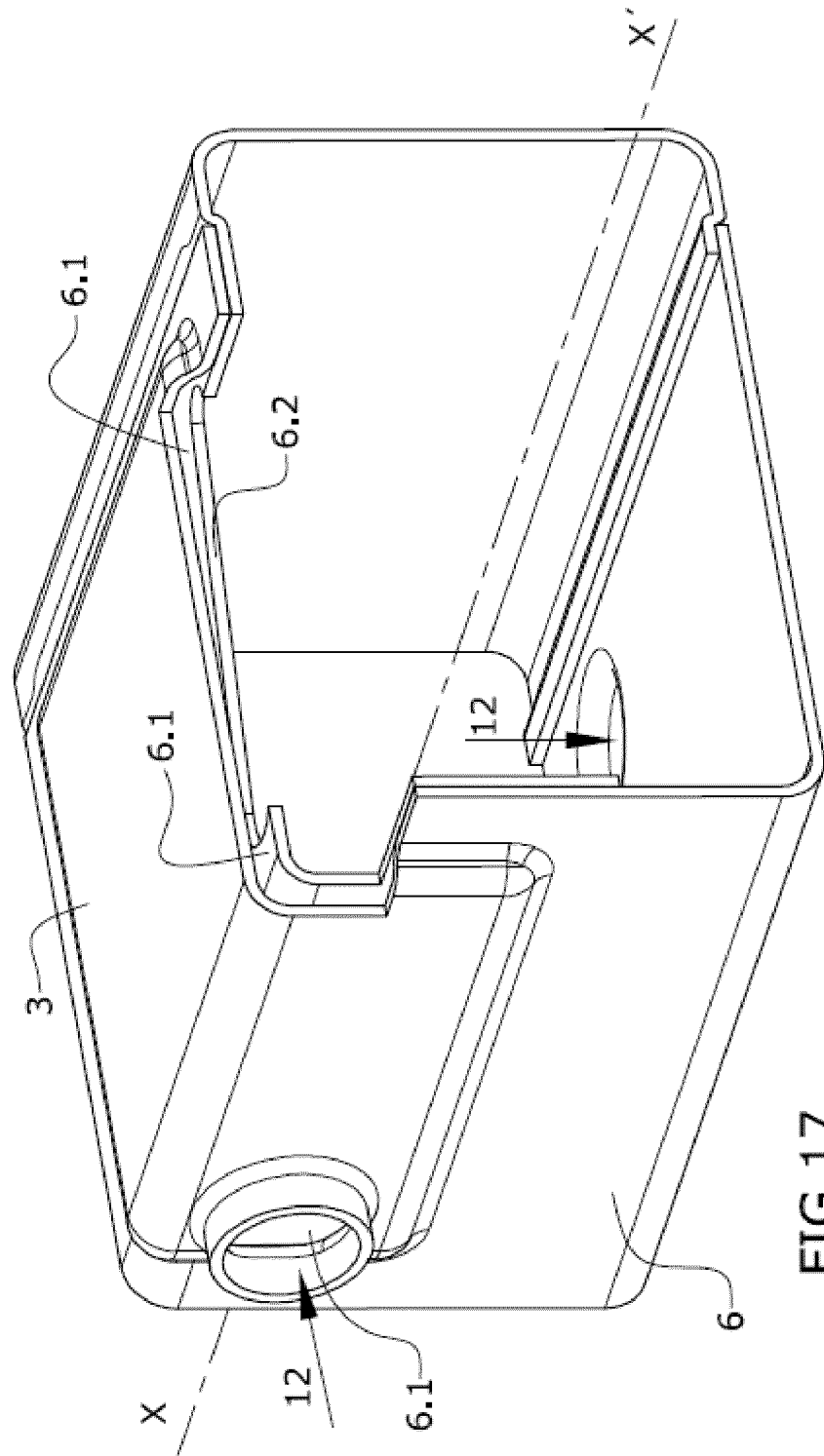


FIG.17

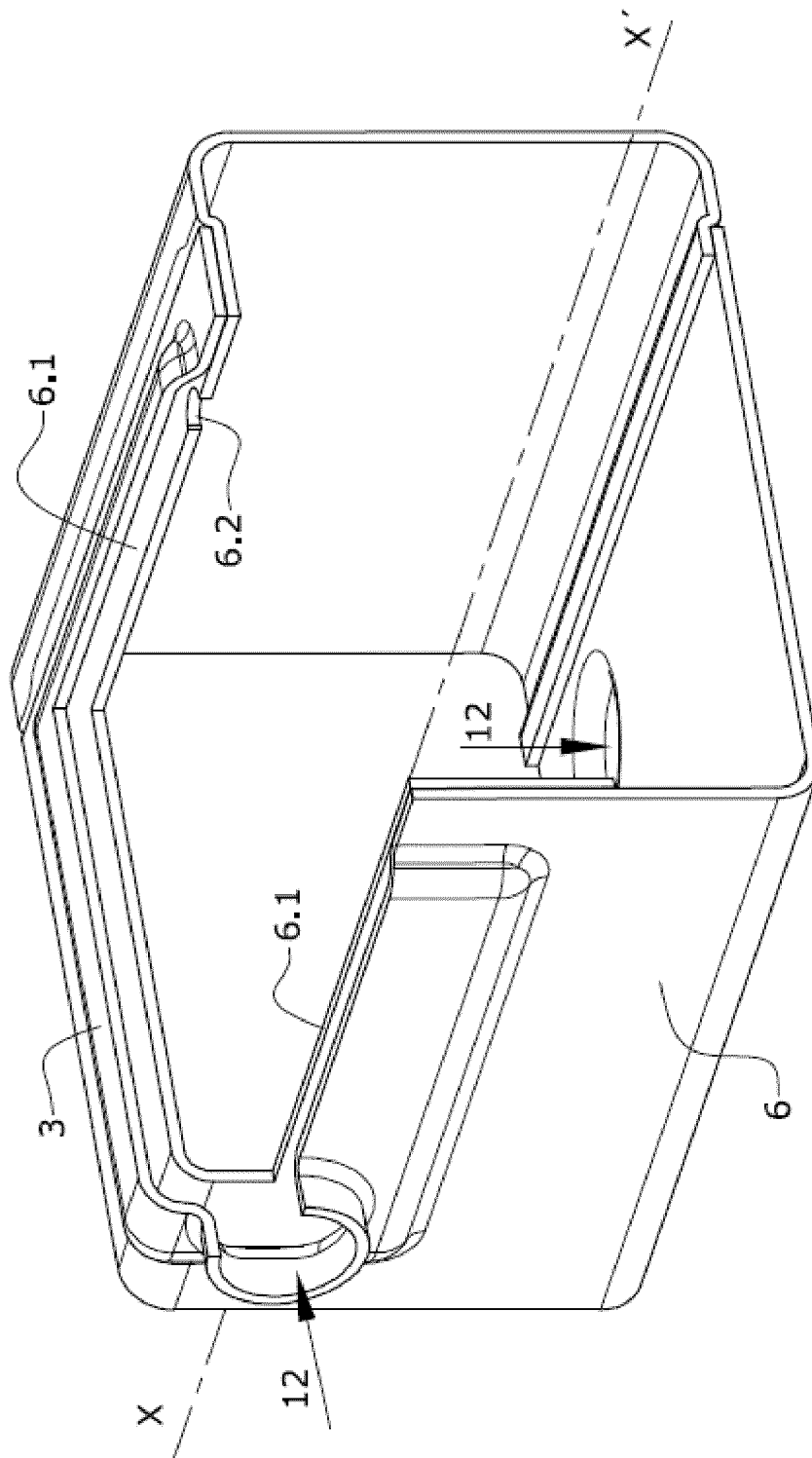


FIG.18

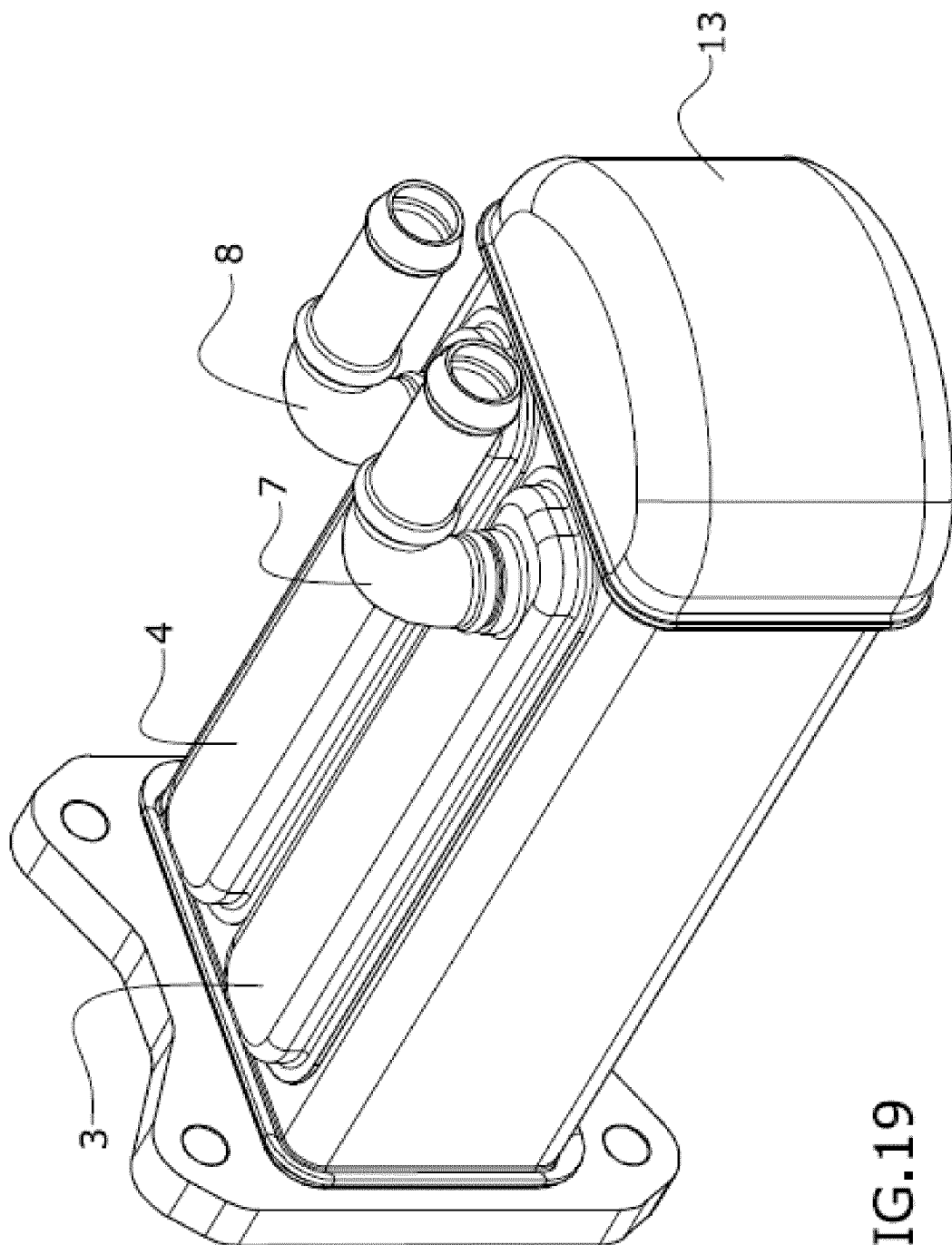


FIG.19

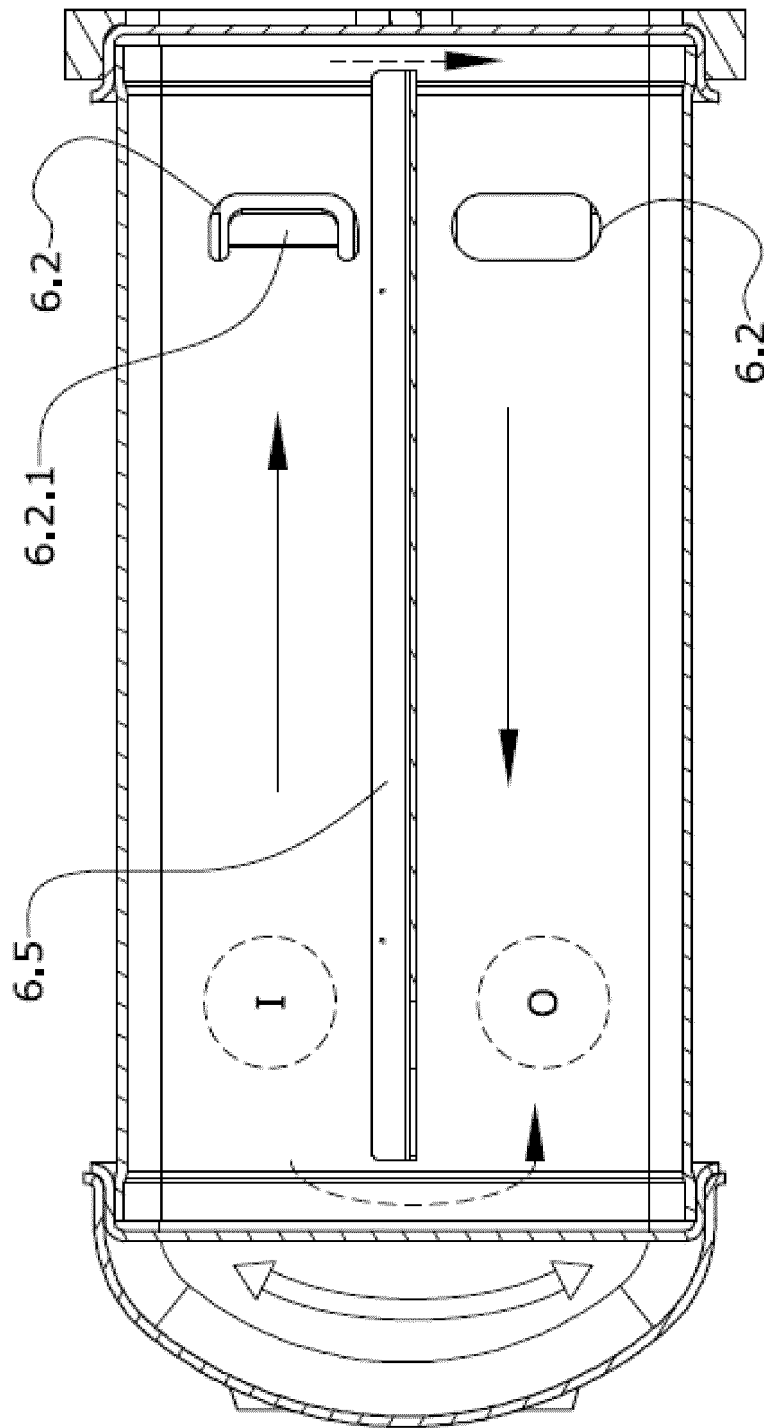


FIG. 20

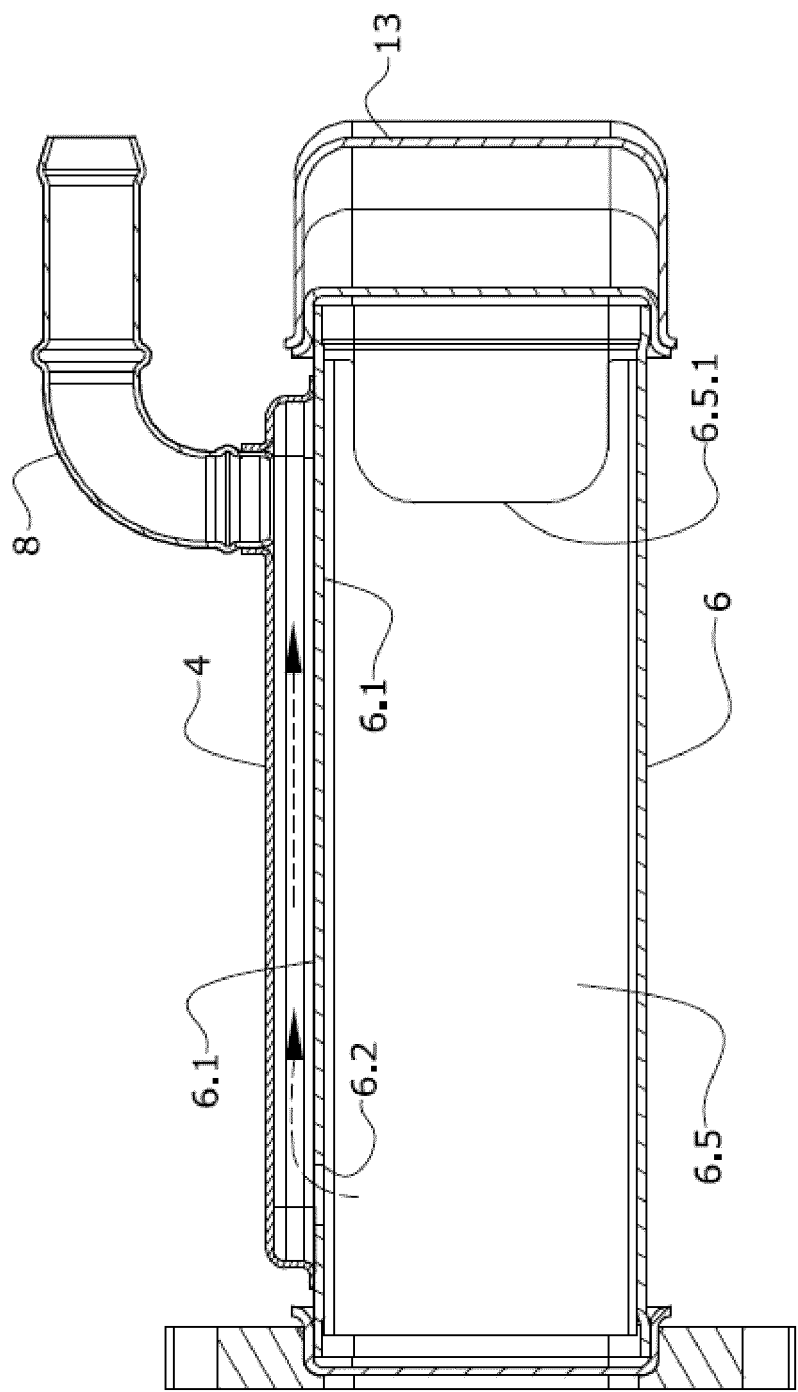


FIG.21

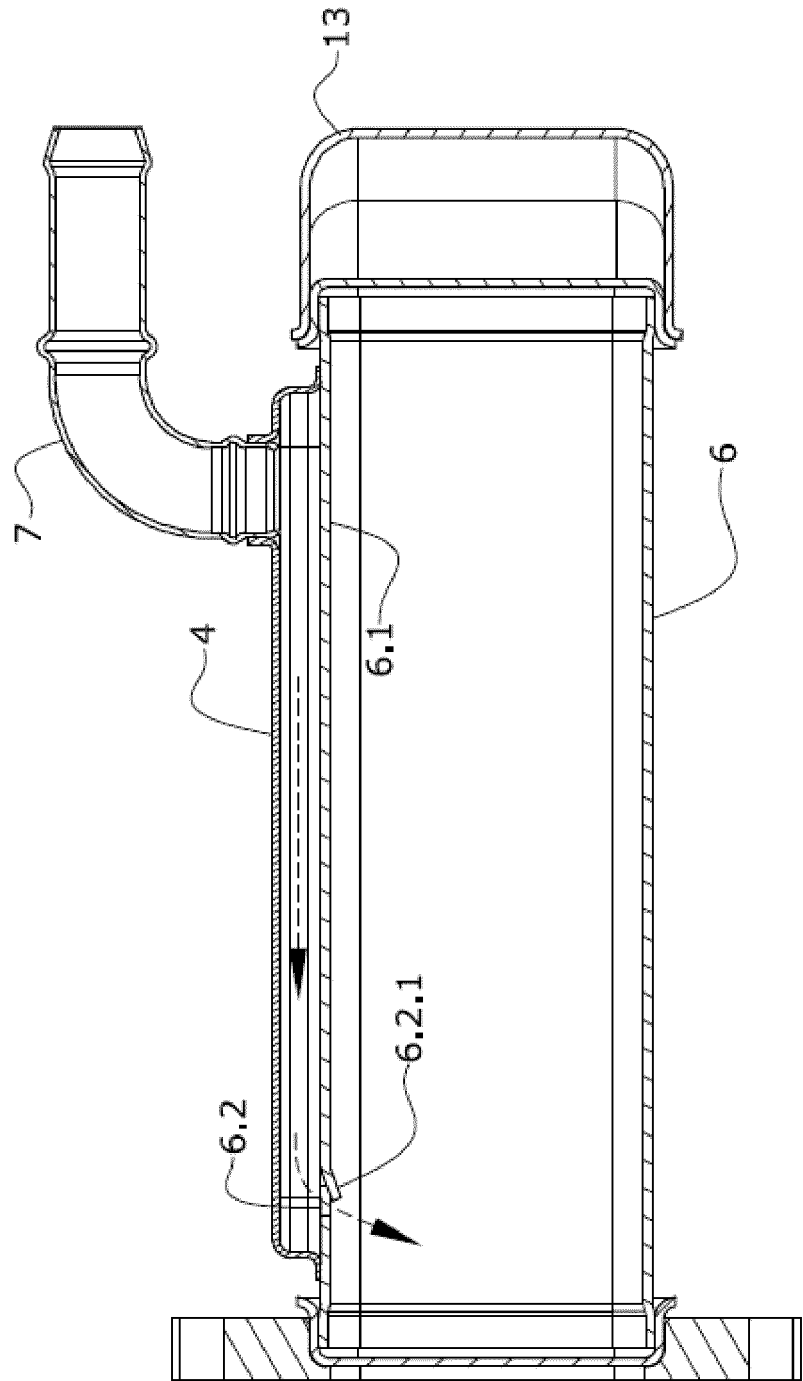


FIG. 22

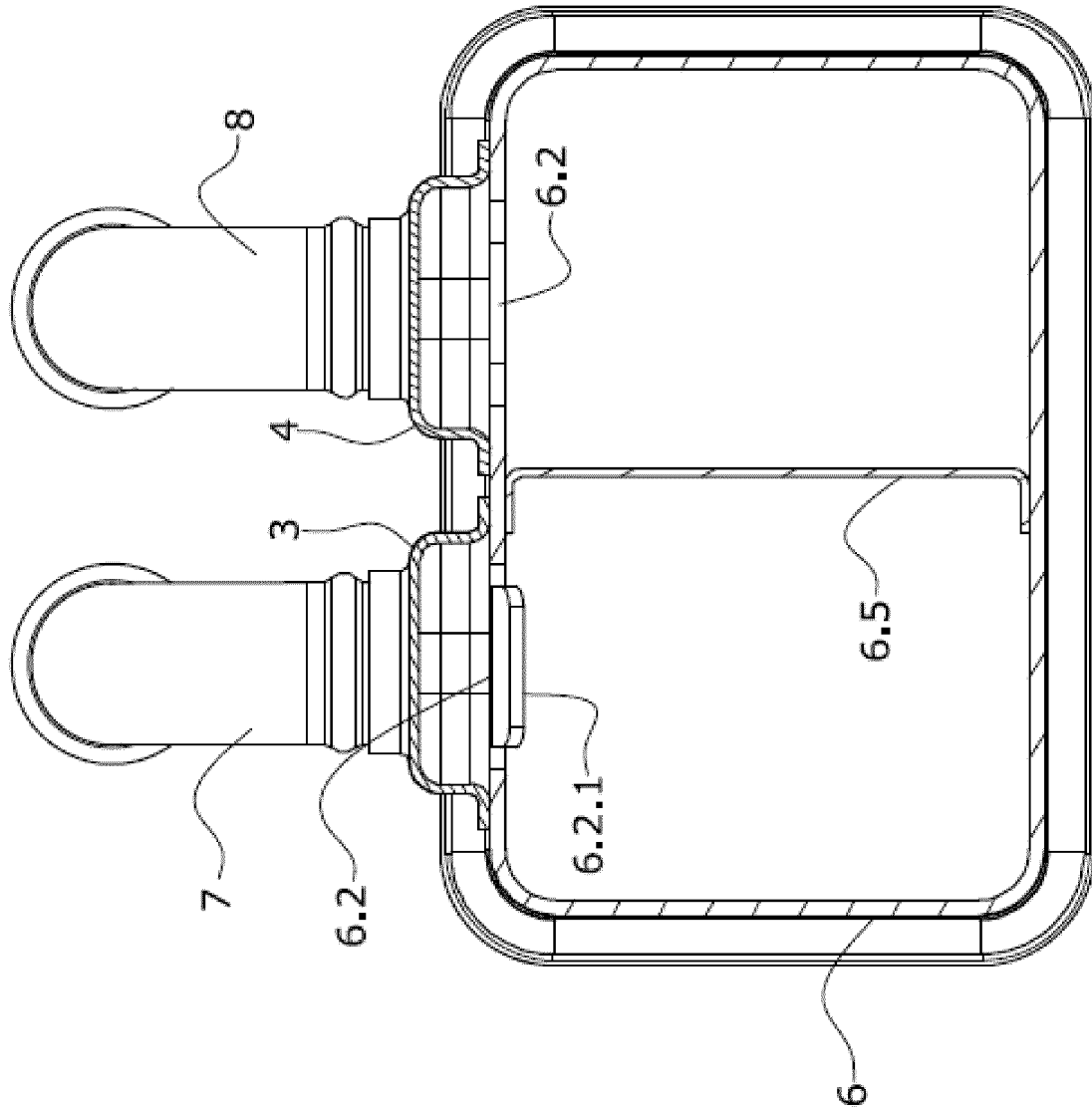


FIG.23

REFERENCES CITED IN THE DESCRIPTION

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