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(54) Flow deflector

(57) The present invention is a flow deflector suitable for a heat exchanger of the type consisting of at least one core made up of tubes forming a bundle arranged inside a shell and at least one baffle. The deflector according to the invention is an easily manufactured part independent from the construction of the bundle of tubes and of the baffle which allows modifying the coolant fluid or liquid flow path with greater freedom than that achieved by combining internal openings in the baffle or baffles. Another object of this invention is the heat exchanger obtained using the deflector for optimising coolant liquid flow path. The application of the invention in heat exchangers for EGR (Exhaust Gas Recirculation) systems is of special interest.

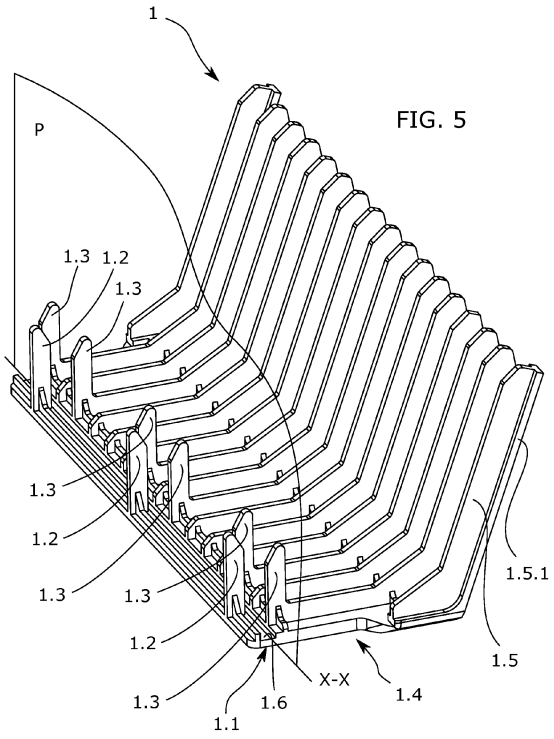

FIG. 5

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Description

Object of the Invention

[0001] The present invention is a flow deflector suitable for a heat exchanger of the type consisting of at least one core made up of tubes forming a bundle arranged inside a shell and at least one baffle. The deflector according to the invention is an easily manufactured part independent from the construction of the bundle of tubes and of the baffle which allows modifying the coolant fluid or liquid flow path with greater freedom than that achieved by combining internal openings in the baffle or baffles.

[0002] Another object of this invention is the heat exchanger obtained using the deflector for optimising coolant liquid flow path.

[0003] The application of the invention in heat exchangers for EGR (Exhaust Gas Recirculation) systems is of special interest.

Background of the Invention

[0004] The configuration of heat exchangers for EGR systems usually consists of a bundle of tubes through which the recirculated gas passes and of a shell housing said bundle of tubes. A coolant fluid circulates between the bundle of tubes and the shell such that the gas circulating through the tubes transfers heat to the coolant liquid.

[0005] In most cases the entry of the coolant liquid occurs at one point of the shell corresponding to an end of the bundle; and the exit at another point of the shell located at the opposite end of the bundle. The entry through a point establishes regions of the volume occupied by the coolant liquid which are stagnation regions. Since the speed is zero or very small in stagnation regions, convection is very low and therefore heat dissipation to other areas does not occur. As a result, the temperature is higher in these areas and worse still the materials which are in contact with these stagnation regions suffer greater thermal stresses. As a result of these high stresses in localised sites of the device, the service life of the materials is unfailingly reduced since they withstand a lower number of thermal fatigue cycles.

[0006] A decrease in thermal stress level implies an increase in the number of thermal fatigue cycles withstood by the device without it malfunctioning. This increase in thermal fatigue cycles withstood by the device follows the behaviour similar to that of an exponential function. The decrease in thermal stresses and therefore in thermal fatigue, and the subsequent increase in the exchanger durability is achieved by means of a homogenous temperature distribution especially in the hotter areas.

[0007] To prevent the existence of stagnation regions, flow deflection means are incorporated, for example, for moving the coolant liquid in a zigzag manner and increasing its speed and thus improving heat convection.

[0008] This flow deflection is achieved by means of the shape of the inner openings of the baffles responsible for securing the tubes of the bundle of tubes assuring a specific separation between said tubes. The more common configuration of these baffles is that of a perimetric ring-shaped die-cut plate according to the configuration of the perimeter of the bundle of tubes; and, having elongations towards the inside of the comb-shaped perimetric ring. These comb-shaped elongations are intended for being housed between the tubes of the bundle and prevent the passage of the coolant liquid through them.

[0009] If the elongations are short the opening left by these elongations inside the bundle are larger. The flow passing through these baffles is forced to follow the path imposed by the position and size of the openings by combining several baffles with different internal openings, the openings defining the ends of these elongations. For example, placement on alternate sides of the internal openings will give rise to a zigzag path.

[0010] Even though it reduces the existence of stagnation regions this solution has significant limitations as detailed below.

[0011] Incorporating the baffles to the bundle of tubes allows assuring the distances between tubes. Manufacturing is carried out by die-cutting sheet metal which is welded to this bundle. If the comb-shaped elongations of the baffles are excessively styled the manufacturing complexity increases given that dimensional stability and the tolerances demanded by mass production are more difficult to achieve.

[0012] Increasing the internal distance between tubes allowing wider and therefore stiffer and more stable elongations is a possible option when faced with this problem. This solution has the drawback of reducing the amount of tubes which can be bundled into one and the same volume and therefore the efficiency is severely reduced.

[0013] Reducing the length of the comb-shaped elongations is also possible. The drawback of this alternative is that the distribution of coolants is worse since the flow deflection and interaction are lower.

[0014] Other additional limitations of the baffles is the need of being arranged essentially perpendicular to the tubes of the bundle of tubes therefore the deflection is not always optimum and the pressure losses are higher than if oblique flow deflections could occur.

[0015] In order to solve these problems the present invention uses a part intended for being secured, preferably by clipping, in an already existing baffle the configuration of which is not limited by manufacturing demands, by geometry limitations of a part obtained by die-cutting sheet metal, and by limitations of baffle welding.

Description of the Invention

[0016] The present invention solves the problems identified above by using a part which can be manufactured in plastic, resin or other materials, intended for being installed, preferably by clipping, on a baffle. In this

case the baffle can be of very simple design since it is no longer required to be responsible for coolant fluid or liquid flow deflection.

[0017] The part according to the invention is a flow deflector suitable for a heat exchanger of the type consisting of at least one core made up of tubes forming a bundle arranged inside a shell and at least one baffle, such that said deflector comprises:

- *a main body extending along an X-X direction,*

[0018] This main body extends on the edge of said baffle when the deflector is operatively installed on the baffle. Given that the baffle is arranged perpendicular to the tubes of the bundle, the direction identified as X-X will correspond both to the transverse direction and to the direction in which the mentioned main body extends.

[0019] The X-X direction is a geometric reference for the remaining components of the deflector of the invention.

- *a plurality of at least three fixing elongations protruding transversely with respect to the X-X direction of the main body defining a main plane P containing the X-X direction, wherein such fixing elongations are such that:*

  ○ *they are formed by two groups, a first group of fixing elongations and a second group of fixing elongations such that the first group of fixing elongations is distributed along the X-X direction and located on one side of the main plane P; and wherein the second group of fixing elongations is distributed along the X-X direction in positions different from the positions of the elongations of the first group of fixing elongations and located on the opposite side of the main plane P,*

  ○ *each of the elongations is arranged at least in a sector away from the main plane defining a housing such that the set of housings of the elongations is suitable for housing a sector of baffle of the heat exchanger for fixing the flow deflector,*

[0020] Once the X-X axis has been defined, the position and orientation of the plurality of fixing elongations also defines the main plane P containing the X-X direction.

[0021] When the deflector is placed on the baffle, the fixing elongations are responsible for attaching the deflector to the bundle of tubes. The plane P coincides with the main plane of the baffle in this one and the same operating position of the deflector on the baffle. The condition of distributing fixing elongations on both sides of plane P results in the operating position with a distribution of such elongations on both sides of the baffle.

[0022] The relative movement between the deflector and the bundle of tubes in the direction perpendicular to the bundle is prevented by resting the main body on the baffle. The exit direction is limited by the existence of the shell or, as will be seen in the embodiments, by particular ways of making these fixing elongations which incorporate staggerings to secure the clipping.

[0023] The distribution on both sides of the main plane prevents the relative movement in the direction coinciding with the direction of the tubes of the bundle.

[0024] Lastly, movement parallel to the X-X direction is prevented because the fixing elongations are inserted between the tubes of the bundle in operating mode. Nevertheless, according to the embodiments which will be described below, some of these fixing elongations, preferably the end fixing elongations can have reinforcements limiting movements in this direction to the greatest extent possible.

[0025] The way in which the elongations are distributed on both sides of the plane is such that they leave a spacing to allow housing the baffle. In a view of the part according to the X-X direction, this spacing is shown in projection in an area which allows accommodating the section of the baffle on which the deflector is fixed by means of the fixing elongations.

- *deflecting extensions suitable for being located in the spaces located between the tubes of the core made up of tubes of the heat exchanger suitable for modifying the coolant flow path.*

[0026] Once the deflector is fixed on the baffle, the part of the deflector which intervenes by modifying the coolant fluid flow path is the deflecting extensions. The position thereof depends on the particular embodiment. Two particular examples will be shown below, although there can be more; a first example in which the deflecting extensions are located at the end of the fixing elongations giving continuity to such elongations; and a second example in which these deflecting extensions are located on one side of the main plane P linked to the main body by means of a resistant bridge. This second embodiment gives no reason for flow deflection to occur in the position of the baffle. Likewise, these deflecting extensions can adopt degrees of inclination or curvature which would not be possible, or would be very complicated, to impose on one part of the baffle. These extensions, given that they do not have to be attached to the tubes of the bundle, can cover the entire width defined by the gap between the tubes producing total flow deflection; or they can partially cover the width for example for allowing the passage of coolant liquid flow and preventing stagnation regions therebehind.

Description of the Drawings

[0027] These and other features and advantages of the invention will be seen more clearly from the following detailed description of a preferred embodiment provided

only by way of illustrative and non-limiting example in reference to the attached drawings.

Figure 1 shows an embodiment according to the state of the art of a heat exchanger for cooling EGR gases by means of a coolant liquid. A zigzag coolant liquid flow is imposed by means of baffles as shown by the line with arrows.

Figure 2 shows a baffle according to an example of the state of the art with comb-shaped elongations which do not need to have the same length. The length of the ends of these elongations defines the size of the opening for coolant liquid passage.

Figures 3a and 3b show a bundle of tubes of a heat exchanger from which the outer shell has been removed. Figure 3a shows a deflector according to a first embodiment before being fixed to a baffle of the bundle of tubes. Figure 3b shows the same part once inserted and in an operating position.

Figures 4a, 4b, 4c and 4d show an elevational view, profile view and two different perspective views of the same deflecting part according to the first embodiment.

Figure 5 shows a side perspective view of the deflector according to a second embodiment orientated towards the bundle of tubes and the baffle to allow observing the most relevant attachment means and elements of its structure.

Figure 6 shows the same embodiment as in the preceding figure only that the angle of the perspective is slightly rotated to allow observing details which cannot be observed in the preceding perspective.

Figure 7 shows a sector of the bundle of tubes of a heat exchanger with the baffle and the deflecting part according to the second embodiment before being inserted.

Figure 8 essentially shows the same as in the preceding figure only that the deflecting part is shown already fixed on the baffle.

Figure 9 shows a cross-section with respect to the X-X direction according to a plane passing between two tubes of the bundle of tubes of the exchanger to allow observing the position of the fixing elements and of the deflecting extensions in their operating position.

Detailed Description of the Invention

[0028] Figure 1 shows a heat exchanger according to the state of the art formed by a core (2) and a shell (3) where coolant liquid flow is directed by means of baffles (2.2) for the purpose of increasing heat convection and therefore exchanger efficiency. The existence of stagnation regions in the coolant liquid flow means that the liquid which is in said stagnation region raises its temperature reaching boiling temperature.

[0029] Such effects cause material fatigue and breakage drastically reducing the service life of the device.

[0030] The baffles (2.2) are resistant elements which must be welded to the bundle (2) of tubes (2.1). The manufacturing and welding requirements do not have to be compatible with the deflection surface requirements and therefore do not allow defining an optimum flow configuration.

[0031] Figure 2 shows a baffle (2.2) incorporating comb-shaped elongations intended for being housed between the tubes (2.1) of the bundle (2) covering the space defining the separation between the tubes. The ends of the comb-shaped elongations are the edges of the internal window through which the passage of the coolant liquid is allowed. The passage and path of the coolant liquid can be modified by alternating the areas and positions of these windows but it has the drawbacks already mentioned in the state of the art.

[0032] The present invention uses a part, the deflector (1), intended for being incorporated in a baffle (2.2) where this baffle (2.2) is very simple to manufacture since it does not require thin and long elongations for modifying inner coolant liquid flow.

[0033] A first embodiment of the invention is shown in detail in Figures 4a, 4b, 4c and 4d. Figures 4a and 4b are the elevational, profile view of this first example whereas Figures 4c and 4d are two perspective views which allow observing the same part (1) from almost opposite positions for offering visual access to all the details.

[0034] Before describing this embodiment in detail, the deflector (1) according to this first embodiment is seen before and after being inserted in its operating position by means of Figures 3a and 3b. In Figure 3a the deflector (1) is located on the baffle (2.2) such that in this view it is possible to see the protruding edge of the baffle (2.2) on which the deflector (1) will be located. In this embodiment, the baffle (2.2) has a configuration with short internal elongations such that it does not limit the flow of coolant liquid through it.

[0035] Using Figures 4a-4d it is seen that the deflector (1) comprises a main body (1.1) extending along the X-X direction. The main body (1.1) is intended to rest on the baffle (2.2) and the elongations (1.2, 1.3) which allow fixing on the baffle (2.2) protrude from the main body. Figure 4b shows the main plane P, which in this embodiment coincides with the plane of symmetry, leaving a group of fixing elongations (1.2) on one side and the remaining fixing elongations (1.3) on the other side. This same view 4b as well as the perspective view 4d allow observing the spacing of the fixing elongations (1.2, 1.3) with respect to plane P and therefore the separation between both groups of elongations. Said separation gives rise to a housing (H) for the sector of baffle (2.2) resulting in a fixing mode between both elements (1, 2.2).

[0036] In the particular case of this embodiment, each of the fixing elongations (1.2, 1.3) has a deflecting extension (1.2.2, 1.3.2) configured as a continuation of the fixing elongation (1.2, 1.3). In the attachment between the fixing elongation (1.2, 1.3) and the deflecting extension (1.2.2, 1.3.2) there is a staggering arranged on the

inner side orientated towards the main plane P. This staggering is intended for resting on the end of the elongations of the baffle (2.2) assuring their retention and preventing them from coming out.

[0037] In other cases, instead of using this staggering it is possible for the main body (1.1) to rest on the internal face of the shell (3) of the heat exchanger.

[0038] The ends of the deflecting extensions (1.2.2, 1.3.2) of this embodiment are bevelled on the inner side orientated towards the main plane P. This bevelling allows the insertion on the baffle (2.2) during assembly facilitating the opening by means of bending the set formed by the deflecting extension (1.2.2, 1.3.2) and the fixing elongation (1.2, 1.3). The insertion is completed when the sector of baffle (2.2) which is housed in the housing (H) overcomes the staggerings (1.2.1, 1.3.1) allowing the shape recovery of the set of fixing elongations (1.2, 1.3) together with the deflecting extensions (1.2.2, 1.3.2). In this embodiment, a material with elastic behaviour in the range of deformations imposed by the thickness of the baffle (2.2) and the different dimensions of the deflector (1) intervening in the insertion has been selected for allowing an easy shape recovery.

[0039] A second embodiment is shown in detail in Figures 5 and 6. According to this embodiment the main body (1) extends according to the X-X direction and comprises a channel (1.6) which also extends in the X-X direction intended for housing the outer edge of the baffle (2.2) when the deflector (1) is installed on the baffle (2.2).

[0040] Figure 5 shows a perspective view of the main plane P passing in the X-X direction and leaving the fixing elongations (1.2, 1.3) on both sides. In this particular case the fixing elongations (1.2, 1.3) are shown in groups of three, and in each group of three, two fixing elongations (1.3) are on one side and the third fixing elongation (1.2) is on the opposite side of the main plane P. This third fixing elongation (1.2) is arranged between the other two fixing elongations (1.3) following the X-X direction. Only three fixing elongations (1.2, 1.3) would thus be sufficient for assuring a fixing preventing movements in directions perpendicular to the X-X direction and even rotational movements.

[0041] In this embodiment the bevelling which facilitates the insertion of the deflector (1) in the baffle (2.2) is in the fixing elongations (1.2, 1.3).

[0042] A resistant bridge (1.4) at the end of which a plurality of deflecting extensions (1.5) starts extends from the main body (1.1). In this embodiment there are as many deflecting extensions (1.5) as there are cavities between tubes (2.1) such that each deflecting extension (1.5) is intended for entering a space between tubes (2.1). Additionally, there are two end side extensions with reinforcement (1.5.1) suitable for externally supporting the bundle (2) of tubes (2.1) and also covering the space between the bundle (2) of tubes (2.1) and the shell (3). The space between tubes (2.1) is narrower than the space between the bundle (2) of tubes (2.1) and the shell (3). The lower flow resistance in this second space means that the entire flow tends to circulate outside the bundle of tubes (2.1). The presence of reinforcement (1.5.1) covering the space between the bundle (2) of tubes (2.1) and the shell (3) has the effect of forcing the flow to circulate between the tubes (2.1) increasing the cooling efficiency.

[0043] With respect to the deflecting extensions (1.5), in this embodiment, they have a width slightly less than the space between tubes (2.1) giving rise to a clearance. Although the deflecting extensions (1.5) divert the flow reaching them, the existence of a clearance allows a small part of the flow to pass between the deflecting extension (1.5) and the tube (2.1) preventing stagnation regions which would give rise to points which could easily reach boiling temperature behind the deflecting extension (1.5).

[0044] In this embodiment, the deflecting extensions (1.5) elongate by way of ribs until reaching the main body (1.1).

[0045] Figure 8 shows the bundle (2) of tubes (2.1) after having removed the shell (3) with the flow deflector (1) before being inserted on the baffle (2.2). The fixing elongations (1.2, 1.3) enter the spaces between tubes (2.1) being located on both sides of the baffle (2.2) by means of the downwards movement thereof (moving downward according to the orientation shown in the figure). In turn, the deflecting extensions also enter the spaces between the tubes (2.1) reaching the final position which is shown in Figure 8. This figure shows two baffles (2.2); nevertheless, flow deflection does not occur in the position of the baffles (2.2) but in the position where the deflecting extensions (1.5) are located which, as a result of the resistant bridge (1.4), are away from the baffle (2.2). The design requirements for positioning the baffles (2.2) based on resistant criteria thus do not impose the position of the deflecting extensions (1.5) this second position depending on flow criteria to be imposed on the coolant liquid so that the heat exchange is carried out efficiently and without stagnation regions.

[0046] Figure 9 shows a section of the heat exchanger according to a plane which is orientated in the direction of the tubes (2.1) of the bundle (2). The tubes (2.1) are essentially planar. This section allows observing how the deflecting extensions (1.5) reach approximately the width of one of the two tubes (2.1) giving rise to the total height of the bundle (2) of tubes (2.1). The flow will be diverted so that it will be redirected to the lower tubes (2.1) (also following the orientation shown in the drawing). In this embodiment, the deflecting surfaces are inclined so that the diverted flow has an axial component according to the main axis of the bundle (2) of tubes (2.1). Nevertheless, these extensions can adopt other more complex configurations such as curves imposing a specific configuration to the stream lines.

Claims

1. A flow deflector suitable for a heat exchanger of the type consisting of at least one core made up of tubes forming a bundle (2) arranged inside a shell and at least one baffle, such that said deflector comprises:

   - a main body (1) extending along an X-X direction,
   - a plurality of at least three fixing elongations (1.2, 1.3) protruding transversely with respect to the X-X direction of the main body (1) defining a main plane (P) containing the X-X direction, wherein such fixing elongations (1.2, 1.3) are such that:

     ○ they are formed by two groups, a first group of fixing elongations (1.2) and a second group of fixing elongations (1.3) such that the first group of fixing elongations (1.2) is distributed along the X-X direction and located on one side of the main plane (P); and wherein the second group of fixing elongations (1.3) is distributed along the X-X direction in positions different from the positions of the elongations of the first group of fixing elongations (1.2) and located on the opposite side of the main plane (P),
     ○ each of the elongations (1.2, 1.3) is arranged at least in a sector away from the main plane (P) defining a housing (H) such that the set of housings (H) of the elongations (1.2, 1.3) is suitable for housing a sector of baffle (2.2) of the heat exchanger (2) for fixing the flow deflector (1),

   - deflecting extensions (1.2.2, 1.3.2, 1.5) suitable for being located in the spaces located between the tubes (2.1) of the core made up of tubes of the heat exchanger (2) and suitable for modifying the coolant flow path.

2. The deflector according to claim 1, **characterised in that** the fixing elongations (1.2, 1.3) are distributed in groups of 3 elongations, two elongations belonging to the first group of fixing elongations (1.2) and one belonging to the second group of fixing elongations (1.3) or vice versa.

3. The deflector according to claim 1 or 2, **characterised in that** the deflecting extensions (1.2.2, 1.3.2) are extensions of the fixing elongations (1.2, 1.3).

4. The deflector according to claim 3, **characterised in that** the transition between at least one fixing elongation (1.2, 1.3) and the deflecting extension (1.2.2, 1.3.2) is by means of a step (1.2.1, 1.3.1) suitable to allow resting on the edge of the baffle (2.2) arranged inside the bundle (2) of tubes (2.1) of the heat exchanger (1).

5. The deflector according to claim 1 or 2, **characterised in that** the main body (1) extends by means of a resistant bridge (1.4) to one side of the plane (P) and in a direction transverse to the X-X direction such that at the end of said resistant bridge (1.4) there are located the deflecting extensions (1.5) being orientated such that in the operating position they are located in the spaces between the tubes of the bundle (2) of tubes (2.1) of the heat exchanger (2).

6. The deflector according to claim 5, **characterised in that** the deflecting extensions (1.5) are inclined with respect to the direction perpendicular to the direction in which the resistant bridge (1.4) extends.

7. The deflector according to claim 5 or 6, **characterised in that** the deflecting extensions (1.5) are elongated by means of reinforcement ribs to the group of fixing elongations (1.2, 1.3) arranged on the side of the plane (P) coinciding with the side to where the resistant bridge (1.4) extends.

8. The deflector according to any of the preceding claims, **characterised in that** the main body (1) comprises a channel (1.6) arranged in the X-X direction suitable for housing the edge of the baffle (2.2).

9. The deflector according to any of the preceding claims, **characterised in that** one or more deflecting extensions (1.2.2, 1.3.2, 1.5) has a reinforced sector for fitting in the space between the tubes.

10. The deflector according to any of the preceding claims, **characterised in that** the end arranged deflecting extensions (1.2.2, 1.3.2, 1.5) have a reinforced sector (1.5.1) for resting on the outer surface of the bundle (2) of tubes (2.1).

11. A heat exchanger consisting of at least one core made up of tubes (2.1) forming a bundle (2) arranged inside a shell for the circulation of a coolant fluid between the bundle (2) of tubes (2.1) and the shell such that the bundle (2) comprises at least one baffle (2.2) for maintaining the separation between the tubes of the bundle (2) of tubes (2.1) this baffle (2.2) being formed, at least on one of its sides, by a plate sector with an edge protruding from the bundle (2) being extended according to a direction (X-X) transverse to the direction of the tubes of said bundle (2) and wherein the plate has an opening arranged inside the bundle (2) for the coolant fluid to pass through it and comprising at least one flow deflector according to any of the preceding claims.

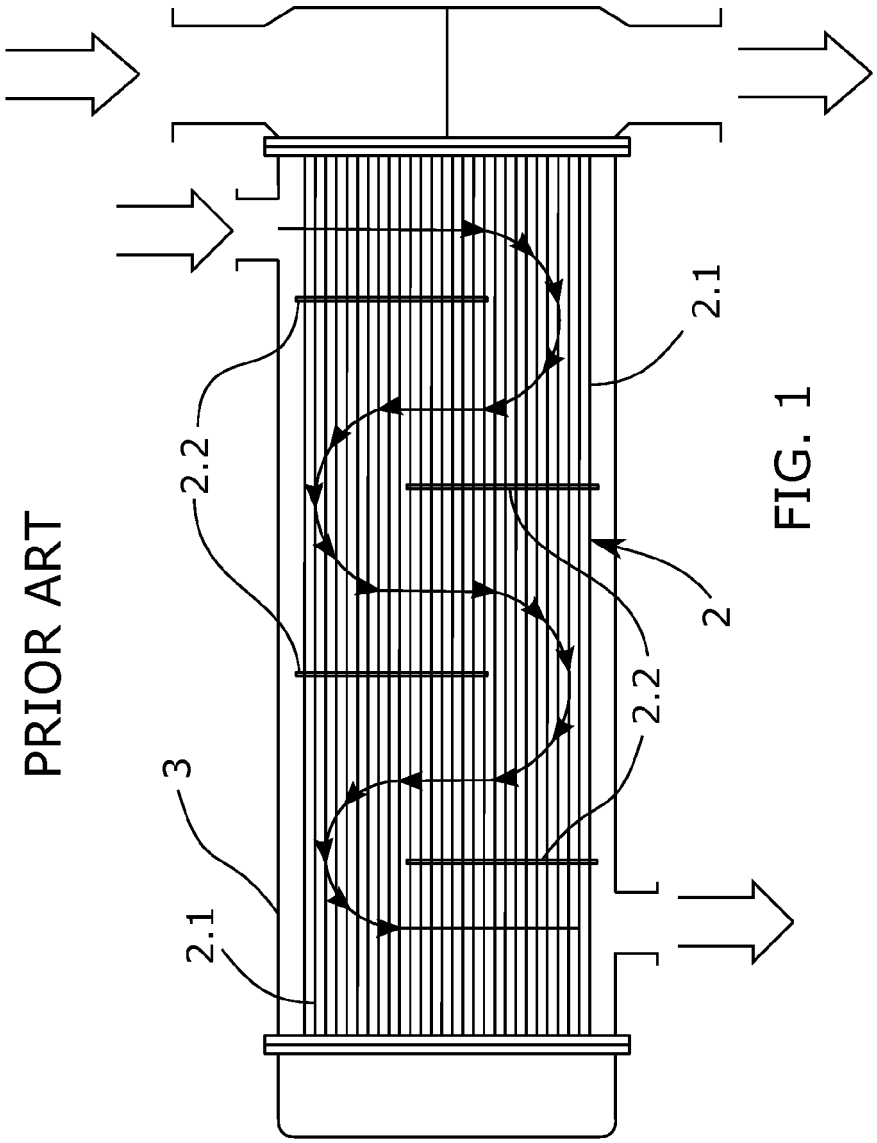


FIG. 1

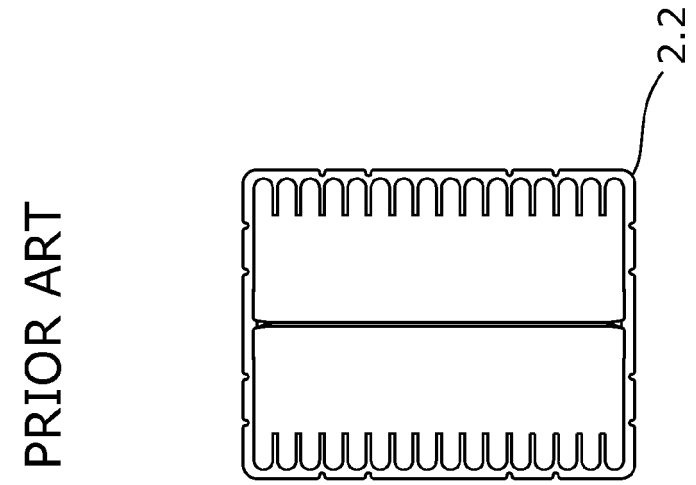


FIG. 2

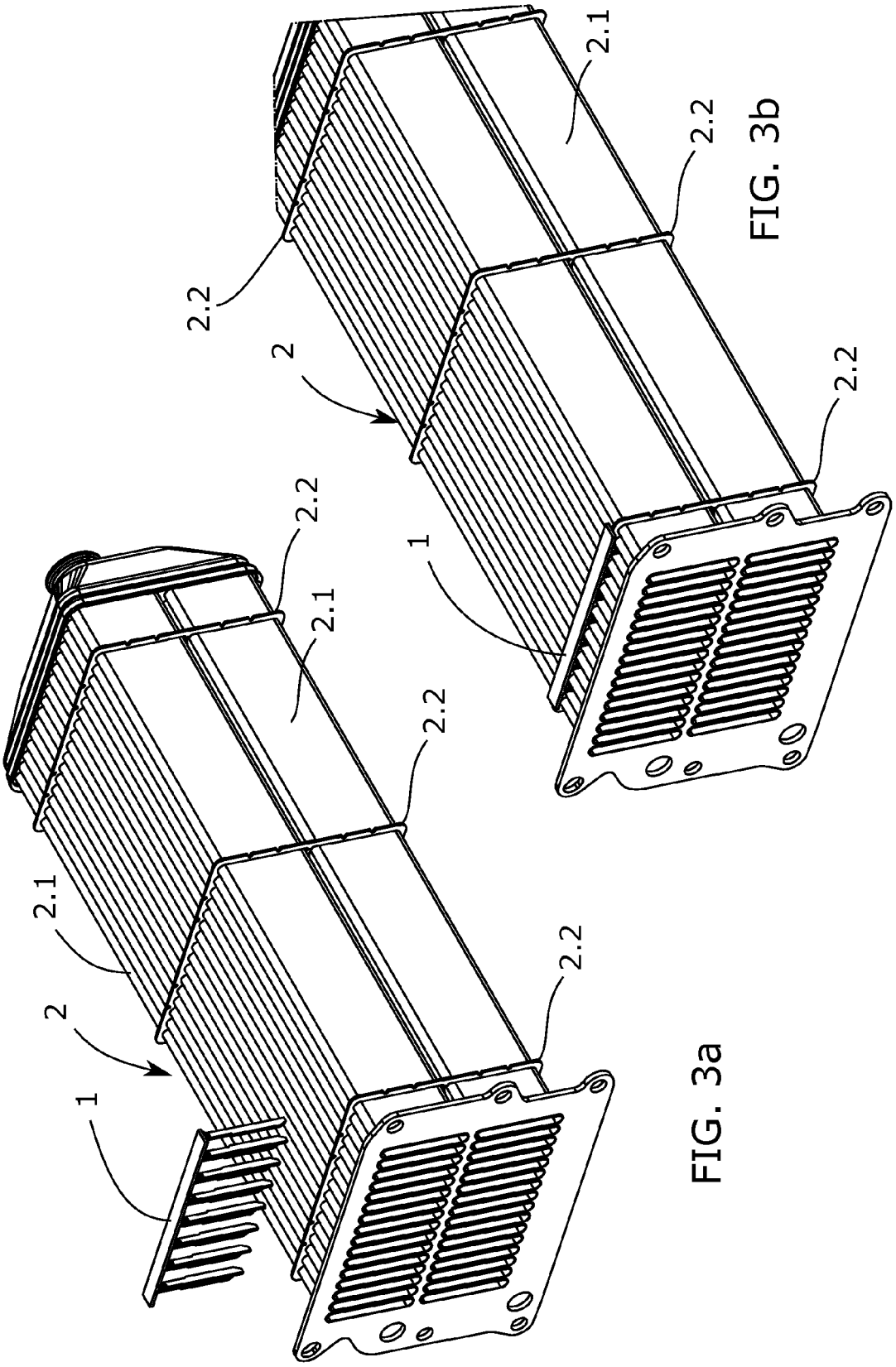


FIG. 3b

FIG. 3a

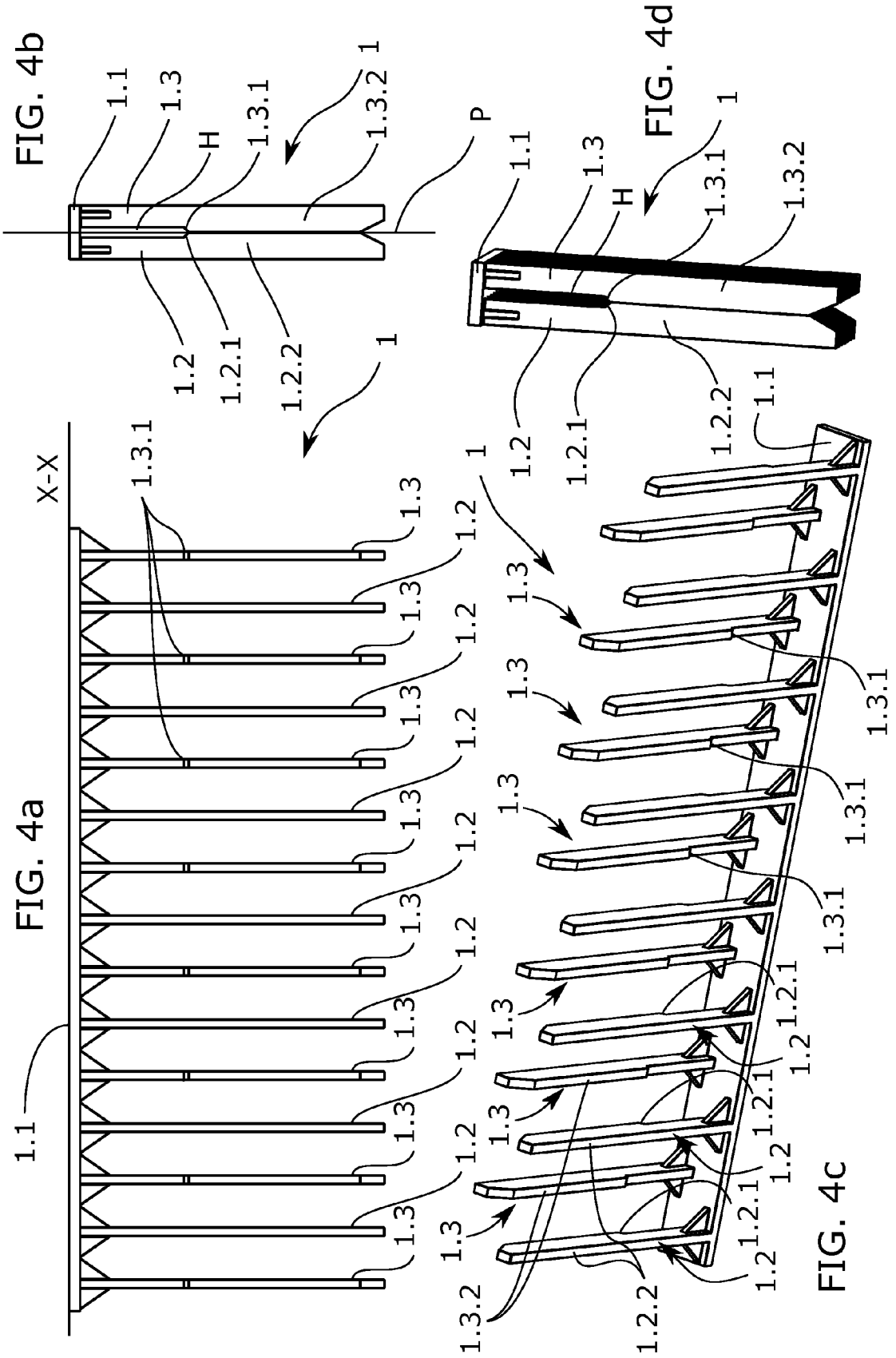


FIG. 4a
X-X
1.1
1.3.1
1.3
1.2
FIG. 4b
1.1
1.3
H
1.3.1
1.3.2
1
P
1.2
1.2.1
1.2.2
FIG. 4c
1.3.2
1.2.2
FIG. 4d
1.1
1.3
H
1.3.1
1.3.2
1.2
1.2.1
1.2.2

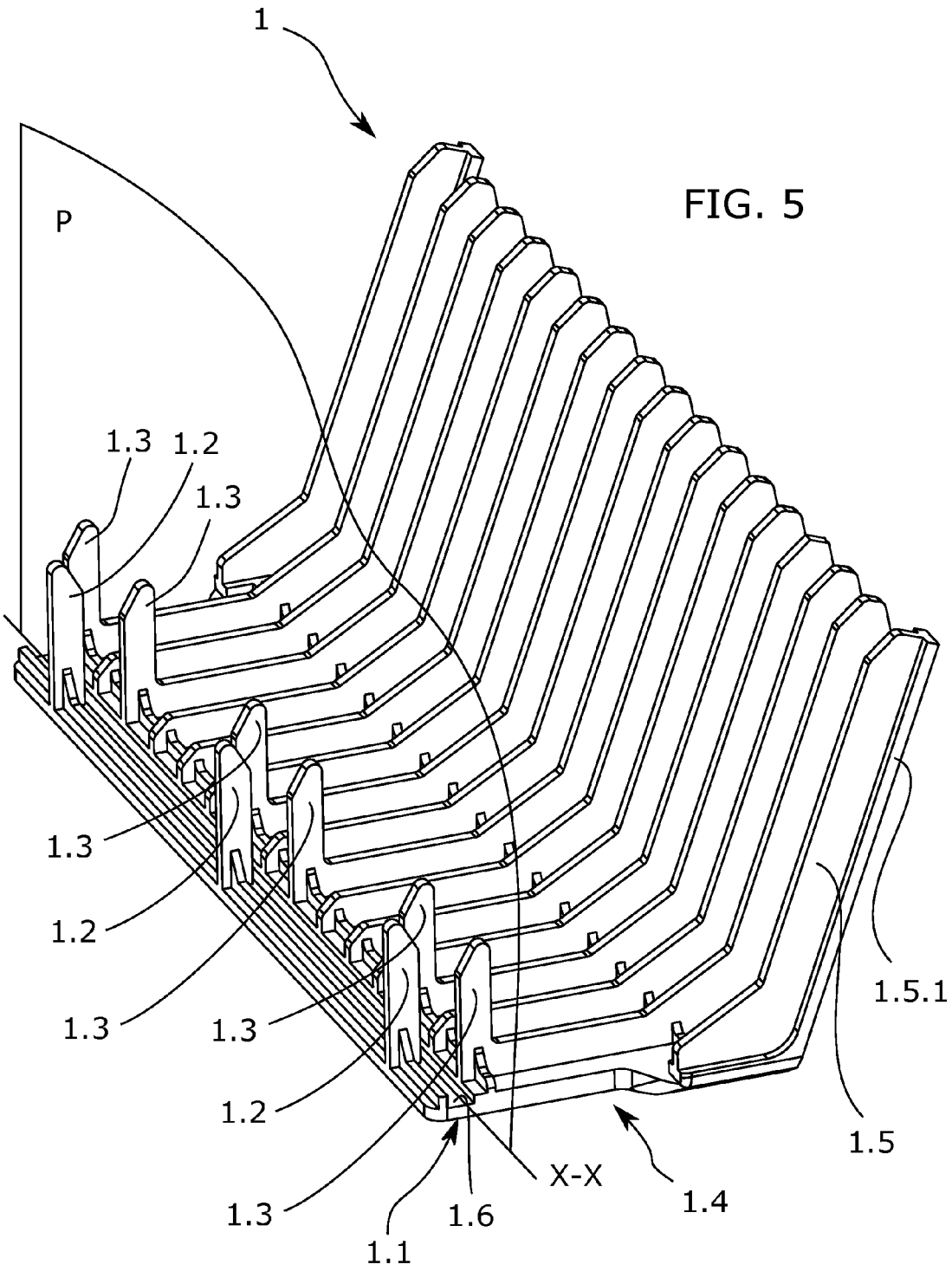


FIG. 5

FIG. 6

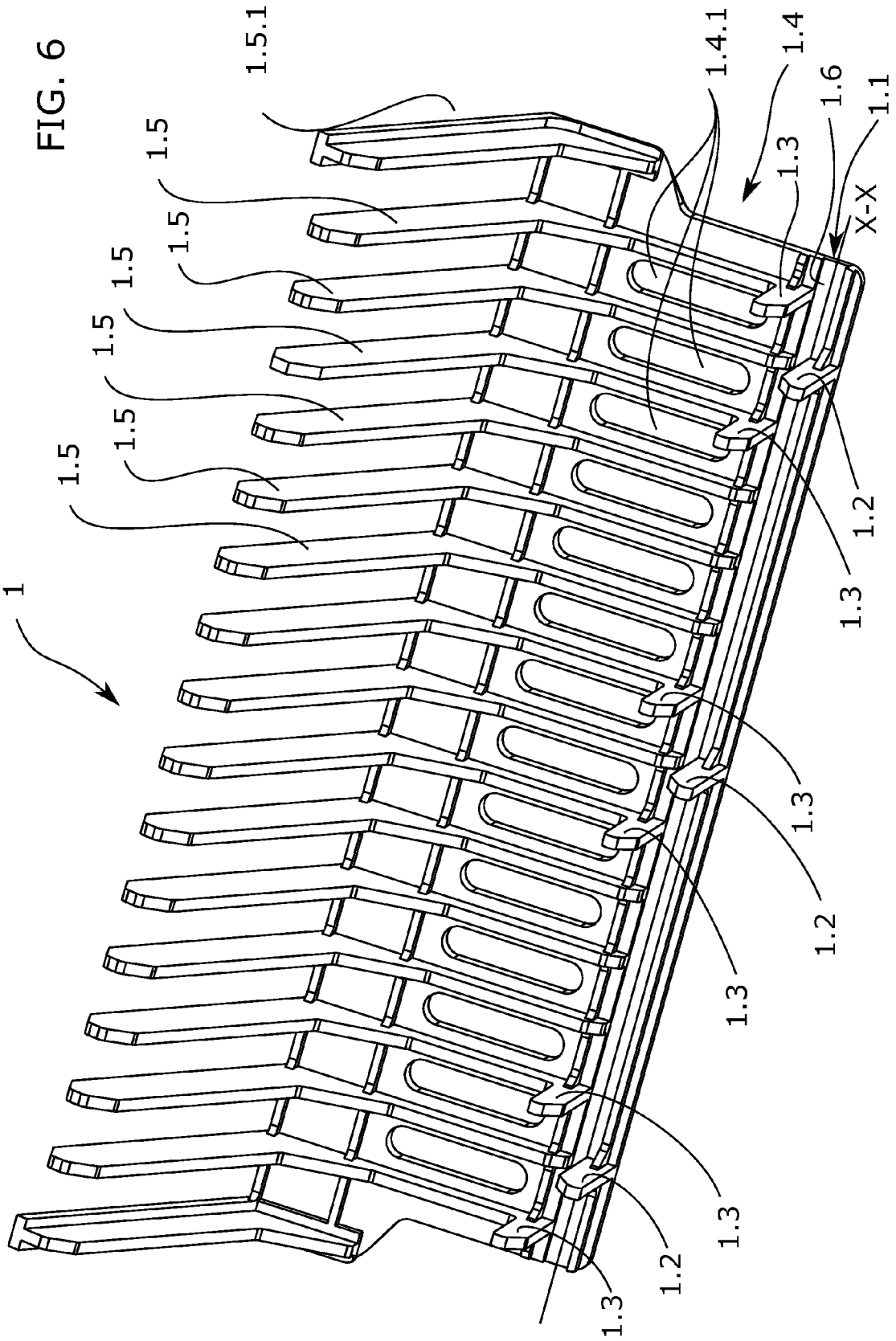
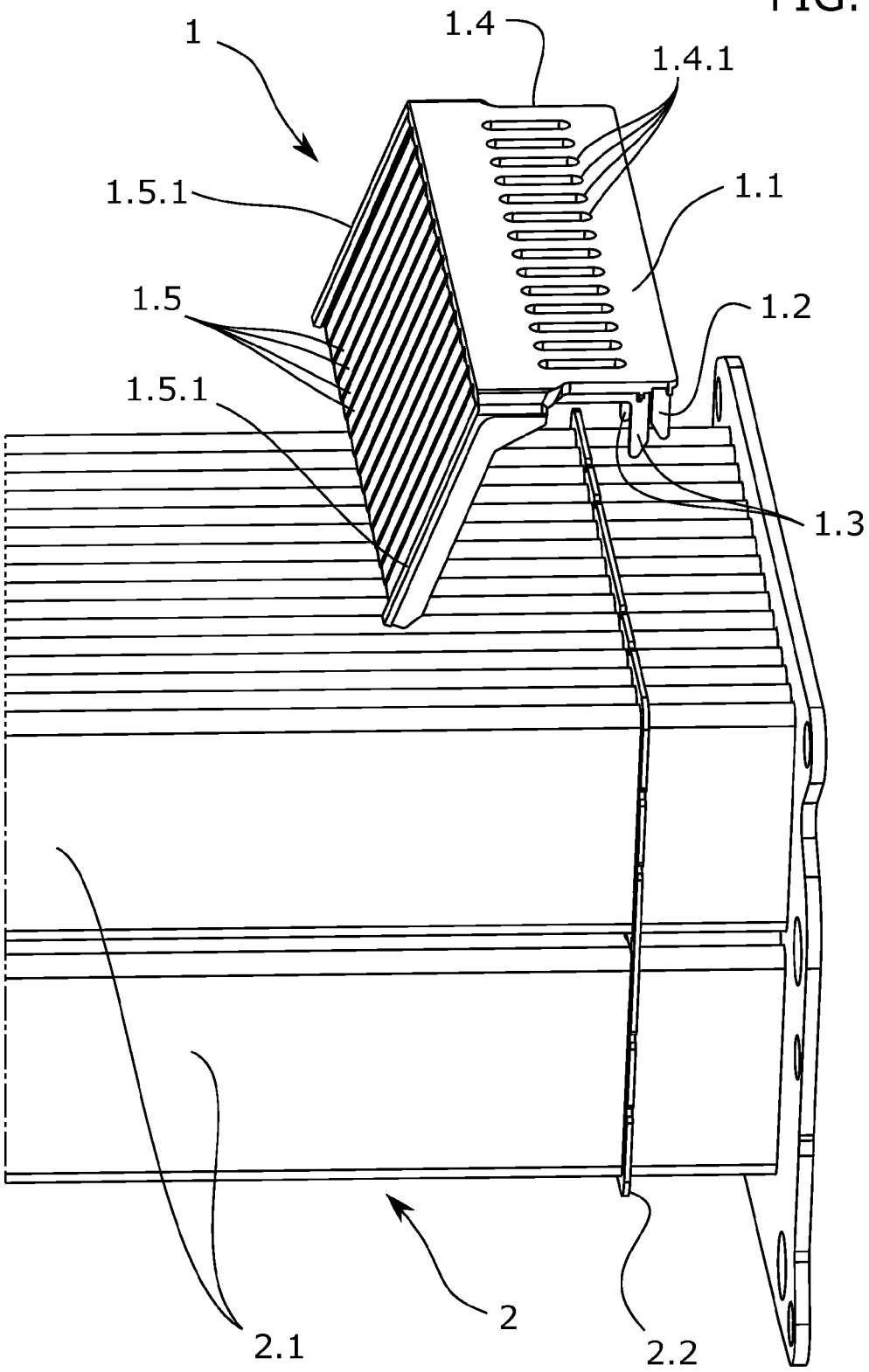


FIG. 7



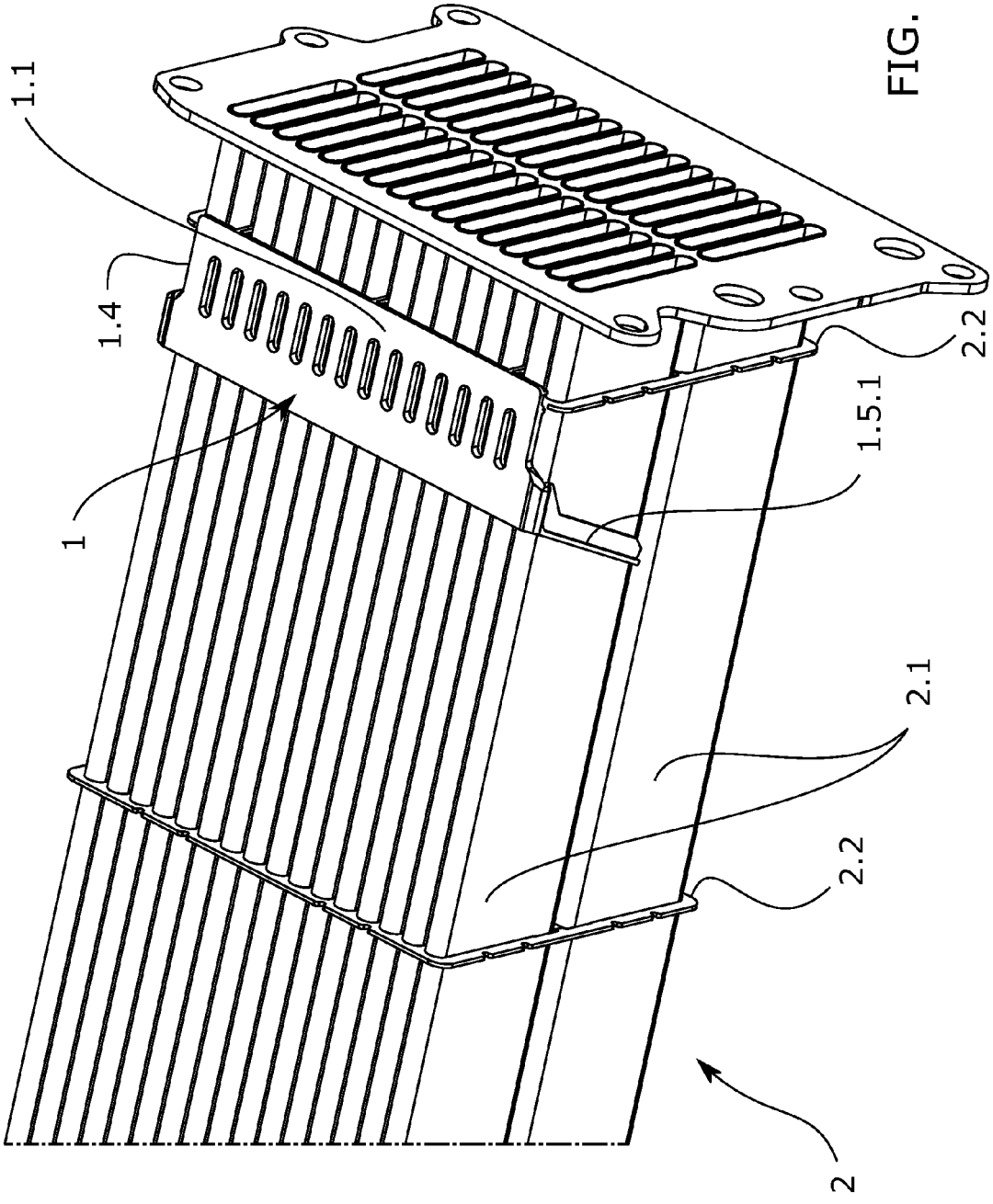


FIG. 8

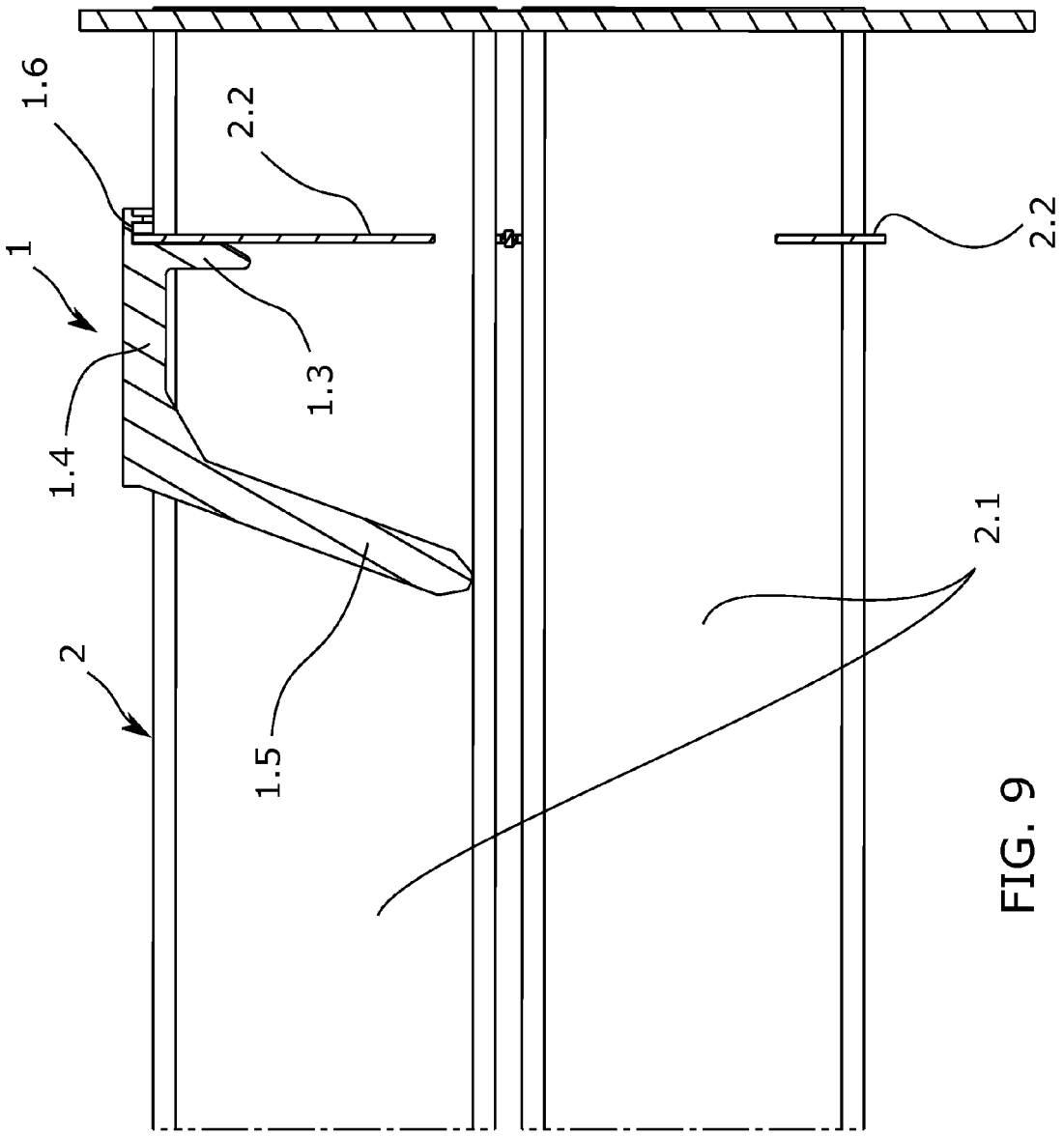


FIG. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 12 38 2412

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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