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(54) Heat exchanger

(57) The invention relates to a heat exchanger provided with a series of first and a series of second fluid ducts that are in heat exchanging contact with each other, in which the ducts are bounded by circumferential walls comprising duct partitions and duct side walls, in which the heat exchanger is formed by means of folding substantially one metal plate into a packet of ducts having four sides, in which the duct side walls form opposite first and second sides of the heat exchanger and every other one respectively is provided with first and second passages, respectively, for access to the ducts of the first and second series of ducts, respectively, and in which the first series of ducts is closed off at the third side by means of folded down wall members of the duct partitions and is open at the fourth side and the second series of ducts is closed off at the fourth side by means of folded down wall members of the duct partitions and is open at the third side.

The invention moreover relates to a method for making such a heat exchanger, in which at at least one edge of a metal plate wall members are arranged, the wall members are folded out of the plane of the plate, the plate is provided with channel sections provided with folding lines in the channel sections, in which the plate is subsequently folded into a heat exchanger over the folding lines.

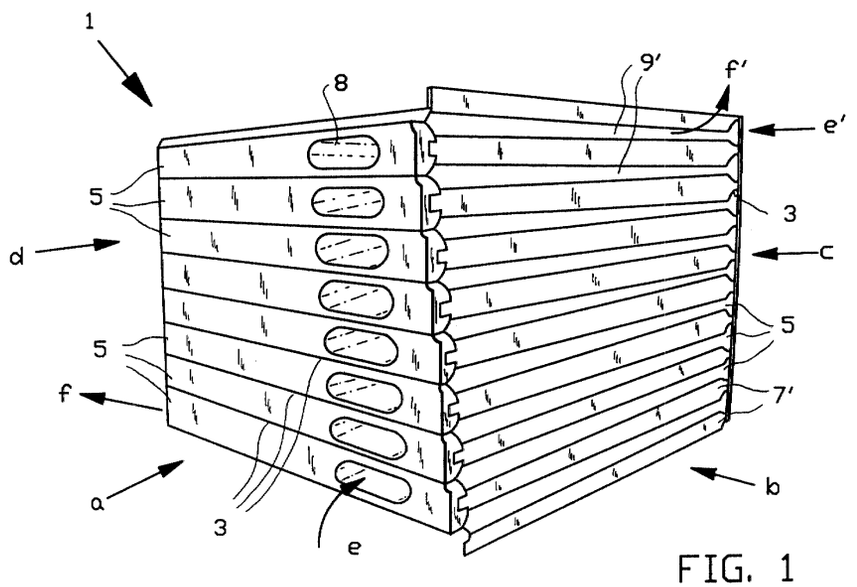

FIG. 1

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Description

[0001] The invention relates to a heat exchanger.

[0002] In general many heat exchangers are known. Heat exchangers are particularly used in so-called convector heatings, but also as coolers in which a flow of outside air cools a flow of air circulating in an installation. In this case direct access of outside air in an installation is undesirable.

[0003] In said uses such heat exchangers are constructed from very many parts. As a result, such heat exchangers are difficult to make, expensive, and vulnerable. Moreover, plate material that is thicker than strictly necessary, is often used as a result. This is disadvantageous for the heat exchanging properties. The quicker heat can be exchanged, the smaller the heat exchanger can after all be.

[0004] Apart from that the costs of such a heat exchanger rise more quickly as the distance between the plates needs to be smaller and/or the heat exchanger needs to be of larger dimensions.

[0005] It is an object of the invention to provide a heat exchanger which overcomes at least part of said drawbacks. The heat exchanger according to the invention can also provide in a heat exchanger that is simple to manufacture in complex shapes and variable dimensions.

[0006] It is therefore amongst others an object of the invention to provide a heat exchanger which is very simple and cheap to produce.

[0007] Additionally it is an object of the invention to provide a heat exchanger in which the heat exchanging flows remain separate as much as possible.

[0008] To that end the invention provides a heat exchanger provided with a series of first and a series of second fluid ducts that are in heat exchanging contact with each other, in which the ducts are bounded by circumferential walls comprising duct partitions and duct side walls, in which the heat exchanger is formed by means of folding substantially one metal plate into a packet of ducts having four sides, in which the duct side walls form opposite first and second sides of the heat exchanger and every other one respectively is provided with first and second passages, respectively, for access to the ducts of the first and second series of ducts, respectively, and in which the first series of ducts is closed off at the third side by means of folded down wall members of the duct partitions and is open at the fourth side and the second series of ducts is closed off at the fourth side by means of folded down wall members of the duct partitions and is open at the third side.

[0009] Preferably the passage of a duct is situated near the side of said duct that is closed off by means of folded down wall members. As a result the possibility is provided that fluid can flow almost in counterflow through two series of ducts, as a result of which an improved heat exchange can arise.

[0010] Additionally, for a good heat exchange, it is preferred when the ducts of the first series of ducts and the ducts of the second series of ducts are ranged in turns.

[0011] The heat exchanger according to the invention preferably is made of a metal plate that is folded in a concertina manner. This is preferably done in such a manner that an almost equal intermediate space arises between each duct partition and the duct partitions are each positioned almost parallel with respect to each other.

[0012] In order to realise this in a simple manner the metal plate preferably is provided with each time two parallel folding lines between two duct partitions. In order to make a simple folding without too many finishing treatments possible, the distance between the two folding lines preferably is larger than the distance between the duct partitions.

[0013] In order to easily adapt the dimension of the heat exchanger to customer wishes, the metal plate from which the heat exchanger is made preferably is strip-shaped.

[0014] In order to be able to seal the ducts well it is preferable when the heat exchanger according to the present invention is folded from a metal plate provided with trough-shaped sections over the width of the metal plate, in turns at the bottom side and the top side projecting from the plane of the metal plate. And to necessitate as few finishing treatments as possible it is preferred here that the trough-shaped sections have a substantially level bottom. As a result the connecting parts between the folding lines form a straight side and the remaining bottom parts a level and tight connection and sealing of the ducts. More preferably the trough-shaped sections are boat-shaped in cross-section.

[0015] For effecting a good sealing and connection the metal plate preferably is provided with folding lines within the trough-shaped sections, more preferably the folding lines have been arranged in the level bottom of the trough-shaped sections. More preferably the level bottom is wider than the distance between the folding lines. As a result almost no finishing treatment of the sides of the heat exchanger are necessary and a tight, level finishing is obtained as well as a good sealing.

[0016] In order to simply and neatly fold the metal plate and to obtain a tight connection of the several parts, it is preferred that the folding lines consist of continuous wedge-shaped grooves.

[0017] It is possible to let at least one conduit run substantially perpendicular to the plates, trough the duct partitions, which conduit is connected in heat exchanging contact to the parallel, preferably equidistant duct partitions. A first fluid running through the conduit, preferably at last two pipes, preferably for a reciprocally running flow of first fluid, then either absorbs or gives off heat quickly by means of the duct partitions to a second fluid that is present outside of the pipes between the plates. The second fluid then preferably is air, the first fluid preferably water.

[0018] Such a heat exchanger preferably forms a part of a convector element, possibly combined with several of such heat exchangers. It may be possible to couple a number of such convector elements into one convector heating element.

[0019] In another possible embodiment of the present invention the duct partitions form sides of the fluid ducts. Preferably the ducts form at last a series of first ducts and a series of second ducts. As a result a very compact heat exchanger is created.

[0020] Preferably the series of first ducts are connected to a first fluid source, and the series of second ducts are connected to a second fluid source, and more preferably the series of first ducts and the series of second ducts are in heat exchanging contact with each other. As a result a very efficient heat exchange takes place.

[0021] Preferably each duct of the first series of ducts is provided with first inlets for the first fluid and first outlets, and each duct of the second series of ducts is provided with second inlets for the second fluid and second outlets. Preferably the inlets are perpendicular to the outlets, as a result of which a compact structure becomes possible.

[0022] Preferably the first series of ducts at the bottom side and the second series of ducts at the top side are closed off by means of folded down wall members, in which preferably the wall members are integrally formed with the metal plate, more preferably the wall members are integrally formed with the metal plate at the long side of the strip-shaped metal plate. As a result a heat exchanger can be made in almost one production course.

[0023] In the heat exchanger according to the invention, preferably the trough-shaped sections between the two parallel folding lines are provided with first and second inlets or outlets, preferably the first inlets are situated in the trough-shaped sections that project at the one side from the plane of the metal plate, and the second inlets are situated in the trough-shaped sections that project at the other side of the same metal plate. More preferably the first inlets are situated at one side of the longitudinal axis of the metal plate, and the second inlets are situated at the other side of the longitudinal axis of the metal plate.

[0024] Additionally, the invention relates to a method for making a heat exchanger according to one or more of the above-mentioned embodiments, in which at at least one edge of a metal plate wall members are arranged, the wall members are folded out of the plane of the plate, the plate is provided with channel sections provided with folding lines in the channel sections, in which the plate is subsequently folded into a heat exchanger over the folding lines.

[0025] Preferably the metal plate is cut in at at least one edge in which the cuts bound the wall members. More preferably plate material is taken away at two opposite sides so that wall members are created at opposite sides.

[0026] Preferably the wall members are substantially folded perpendicular to the metal plate. In this manner the heat exchanger can be formed in almost one process course and merely the finishing is needed.

[0027] Preferably the trough-shaped sections and folding lines are arranged over the full width of the metal plate alternatingly at the one side and at the other side of the metal plate, in which after folding up the wall members, the sides of the heat exchanger are dipped into a glue in order to seal off the remaining seams.

[0028] A described heat exchanger is for instance used in cooling electronics, or the discharge of produced excess heat. In such a use it may be undesirable that outside air, full of dust and the like, directly enters the installation. A simple and often chosen solution for this is to let the air circulate within the installation, and at some moment in time bringing this air in heat exchanging contact with relatively cool or cooler flow of outside air, without letting said outside air directly enter the installation. This principle is a possibility for the housing of computers, even desktop computers.

[0029] Preferably the heat exchanger is arranged then in the electronics housing in a manner in which the passages of the first ducts and the open sides of the first ducts are connected to the inside of the electronics housing and the passages of the second ducts and the open sides of the second ducts debouch outside the electronics housing. In this way a simple mounting is possible in a cheap manner.

[0030] Additionally the invention regards a heat exchanger provided with a first series of rectangular ducts for a first fluid and a second series of rectangular ducts for a second fluid, in which the ducts of the first and second series of ducts are ranged in turns and are in heat exchanging contact, and the ducts are bounded by duct partitions, in which the duct partitions are connected by means of connection members that are formed as one unity with it.

[0031] Preferably adjacent or neighbouring ducts have duct partitions in common, i.e. one duct partition forms the wall of two adjacent ducts.

[0032] In the following figures some specific preferred embodiments and ways of production of the heat exchanger according to the invention are shown. It should be understood that the invention is not limited to said embodiments.

Figure 1 shows a front view of a heat exchanger according to the invention,

figure 2 shows a rear view of the heat exchanger of figure 1,

figure 3 shows a step from the method for making a heat exchanger according to the invention,

figure 4 shows a detail of the wall members and the parts of figure 3 that are taken away,

figure 5 shows a detail of a heat exchanger according to figure 1,

figure 6 shows an alternative embodiments for a heat exchanger,

figure 7 shows a view in perspective of a use of a heat exchanger according to the invention,

figure 8 shows a heat exchanger provided with lines perpendicular through the duct partitions.

[0033] Figure 1 shows a front view of a heat exchanger 1 according to the invention. In the heat exchanger two series of ducts can be seen in which the first series at the one side is closed off by means of folded down wall members 7'. The second series of ducts is opened at this side and comprises inlets 9'. The side of the heat exchanger is formed by the bottom side 5 of the trough-shaped sections, said side members are bounded by folding lines 3. In the figures outlets 8 of the ducts that are closed off by means of wall members 7' can also be seen.

[0034] The first and second series of ducts form a packet of ducts having four sides a, b, c and d. The duct side walls 5 of the first series of ducts are provided with passages 8 and together form the first side a of the heat exchanger 1. The open end of the first ducts is situated in the fourth side d that is not visible of the heat exchanger. Via a passage 8, a first fluid flows (indicated by arrow e) into the first ducts, and via the open side of the ducts at the fourth side d that is not visible out of the heat exchanger (arrow f) at the fourth side d of the heat exchanger. The first ducts are closed off by means of the folded down wall members 7 at the third side b of the heat exchanger.

[0035] Via the passages in second side c (that is not visible) of the heat exchanger, a second fluid flows into the second ducts and is indicated by arrow e'. Said fluid flows (indicated by arrow f') out of the heat exchanger 1 via the open side in the third side b of the heat exchanger. The second ducts are (not visible in this figure) closed off by means of folded down wall members at the fourth side d of the heat exchanger.

[0036] The two flows run more or less crosswise.

[0037] In figure 2 a rear view of the heat exchanger of figure 1 can be seen. Here it can be seen that the second series of ducts is closed off by means of folded down wall members 7 and the first series of ducts is opened by means of inlets 9. It can also be seen that here as well the side of the heat exchanger is formed by the bottom side of the trough-shaped sections 5 that are bounded by the folding lines 3. It can also be seen here that the outlets or passages 8' as well are present in the sides.

[0038] In the embodiment the duct partitions are equidistant and substantially parallel.

[0039] Figure 3 shows a top view an below it a side view of a strip-shaped metal plate, from which the heat exchanger can be made. In the top view the axial line A is shown. In the figure it can be seen that the trough-shaped sections 4 have been arranged and parts have been taken away at the sides of the strip-shaped metal plate as a result of which wall members 10 have been formed. In the side view shown below the strip-shaped plate it can be seen that the trough-shaped sections 4 in turns extend below the plate surface and extend above the plate surface. It can also be seen that in the bottom 5 of the trough-shaped sections 4 the folding lines 3 have been arranged. Said folding lines have been arranged over the full length of the trough-shaped sections 4 and have been formed like wedge-shaped or V-shaped grooves in the plate material. In the figure it can also be seen that the first outlets 8 and the second outlets 8' have alternatingly been arranged at either side of the axial line A. In the figure the total width of the trough-shaped sections 4 is also indicated with the help of a figure 8, and the level bottom of the trough-shaped sections 4 is indicated by the figure 5. In the figure it can clearly be seen that the folding lines 3 are situated in the level part of bottom 5 of the trough-shaped sections 4. In order to fold the strip-shaped metal plate into a heat exchanger, the metal plate only has to be stopped at the end of the metal plate and the rest of the metal plate has to be moved on. As a result the metal plate folds concertina-wise over the folding lines 3, each time upwards and downwards. Before folding the strip-shaped metal plate into a heat exchanger first the wall members 10 have to be folded out of the plane of the strip-shaped metal plate. Here a small wall member 10 for instance has to be folded downwards, the two longer wall members 10 following it also have to be folded downwards, the following short wall member 10 has to be folded upwards, the following long wall members 10 have to folded upwards at one side and so on. At the other side of the strip-shaped metal plate the same has to take place in a staggered way with respect to the first side. When the strip-shaped metal plate has been folded into a heat exchanger, the wall members 10 in turns close off the ducts formed on either side.

[0040] It is also possible to make the longer wall members wider, as a result of which one wall member closes off the duct end. As a result an abutting wall member can be left out each time.

[0041] Figure 4 shows an enlargement of a side of a strip-shaped metal plate of figure 3. The folding lines 3 are clearly indicated here, which folding lines are situated within the level bottom 5 of the trough-shaped sections 4 and the total channel width 8. As could also be seen in figure 3, each time one small wall member and two longer wall members have been formed in turns and at the other edge of the strip-shaped metal plate the same staggering has taken place.

[0042] Figure 5 shows a top view of the heat exchanger of figure 1 in detail. It can clearly be seen here that the heat exchanger is formed out of one strip-shaped

metal plate. In figure 6 it can be seen that the metal plate is folded over the folding lines 3. It can be seen that the duct partitions 2 are parallel and equidistantly oriented. Here the wall members 10 are folded perpendicular to the duct partitions 2 as a result of which every other one of them closes off a duct. Each time the other duct is opened via outlet 8. In figure 6 an enlargement is also shown, in which it can be seen that the folding line has been made wedge-shaped or V-shaped in the metal plate as a result of which a neat wall is created when folding. Said fold has not been made entirely through the metal plate, otherwise the metal plate would break during folding.

[0043] In figure 5a it is schematically shown how a heat exchanger is folded out of one plate by the drawing the abutting parts separate from each other.

[0044] Figure 6 shows an alternative embodiment of a heat exchanger according to the invention, here a metal plate is folded such that it resembles battlements and integrally formed wall members 10 have been folded down in order to each time close off a duct at one side. At the other side the same has happened with the adjacent duct. By covering the folded metal plate on both sides with a metal plate 14 a heat exchanger is also formed in a simple way.

[0045] Figure 7 shows a use of a heat exchanger according to the invention in a electronics housing which is closed off to the outside air. Here the heat exchanger is placed in a separate housing 15 provided with inlet grids for internal air of the electronics housing 18 and inlet grids 17 for the outside air. Said separate housing 15 is also provided with outlets 8. By means of air movement devices such as fans or the like, the air is urged into grids 8. The air is therefore able to circulate internally in the electronics housing 16 without contacting the outside air. As a result for instance no dust will get into the electronics housing.

[0046] Figure 8 shows a heat exchanger in which conduits 12, perpendicular to the duct partitions, are guided perpendicularly through the duct partitions and in heat exchanging contact therewith. As a result a convector element is created in a simple manner in which the duct partitions are oriented equidistantly and parallel with respect to each other. An additional advantage is that the sides of the convector element are closed off, as a result of which little dust can get inside and it is easy to attach ornamental parts on such a convector element.

[0047] It should be clear from the entire description that the corresponding inlets and outlets can of course be interchanged: the inlets may serve as outlets and vice versa.

[0048] It is of course also possible to use the heat exchanger according to the invention for other fluid material flows than just air. It is for instance possible to let water and air exchange heat with the help of the heat exchanger according to invention. Two flows of water or another liquid able to exchange heat, can also be thought of.

[0049] Apart from air of course other gas flows can exchange heat with the help of the heat exchanger according to the present invention, or other liquids are able to exchange heat with gasses. In general the heat exchanger according to the invention is suitable as heat exchanger for fluid flows.

[0050] However, it should be clear that the heat exchanger according to the invention for instance used as for instance a radiator in buildings, should meet the specific applicable requirements made to that end, such as for instance pressure resistance. As a result, for such uses a thicker metal plate will be chosen or copper or steel instead of a thin aluminium plate of approximately 0.5 mm.

Claims

1. Heat exchanger provided with a series of first and a series of second fluid ducts that are in heat exchanging contact with each other, in which the ducts are bounded by circumferential walls comprising duct partitions and duct side walls, in which the heat exchanger is formed by means of folding substantially one metal plate into a packet of ducts having four sides, in which the duct side walls form opposite first and second sides of the heat exchanger and every other one respectively is provided with first and second passages, respectively, for access to the ducts of the first and second series of ducts, respectively, and in which the first series of ducts is closed off at the third side by means of folded down wall members of the duct partitions and is open at the fourth side and the second series of ducts is closed off at the fourth side by means of folded down wall members of the duct partitions and is open at the third side.

2. Heat exchanger according to claim 1, in which the passage of a duct is situated near the corner with the side of the duct that is closed off by means of folded down wall members.

3. Heat exchanger according to claim 1 or 2, in which the ducts of the first series of ducts and the ducts of the second series of ducts are ranged in turns.

4. Heat exchanger, according to claim 1 or 2 or 3, in which the metal plate between two duct partitions is provided with each time two parallel folding lines, in which preferably the distance between the two folding lines is larger than the distance between the duct partitions, and in which the metal plate preferably is strip-shaped.

5. Heat exchanger according to one or more of the preceding claims, folding from a metal plate provided with trough-shaped sections over the width of the

metal plate, in turns at the bottom side and the top side projecting from the plane of the metal plate.

6. Heat exchanger according to claim 5, in which the trough-shaped sections have a substantially level bottom, in which the metal plate preferably is provided with folding lines within the trough-shaped sections, preferably in the level bottom of the trough-shaped sections.

7. Heat exchanger according to one or more of the preceding claims, in which the folding lines consist of continuous wedge-shaped grooves in the metal plate.

8. Heat exchanger according to claim 6 or 7, in which the trough-shaped sections between the two parallel folding lines are provided with first and second passages for the first and second series of ducts, respectively.

9. Heat exchanger according to one or more of the preceding claims 6-8, in which the first passages are situated in the trough-shaped sections that project at the one side from the plane of the metal plate, and the second passages are situated in the trough-shaped sections that project at the other side of the same metal plate.

10. Heat exchanger according to one or more of the preceding claims 6-9, in which the first passages are situated at one side of the longitudinal axis of the metal plate, and the second passages are situated at the other side of the longitudinal axis of the metal plate.

11. Electronics housing provided with heat exchanger according to one or more of the preceding claims.

12. Electronics housing according to claim 11, in which the heat exchanger is arranged in the electronics housing in which the passages of the first ducts and the open sides of the first ducts are connected to the inside of the electronics housing and the passages of the second ducts and the open sides of the second ducts debouch outside the electronics housing.

13. Method for making a heat exchanger according to one or more of the preceding claims 6-10, in which at at least one edge of a metal plate wall members are arranged, the wall members are folded out of the plane of the plate, the plate is provided with channel sections provided with folding lines in the channel sections, in which the plate is subsequently folded into a heat exchanger over the folding lines.

14. Method for making a heat exchanger according to claim 13, in which the metal plate is cut in at at least one edge in which the cuts bound the wall members, and in which preferably plate material is taken away at two opposite sides so that wall member arise at two opposite sides, in which preferably the wall members are substantially folded perpendicular to the metal plate.

15. Method for making a heat exchanger according to claim 13 or 14, in which alternatingly at the one side and at the other side of the metal plate, the trough-shaped sections and folding lines are arranged over the full width of the metal plate, and after that preferably the sides of the heat exchanger, after folding up the wall members, are dipped into a glue in order to seal off the remaining seams.

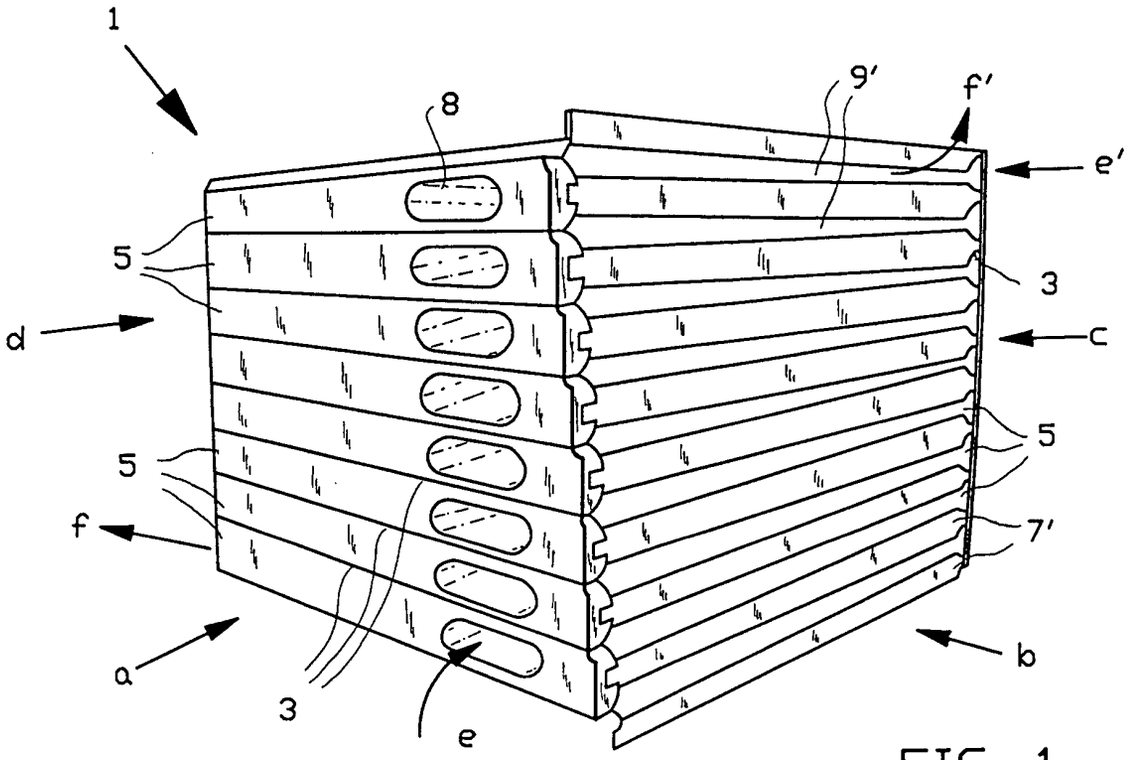

FIG. 1

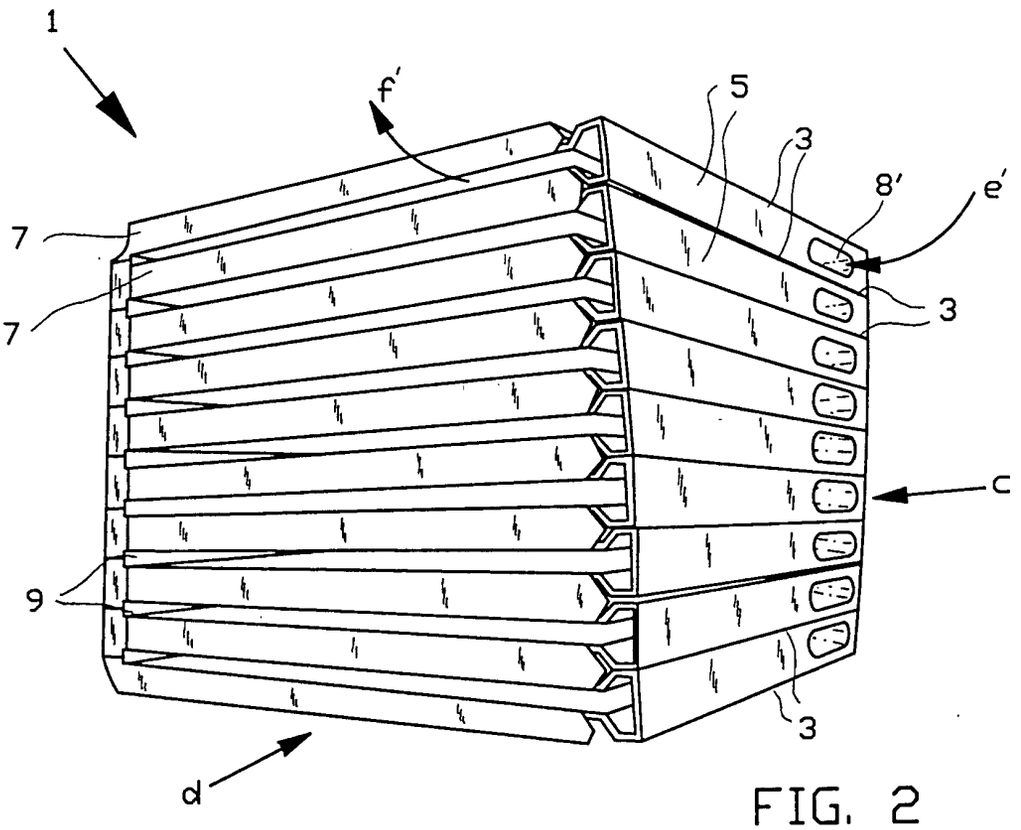

FIG. 2

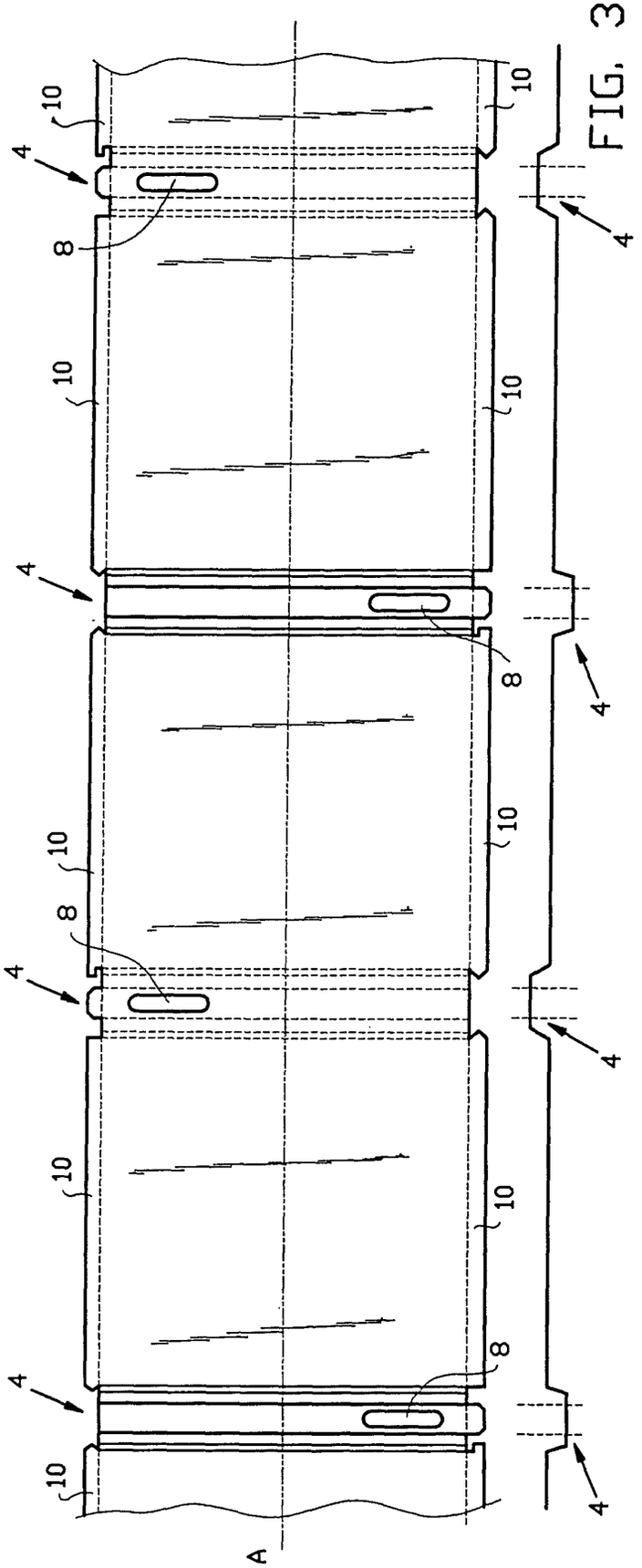

FIG. 3

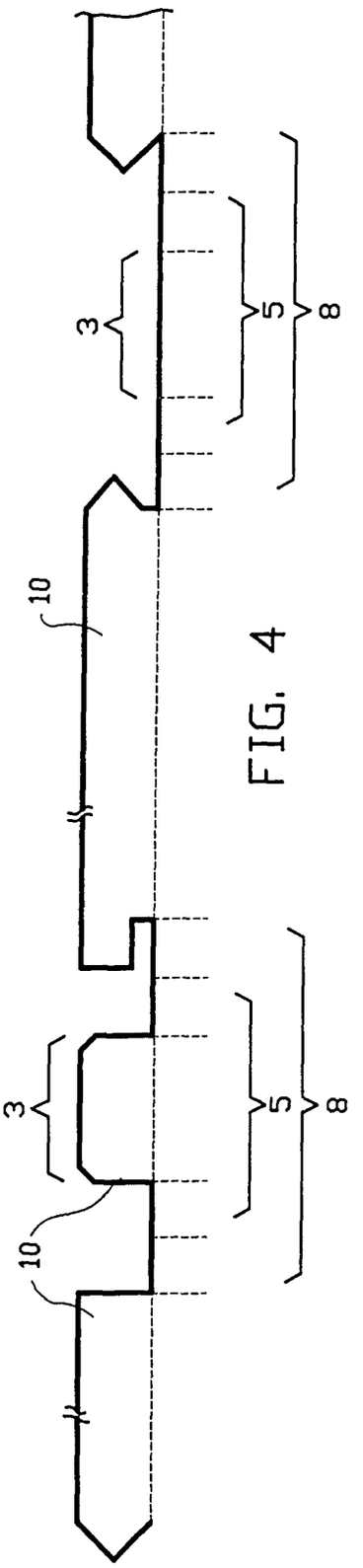

FIG. 4

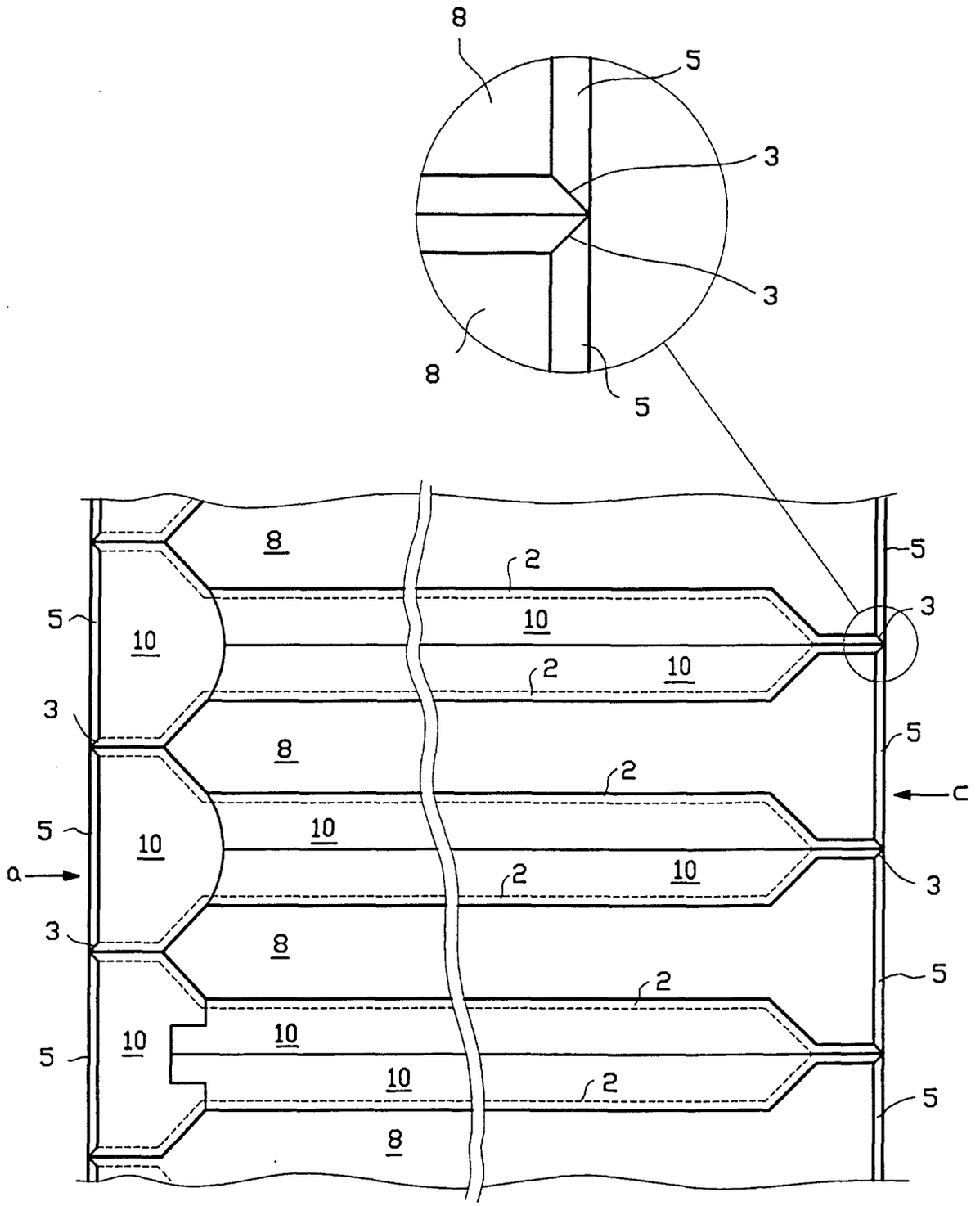
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FIG. 5

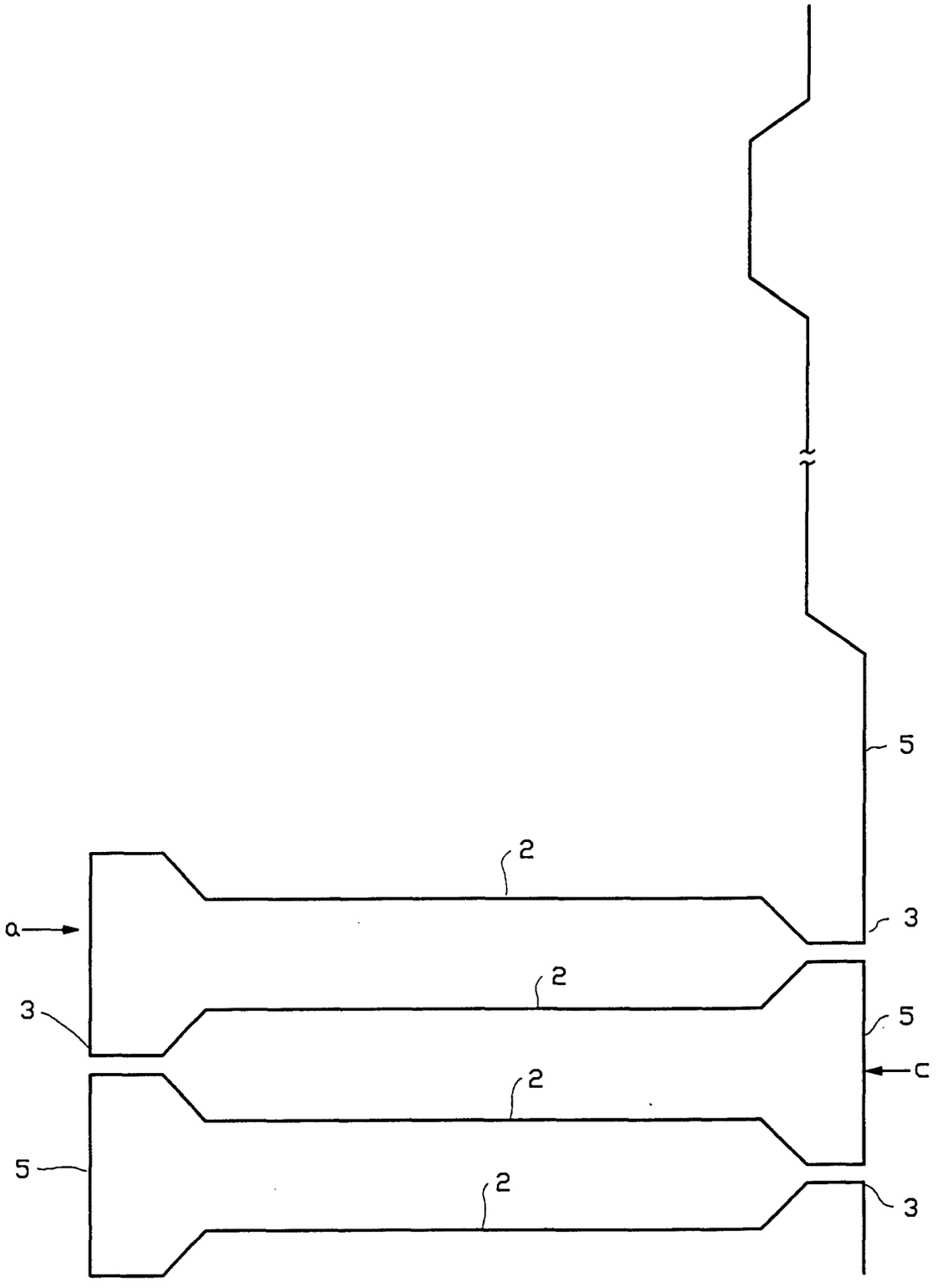

FIG. 5A

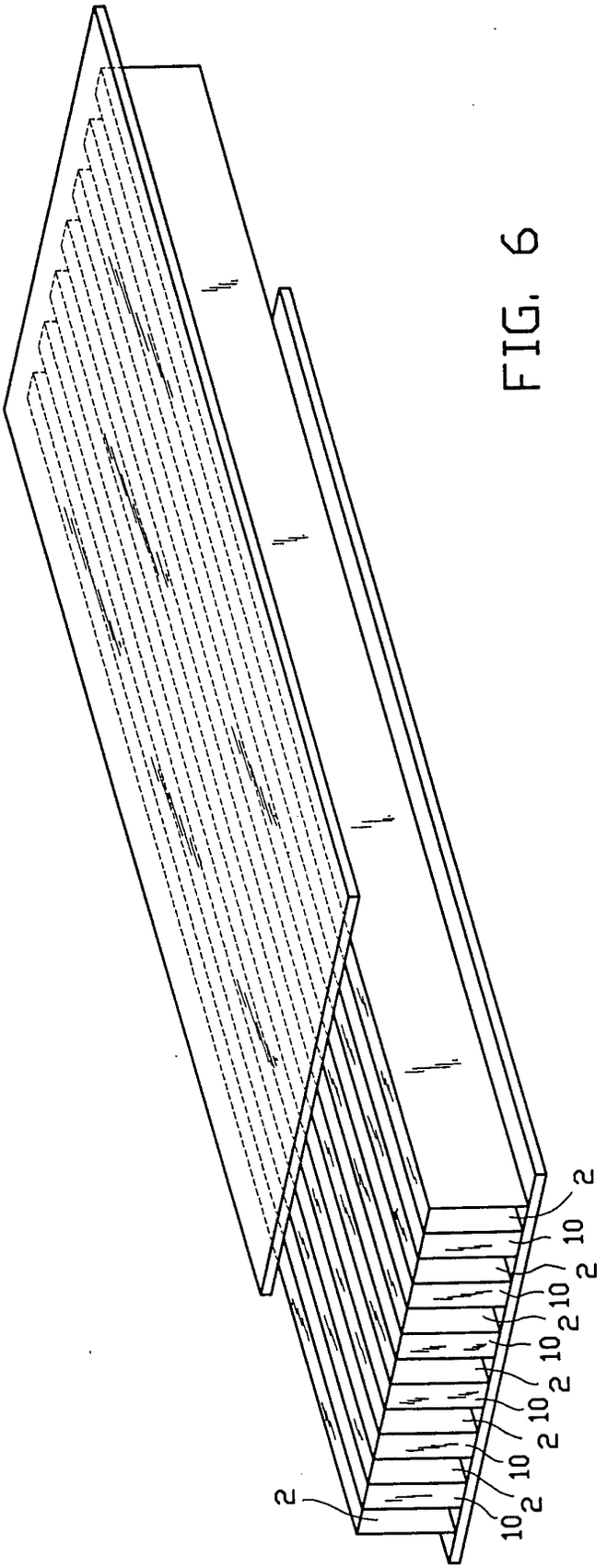

FIG. 6

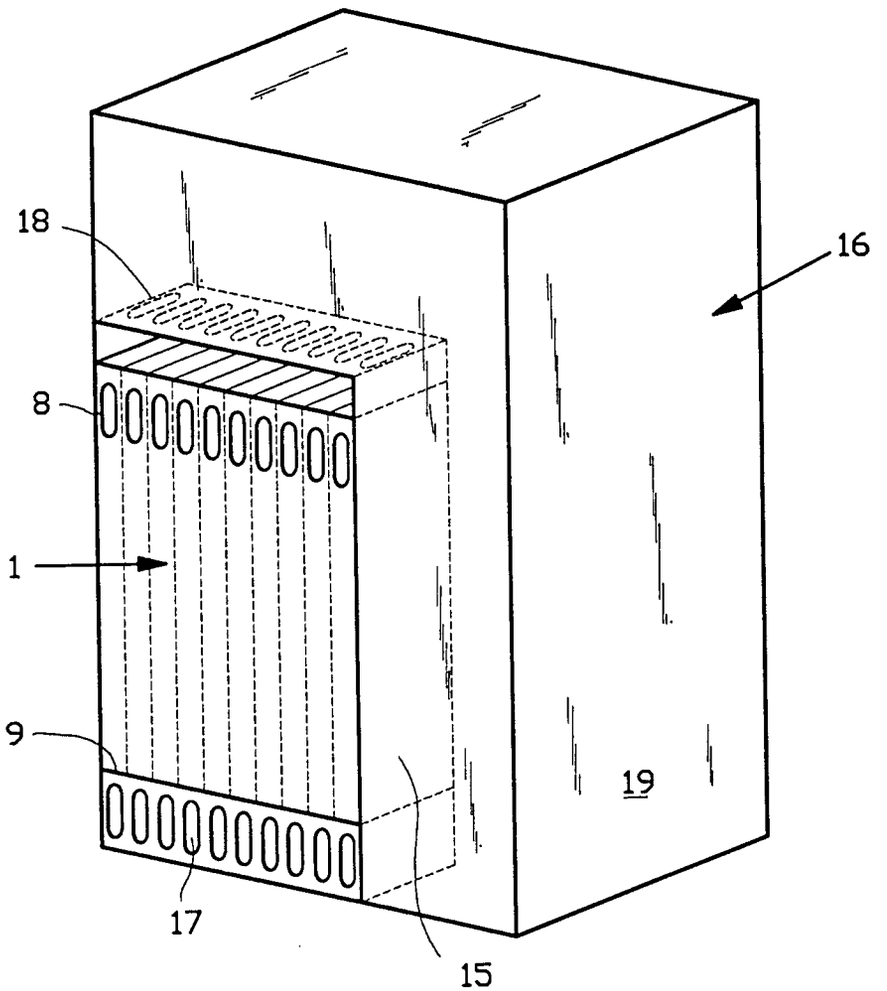

FIG. 7

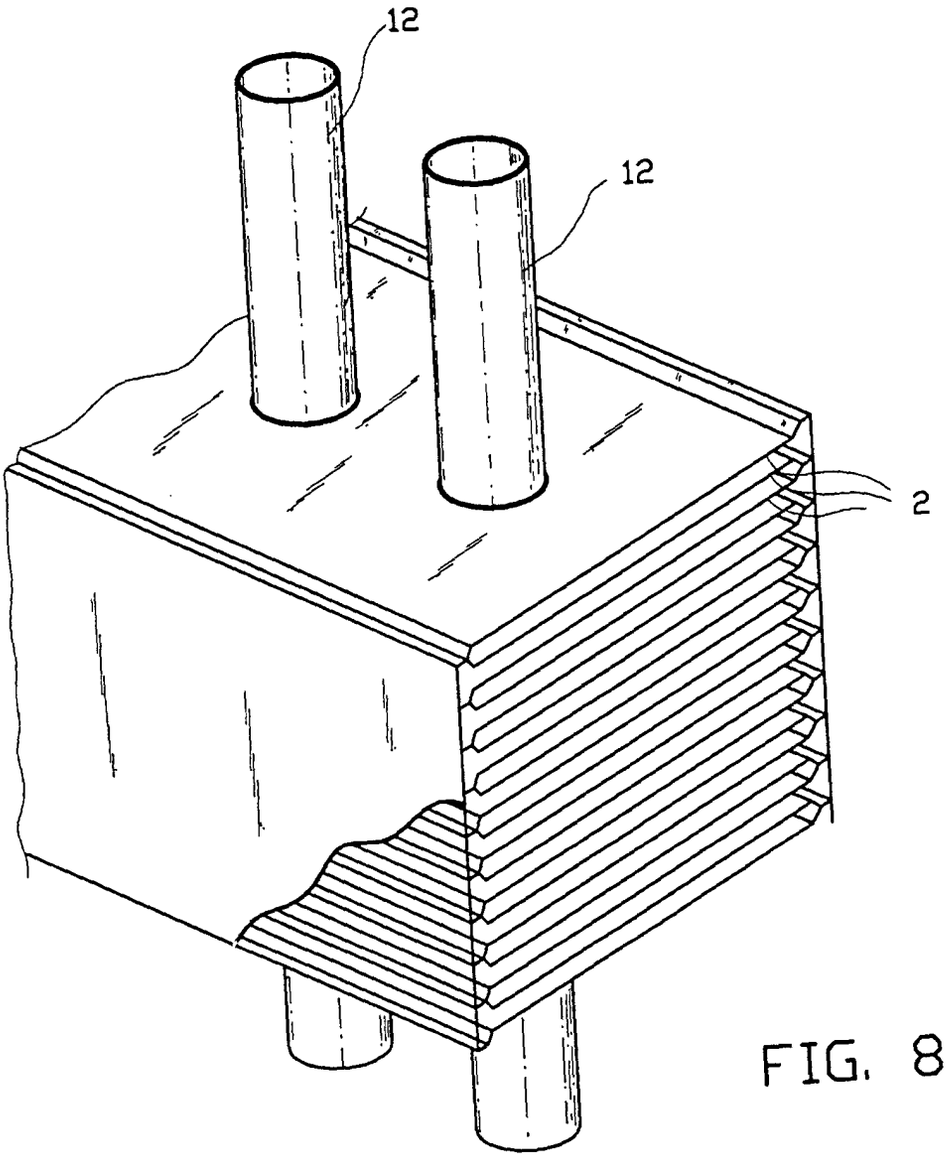

FIG. 8