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(54) Heat exchange panel and method for manufacturing the same

(57) The plate comprises two metallic sheets attached to each other and tightly joined to each other along all their perimeter (3), a plurality of joining areas (8,9) between sheets within such perimeter (3) and a plurality of dished areas (5) of the sheets determining channels for the fluid flowing from an inlet (6) to an outlet (7) around such joining areas (8,9), which define first and second straight joining lengths (8,9) which define first and second straight joining lengths (8,9) respectively aligned according to lines parallel to first and second directions, each first length (8) interposed between contiguous ends of two of such second lengths (9) and vice versa. The process comprises to carry out such junctions by means of laser welding and then injecting a pressurized fluid between the sheets to carry out the dished areas (5) by inflating them.

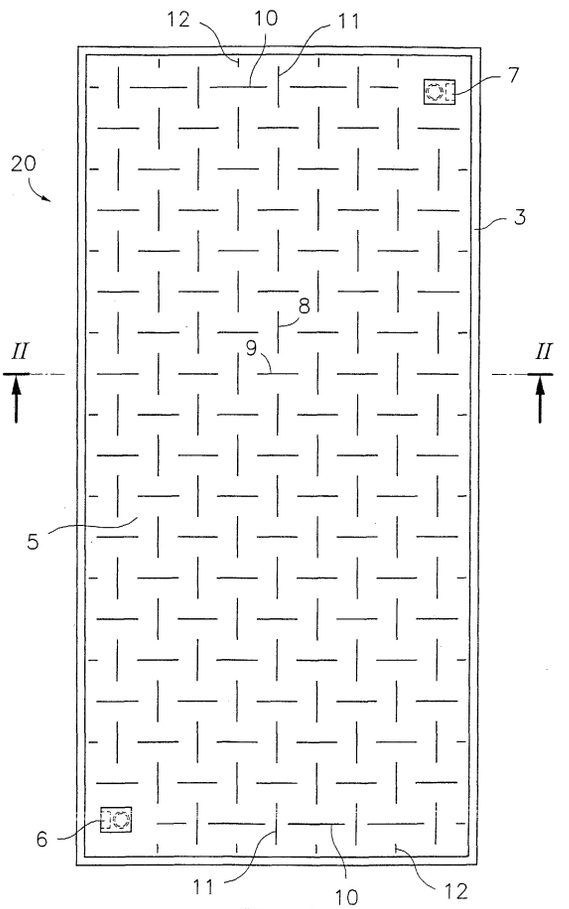

Fig. 1

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Description

Field of the invention

[0001] This invention refers to a heat exchanger plate formed by two metallic sheets attached to each other and tightly joined to each other along all their perimeter, with a plurality of outwardly dished areas formed on both metallic sheets determining channels for fluid flowing from an inlet to an outlet around such joining areas.

[0002] This invention also refers to a process for producing such heat exchanger plate which means laser welding and pressurized fluid injection.

Technical background

[0003] By document ES-A-8303662 a compact heater is known which uses at least a flat panel type collector of solar energy which is formed of two rolled steel sheets attached and welded to each other along all their perimeter except at intersections with fluid inlet and outlet nozzles. Between the two sheets and within such perimeter, are systematically located a plurality of welding points. Once welded, the two sheets are permanently deformed by inflating them through the introduction of a pressurized fluid within the assembly, so that the panel adopts an external shape similar to a mattress and gaps are achieved between the two sheets through which water will flow acting as heat exchanging agent. Such construction has the drawback of providing a virtually single gap between the two sheets, only interrupted by the welding points so that the heat exchanging fluid tends to flow in a rather straight way from the inlet to the outlet without completely spreading to contact the whole of the sheets internal surface.

[0004] Document ES-A-479755 discloses a solar energy absorber comprising two sheets attached and welded by their perimeter. Both sheets comprise repeated regular configurations outwardly shaped and located the facing each other with a given shift between them to form channels between both sheets for a heat exchanging fluid flow between an inlet and an outlet. At the non deformed flat parts of the two sheets in contact, there exists joining areas formed by welding points. Such construction provides a network of channels for the heat exchanging fluid obliging the liquid to spread substantially through all the internal spaces between the two sheets. However, such conformations are obtained by shaping in the sheets before joining them and for this relatively big and expensive equipments are required which make the production process expensive and has an effect on the cost of the product. In addition, the shaping equipments use mould and dies which are little flexible when carrying out changes in the configurations and in the moulding of the sheets to different sizes.

[0005] The Spanish utility model ES-A239429 refers to a plate for absorbing heat radiations which is constituted of two equal sheets arranged contiguous being joined at their peripheral edges, which include a series of cylindrical or frustum shaping which will remain facing each other and with their bottom in contact and joined by welding, within the plate a series or circulating spaces being established which will be occupied by water which can thus flow on every direction.

Short explanation of the invention

[0006] An object of this invention is to provide an heat exchanging plate formed of two metallic sheets attached and tightly welded to each other along all their perimeter with a plurality of outwardly dished areas formed on both metallic sheets determining channels for fluid flowing from an inlet to an outlet around a plurality of joining areas between the two sheets, where the configuration of such channels secures a maximum effectiveness of heat exchange between the sheets and fluid and where such plate can be obtained in a relatively easy and quick way at a low cost.

[0007] Another object of this invention is to provide a production process for such heat exchanging plate allowing to obtain it in a relatively easy and quick way at low cost and which is sufficiently flexible to accept changes on the configurations and sizes of the sheets to be moulded without a significant added cost.

[0008] The former of such objects is achieved, according to this invention, providing a heat exchanging plate of the type comprising two metallic sheets attached to each other and tightly joined to each other along all their perimeter, a plurality of joining areas between the two sheets within such perimeter, and a plurality of outwardly dished areas of such metallic sheets determining channels for fluid flowing from an inlet to an outlet around such joining areas. The plate of this invention is characterized in that such joining areas define a plurality of first discrete straight joining lengths grouped aligned in several assemblies according to lines parallel to a first direction and a plurality of second discrete straight joining lengths grouped aligned in several assemblies according to lines parallel to a second direction each of two of such first joining lengths being interposed between contiguous ends of two of such second joining lengths and each of such second joining lengths being interposed between contiguous ends of such first joining lengths. Preferably, such first and second joining lengths are laser welding lines. The tight junction of the perimeter is also preferably obtained by laser welding, although equivalent results could be achieved with other processes, such as wheel welding.

[0009] The second of above objects is achieved, according to this invention, providing a process for producing one of such heat exchanging plates of the type comprising to attach two metallic sheets and tightly joining them to each other along all their perimeter; then producing a plurality of joining areas between such two metallic sheets on such perimeter; then fastening by several areas distributed along the perimeter the said me-

tallic sheets thus attached and joined; and last, injecting a pressurized fluid between the metallic sheets until achieving a plurality of dished areas by permanent deformation of both metallic sheets determining channels for a fluid flowing from an inlet to an outlet around the said joining areas. The process of this invention is characterized in that it comprises to carry out such joining areas in the form of a plurality of first discrete straight joining lengths grouped in several assemblies aligned according to lines parallel to a first direction and a plurality of second discrete straight joining lengths grouped in several assemblies aligned according to lines parallel to a second direction crosswise such first direction, each of such first joining lengths being interposed between contiguous ends of two of such second joining lengths and each of the second joining lengths interposed between contiguous ends of two of the first joining lengths.

[0010] Advantageously, the process comprises to carry out the first and second joining lengths by laser welding and preferably by means of a laser welding head mounted on a robotic arm controlled by programmable controlling electronic means. For this kind of welding where there is many short, separate lengths, oriented in different directions at the internal area of the sheets, laser welding carried out with a robotic arm provides a great saving of time compared against other processes such as, for example, wheel welding. This is due to the fact that with laser welding it is only required to activate and deactivate the laser ray emitter matched with the displacement of the head at a given distance of one of the sheets of the plate while with wheel welding such displacement has to be matched with the closure, application of pressure and opening of wheel-holder arms on both sheets of the plate.

[0011] Such tight junction of such perimeter is also preferably obtained by laser welding, although as it is dealt with continuous welding beads close to the edges of the sheet they could also be carried out with wheel with equivalent performances.

[0012] The laser welding process with an electronically controlled robotic arm provides a great flexibility of design and production because with it is possible to replace the design with another one or the size of the plate with another one by simple selecting the suitable program out of a series of programs previously stored in a memory associated to such controlling electronic means or by introducing a new program with data suitable for the new design.

[0013] From a number of tests carried out with different configurations for the joining lengths and with slight variations at each of the configurations, it was checked that a configuration as the above disclosed results specially advantageous and that at all the joining lengths as well in the first as in the second direction, they are equally long and they are separated by gaps equal to the joining lengths. In addition, each of the joining lengths in one direction is centred with respect to the line crossing it, according to which joining lengths are aligned in the other direction. Preferably, the first and second directions are mutually perpendicular, although they could also be oblique to each other, forming a given angle close to the straight angle, for example, comprised from 60° to 90° . It results specially advantageous that the first joining lengths are centred with respect to the parallel lines according to which are aligned the second joining lengths and vice versa, because with it dished areas are created determining channels in multiple directions without any of them is a priority for such fluid flow.

[0014] It has also be checked that such configuration and distribution of the joining lengths provide an even blowing up of the areas of the sheet existing between them without a deformation or a general significant bending of the plate occurs.

[0015] The two attached sheets are generally quadrangular or rectangular although it is not essential and there exists no special limitations as for the size and proportion thereof. The mentioned fluid inlet and outlet comprise respective openings in one or the other sheet close to the sides opposite to the perimeter of the plate. Preferably, respective sleeves connecting to a pipe are coupled at such openings. Although the inlet and outlet could both be indistinctly in a same sheet or each in a different sheet, that is to say on the same or different faces of the plate, it is preferred that both are in a same sheet to facilitate the connections between contiguous plates when several plates are connected to each other. The process of the invention allows to place the said connecting sleeves either on one or both sheets, prior to the step of attaching the sheets to each other and tightly welding the perimeter around them.

[0016] With a configuration and geometric arrangement of the junction lengths according to this invention it is achieved that the said plurality of dished areas around the joining lengths determines channels in multiple directions preferably even, equivalent, for such fluid flow. In other words, there exists no circuit or direction preferred for the fluid flow from the inlet to the outlet of the plate but the fluid flow, because of the even equivalent priority of the multiple directions is completely spread on all the plate to make contact with the whole of the sheets internal surface. To prevent the greater difficulty the fluid flow has to reach those corners of the plate farthest from the inlet and/or outlet it has been provided that the joining lengths are longer and at gaps between contiguous ends equivalently shorter at such lines parallel and adjacent to the edges of the plate close to which are arranged the inlet and outlet. This way preferred directions are established from the inlet towards the said corners close to an edge or edges of the plate and from such corners towards the outlet close to another edge or edges of the plate.

Short description of the drawings

[0017] Above and other characteristics and advantages will become more apparent from following detailed

description of examples of embodiment with reference to the drawing appended in which:

Fig. 1 is an elevation view of an heat exchanger plate according to an example of embodiment of this invention;
Fig. 2 is a part view in cross section taken along plane II-II of Fig. 1: and
Fig. 3 is an enlarged detail of the plate of Fig. 1 indicating the fluid flow directions.

Detailed description of an example of embodiment

[0018] With reference to the figures, with numeral 10 is designated in general an heat exchanger plate according to an example of embodiment of this invention. No specific figures are included to illustrate the process of this invention, as they are based on well-known techniques. Therefore, the process will be described at same time as plate 20.

[0019] Plate 20 is composed of two metallic sheets 1,2) (see Fig. 2) attached to each other and tightly joined along all their perimeter 3. The sheets can be of any metallic material which is heat conductor and preferably corrosion resistant, such as for example stainless steel. Only for example purpose, 0.5 mm thick stainless steel sheets AISI 316L are suitable to produce a 1 m long 0.5 m wide plate. Plate 20 includes a plurality of junction areas 8, 9 between such two metallic sheets 1, 2 within such perimeter 3. Plate 20 in addition includes an inlet 6 and an outlet 7 comprising respective openings in one or the other sheets 1, 2, close to opposite edges of plate 20 and respective inlet and outlet 6, 7 connecting sleeves coupled on such openings. In Fig. 1, plate 20 is arranged so that it shows one of the sheets 1. Such inlet and outlet openings with their respective inlet and outlet 6, 7 connection sleeves are both arranged on such same sheet 1. However, in an alternative example of embodiment (not shown) the inlet opening and the respective inlet 6 connection sleeve are arranged on one of the sheets 1, 2 and such outlet opening and respective outlet 7 connection sleeve are arranged on the other of the sheets 1,2.

[0020] To arrives up to this point, the process of the invention comprises, first , attaching the two metallic sheets 1, 2 and tightly joining them to each other along the said perimeter 3 by welding which can easily be carried out with a continuous line of wheel welding. However, and because of the fact that the process comprises to carry out a plurality of junction areas 8, 9 by laser welding, the welding line along the perimeter 3 of the sheets can also be carried out with laser welding in a same operation. Carrying out such laser welding if preferably with a laser welding head mounted on a robotic arm controlled by programmable controlling electronic means. Advantageously, carrying out the inlet and outlet openings and coupling the respective inlet and outlet 6, 7 connection sleeves on such openings is carried out prior to the step of attaching the sheets 1, 2 and welding the tight perimeter 3 around them. As the inlet and outlet 6,7 connection sleeves are not going to be dismounted, their coupling on the respective openings is made by welding.

[0021] Going on with the figures, plate 20 shows a plurality of outwardly dished areas 5 of the two metallic sheets 1, 2 (Fig. 2) determining channels for the fluid flowing from the inlet 6 to the outlet 7, around such joining ares 8, 9. Thanks to such channels 5, the plate 20 is useful, for example, as an element absorbing the heat in an heliothermal captor or as heat absorber or disengaging device in other applications of heat transfer using an heat exchanger fluid flow within the channels 5. The process for obtaining such dished areas 5 is carried out by means of a well-known technique once the sheets 1, 2 are tightly joined along the perimeter 3 and the joining lengths 8,9 have been made. Such technique consisting in fastening at least by several areas distributed along the perimeter 3 the said metallic sheets 1, 2 attached and joined and injecting a pressured fluid between both metallic sheets 1, 2 through, for example, one of such inlet or outlet 6, 7. By the effect of the internal pressure exerted by such fluid, both metallic sheets 1, 2 are deformed in a permanent way giving place to the said plurality of dished areas 5 around such junction areas 8, 9. With the 0.5 mm thick sheets above mentioned, 6 to 8 bar are sufficient to produce the dished areas 5.

[0022] As it can be noted in Fig. 1, the joining areas 8, 9 define a plurality of first discrete straight joining lengths 8, grouped aligned according to lines parallel to a first direction and a plurality of second discrete straight joining lengths 9 grouped aligned according to lines parallel to a second direction. Each of such first joining lengths 8 being interposed between contiguous ends 9a, 9b of two of such second joining lengths 9 while each of the second joining lengths 9 are interposed between contiguous ends 8a, 8b, of two of the first joining lengths 8, as shown with more details in Fig. 3.

[0023] In a preferred example of embodiment, the first joining lengths 8 have substantially same span to those of the second joining lengths 9 and the gaps between contiguous ends of the first joining lengths 8 are substantially the same as the gaps between contiguous end of the second joining lengths 9. In addition, the first joining lengths 8 are centred with respect to the lines parallel according to which are aligned the second joining lengths 9 and the second joining lengths 9 are centred with respect of the parallel lines according to which are aligned the first joining lengths 8, so that such plurality of dished areas 5 determines channels in multiple directions preferably even equivalent to the flow of such fluid.

[0024] Such effect is enhanced is, as shown in the figures, the first joining lengths 8 have substantially same span as the gaps between their contiguous ends and the spans of the second joining lengths 9 are substantially the same as the gaps between their contiguous ends. It is also profitable that such parallel lines along

which are aligned the first joining lengths 8 are equidistant to each other and that also the parallel lines along which are aligned the second joining lengths 9 are equidistant and that the gaps separating the parallel lines in one or the other direction are the same. It is sought to achieve a network of channels having branches in multiple directions as symmetrically and evenly as possible in order that a fluid flowing through them tends to be subdivided into equal parts at each branching-off and spreads through the plate. Although it is not essential, it is preferred that the first and the second directions are perpendicular to each other as in the example of embodiment illustrated in Fig. 1.

[0025] Fig. 3 diagrammatically shows with arrows the possible directions of a fluid flowing through the channels formed by the dished areas 5 on a plate as that of Fig. 1 in which the inlet 6 is at a left lower end and the outlet 7 at a right top end. The flow tends to go parallel to the first joining lengths 8 at both ends thereof and to split into two substantially symmetric branches when reaching the lower part of the second joining lengths 9 to direct themselves towards the ends 9a, 9b. However, part of the fluid of each of such branches will be split when reaching another first joining length 8 and part of it will be mixed with part of the fluid from other branches at the top part of other contiguous joining lengths 9 to pass between one or the other side of the joining length 8 and the ends 9a, 9b of such joining lengths 9 and so on.

[0026] For stimulating the arrival of the fluid flow up to those corners of the plates farthest from the inlet 6 and the outlet 7, that is to say, the lower right corner and the top left corner, respectively, at the plate 20 of Fig. 1, joining lengths, designated as 10 and 11, aligned along lines parallel to the first and second directions and adjacent to such edges of the plate close to such inlet 6 and/or outlet 7 are longer and the gaps between contiguous ends equivalently shorter than the first and second joining lengths 8, 9 and gaps between contiguous ends of the rest of the plate. The plate 20 shown in Fig. 1 and 3 only incorporates the fourth joining lengths 10 close to the top and lower short edges parallel to the second direction, however, another examples of embodiment not shown, the plate incorporate the said third joining lengths close to the long edges parallel to the first direction, preferably matched with the fourth joining lengths. Other small joining lengths 12 can be present close to the edges of the perimeter 3 of the plate 20.

[0027] Above description is for illustration purpose only and does not limit the scope of this invention which is defined in claims appended.

Claims

1. Heat exchanger plate of the kind comprising two metallic sheets (1, 2) attached to each other and tightly joined to each other along all their perimeter (3), a plurality of joining areas (8, 9) between such two metallic sheets (1, 2) in such perimeter (3) and a plurality of outwardly dished areas (5) of the two metallic sheets (1, 2) determining channels for fluid flowing from an inlet (6) to an outlet (7) around such joining areas (8, 9), **characterized in that** such joining areas (8, 9) define a plurality of first discrete straight joining lengths (8) grouped aligned in several assemblies according to lines parallel to a first direction and a plurality of second discrete straight joining lengths (9) grouped aligned in several assemblies according to lines parallel to a second direction each of such first joining lengths (8) being interposed between contiguous ends (9a, 9b) of two of such second joining lengths (9) and each of such second joining lengths (9) being interposed between contiguous ends (8a, 8b) of two of such first joining lengths (8).

2. Plate, according to claim 1, **characterized in that** such first and second joining lengths (8, 9) are discrete lines of laser welding.

3. Plate, according to claim 1, **characterized in that** such tight junction between the two metallic plates (1, 2) along the perimeter (3) is a continuous line of welding.

4. Plate, according to claim 3 **characterized in that** such continuous line of welding is a wheel welding line or a laser welding line.

5. Plate, according to claim 1, **characterized in that** the spans of the first joining lengths (8) are substantially equal to the spans of the second joining lengths (9) and the gaps between contiguous ends of the first joining lengths (8) are substantially equal to the gaps between contiguous ends of the second joining lengths (9).

6. Plate, according to claim 5, **characterized in that** the first joining lengths (8) are centred with respect to the parallel lines according to which are aligned the second joining lengths (9) and the second joining lengths (9) are centred with respect to the parallel lines according to which are aligned the first joining lengths (8) so that such plurality of dished areas (5) determine channels in multiple directions preferably even, equivalent for such fluid flow.

7. Plate, according to claim 6, **characterized in that** the spans of the first joining lengths (8) are substantially equal to the spans between its contiguous ends and the spans of the second joining lengths (9) are substantially equal to the spans between their contiguous ends.

8. Plate, according to claim 7, **characterized in that**

such parallel lines according to which are aligned the first joining lengths (8) are equidistant to each other and such parallel lines according to which are aligned the second joining lengths (9) are equidistant to each other.

9. Plate, according to claim 8, **characterized in that** the gaps between the parallel lines according to which are aligned the first joining lengths (8) are equal to the gaps between the parallel lines according to which are aligned the second joining lengths (9).

10. Plate, according to any of the claims 1 to 9, **characterized in that** such first and second directions are perpendicular to each other.

11. Plate, according to claim 1, **characterized in that** such inlet and outlet (6, 7) comprise respective openings in one or the other sheets (1, 2) close to the opposite edges of the plate and respective inlet and outlet connection sleeves (6, 7) coupled on such openings.

12. Plate, according to claim 11, **characterized in that** such inlet and outlet openings and respective inlet and outlet connection sleeves (6, 7) are both located in a same sheet (1).

13. Plate, according to claim 11, **characterized in that** such inlet opening and respective inlet connection sleeve (6) are arranged in one of the sheets (1, 2) and such outlet opening and respective outlet connection sleeve (7) are arranged in the other sheet (1, 2).

14. Plate, according to claim 11, **characterized in that** the first and/or second joining lengths (8, 9) aligned according to parallel lines and adjacent to the edges of the plate close to such inlet and outlet (6, 7) are longer and the gaps between contiguous ends equivalently shorter than the first and second joining lengths (8, 9) and gaps between contiguous ends in the rest of the plate.

15. Process for producing a heat exchanger plate of the type comprising:

a) attaching two metallic sheets (1, 2) and tightly joining them to each other along all their perimeter (3);
b) carrying out a plurality of joining areas (8, 9) between such two metallic sheets (1, 2) within such perimeter (3);
c) fastening at least by several areas distributed along the perimeter (3) the said two metallic sheets (1, 2) thus attached and joined; and
d) injecting a pressured fluid between both metallic sheets (1, 2) until obtaining a plurality of dished areas (5) by permanent deformation of both metallic sheets (1, 2) determining channels for a fluid flowing from an inlet (6) to an outlet (7) around such joining areas (8, 9)

characterized in that it comprises carrying out such joining areas (8, 9) as a plurality of first discrete straight joining lengths (8) grouped aligned according to lines parallel to a first direction and a plurality of second discrete straight joining lengths (9) grouped aligned according to lines parallel to a second direction crosswise the first direction, each of such joining lengths (8) being interposed between ends contiguous to two of such second joining lengths (9) and being each of the second joining lengths (9) interposed between contiguous ends of two of the first joining lengths (8).

16. Process, according to claim 15 **characterized in that** it comprises to carry out the first and the second joining lengths (8, 9), by means of laser welding.

17. Process, according to claim 15, **characterized in that** it comprises carrying out the said tight junction of such perimeter (3) by means of wheel or laser welding.

18. Process, according to claim 16, **characterized in that** such laser welding is carried out by means of a laser welding head mounted on a robotic arm controlled by programmable electronic controlling means.

19. Process, according to claim 15, **characterized in that** it comprises to carry out inlet and outlet openings in one or the other sheets (1, 2) and coupling respective inlet and outlet connecting sleeves (6, 7) at such respective openings prior to the step of attaching the sheets (1, 2) to each other and tightly welding the perimeter (3) around them.

20. Process according to claim 19, **characterized in that** it comprises carrying out inlet and outlet openings and coupling the respective inlet and outlet connecting sleeves (6, 7) in only one of the sheets (1, 2).

21. Process, according to claim 19, **characterized in that** it comprises carrying out such inlet opening and coupling respective inlet connecting sleeve (6) on one of the sheets (1, 2) and carrying out such outlet opening and coupling the respective outlet connecting sleeve (7) in the other sheets (1, 2).

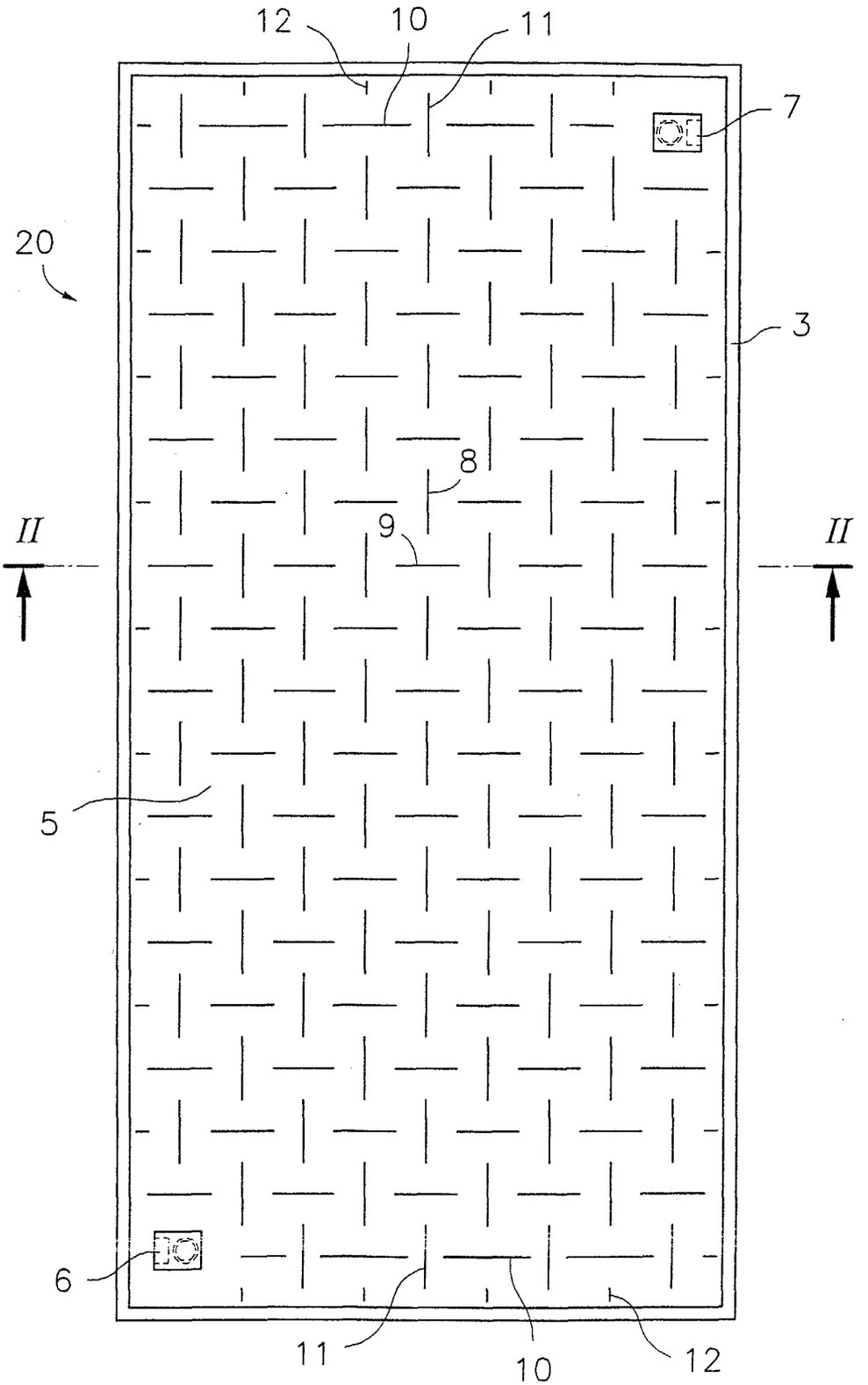

Fig. 1

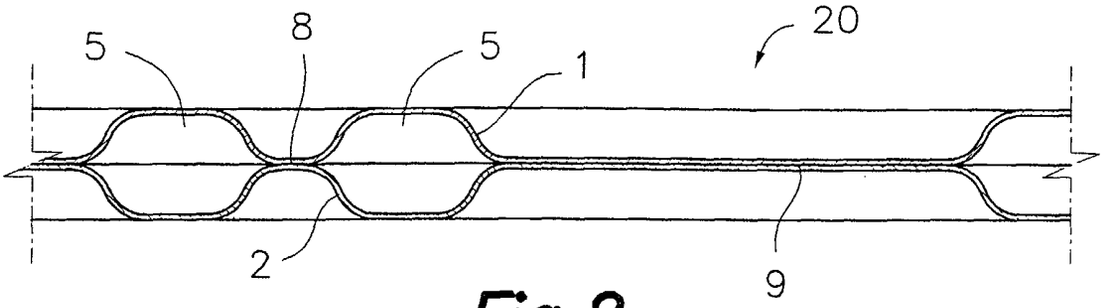

Fig.2

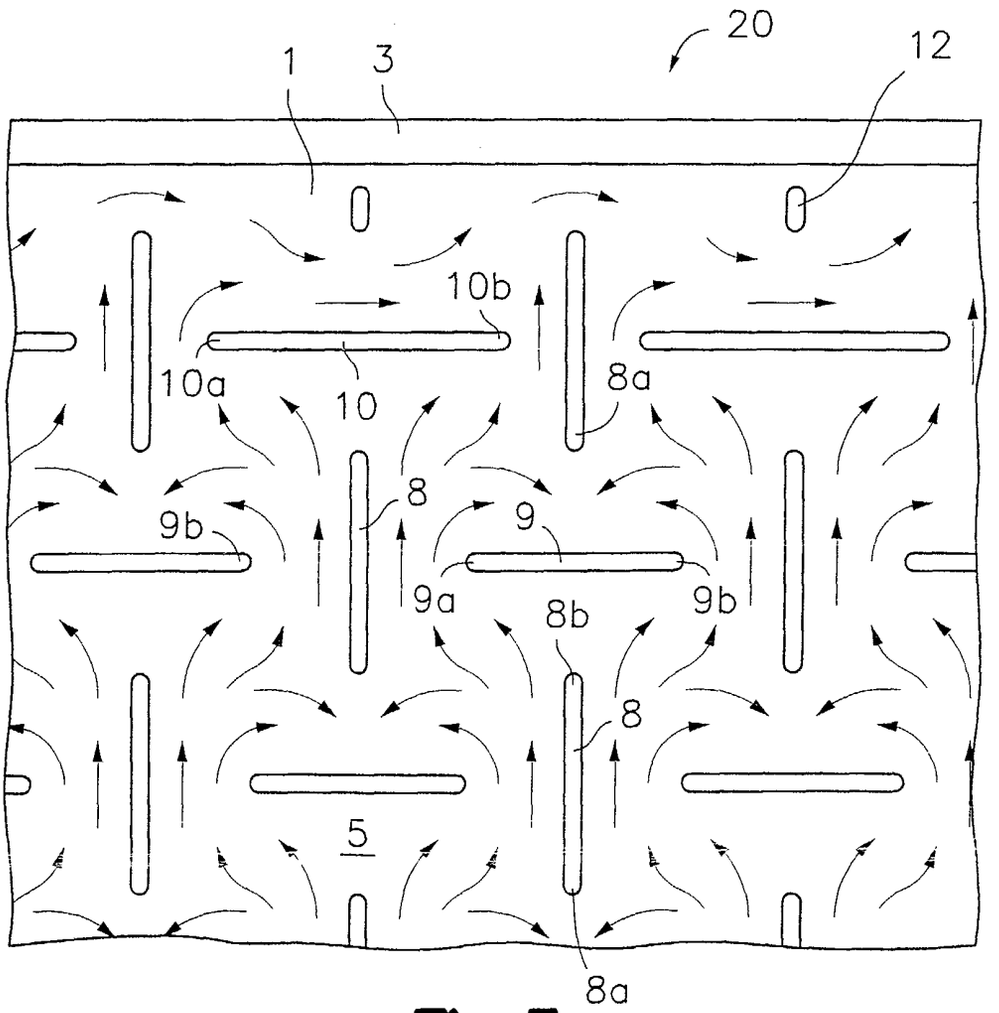

Fig.3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 38 0071

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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
THE HAGUE	4 September 2003	Mootz, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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