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(54) **Filling for cooling towers**

(57) A packing element (100) for evaporative cooling towers for cooling industrial water and for all the other applications in which contact between different fluids is necessary, comprises two parallelepipedal half-elements (1,2) that are provided with ribbings (4) in relief having the shape of half-lozenges with their vertex lines (4a) set inclined with respect to one of the sides of smaller extension of the parallelepipedal panel. The two half-

elements (1,2) are set, in the assembly phase, in mutual contact so that the bottom parts (4d) of the ribbings (4) of a first half element (1) are in contact with the bottom parts (4d) of the ribbings (4) of the second half element (2). The cooling tower filling is made with a plurality of said packing elements (100) set alongside each other. The sides (4b) of the ribbings can be made like a lattice (6).

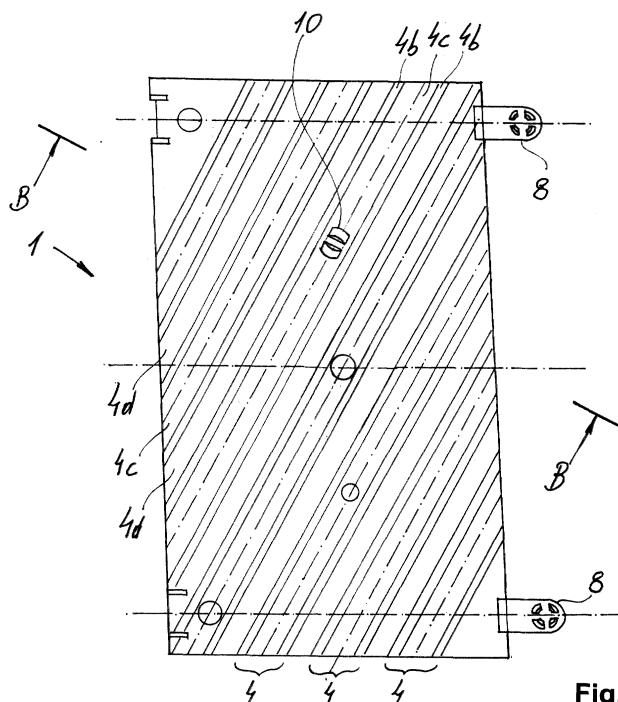


Fig. 1

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Description

Scope of application

[0001] The subject of the present invention is a packing panel for evaporative cooling towers, in particular for the cooling of hot industrial water and for all the other applications in which contact between different fluids is necessary.

Background art

[0002] Fillings for evaporative cooling towers have the purpose of extending the surface of water flow to be cooled, reducing the water to minute drops and/or films which are set in contact with an air flow generated by fans, or, in a natural way, by a «stack effect», to which the drops or films transfer part of the heat contained in the water itself. The dispersion of the hot water inside the cooling tower is a gravity type one through a pack for exchanging heat between air and water which is referred to as of dispersion or filling system.

[0003] The flow of the environmental air and of the water is either of the counterflow type or of the crossflow type, according to the type of cooling towers, which may in fact be divided into two different categories: counterflow towers and crossflow towers. The present invention meets the needs of both such types of flow, as well as the needs of a combination of the two.

[0004] Contact between the fluids may be based upon two different principles: the first is defined as «splash» contact, and enables the flow of water to be broken up into numerous droplets, effected generally by frames, grills, or slats. The second is defined as «film» contact with a structure generally in the form of honeycomb packs, and enables the formation of films of water over the entire surface.

[0005] The mixed splash/film type of filling is a combination of both of these operating principles.

[0006] An evaporative cooling tower of the type which combines a splash- and film-type filling is described in the European patent EP-A-58797.

[0007] A drawback of these fillings is their poor flexibility of use, due to the fact that they are made up of elements of different shapes assembled together to form the complete filling of the tower, and consequently this fact entails an increase in costs.

[0008] Also known from the document EP-A-759142 is a filling of the splash/film type made up of panels provided with ribbings that increase the surface for heat exchange. The panels are assembled when they are installed for operation. In this way, the volume of the filling is reduced during transportation.

Summary of the invention

[0009] A primary object of the present invention is that of eliminating the drawbacks referred to above by pro-

viding a filling for evaporative cooling towers and for all the applications in which it is necessary to create contact between fluids, which presents characteristics of low cost and constructional simplicity and which has a considerable flexibility of use in an extremely wide range of applications.

[0010] This and other purposes, which will appear more clearly from the following description, are achieved with a packing element, particularly for fillings of evaporative cooling towers for industrial water, not excluding other uses, which has the features according to Claim 1.

[0011] Thanks to this particular configuration, the filling is of reduced dimensions as compared to similar known fillings, whilst at the same time ensuring a high cooling capacity, with a more compact shape and smaller overall dimensions. Due to lattice structure of sides of the ribbings, the cooling fillings according to the present invention don't get easily clogged because of the particles, leaves and dirt carried in the water flow.

[0012] The present invention also relates to a method for using the packing elements as previously described; the method according to the present invention has the features according to claim 13.

Brief description of the drawings

[0013] Further characteristics and advantages of the invention will appear more clearly from the detailed description of preferred, but not exclusive, embodiments of the filling according to the invention, illustrated simply to provide non-limiting examples with the aid of the attached plates of drawings, in which:

Figure 1 shows a plan view of a packing element constituting the filling according to the invention; Figure 2 shows a cross section of a detail of the element of Fig. 1;

Figure 3 shows a cross section of a detail of the element of Fig. 1;

Figure 4 shows a cross-sectional view of the element of Fig. 1 according to the section plane B-B; Figure 5 shows a side view of the element of Fig. 1 from direction A-A;

Figure 6 shows a plan view of a variant of the element according to the invention;

Figures 6a and 6b show schematically a detail of two different versions of the hinges of a packing element according to the present invention;

Figure 7 shows a cross-sectional view, according to section plane C-C, of the element of Fig. 6 in a first open position; and

Figure 8 shows a cross-sectional view, according to section plane C-C, of the element of Fig. 6 in a second closed operating position; an enlarged view of hinge 3 is also shown;

Figure 9 shows a preferred setting of a plurality of packing elements of previous Figures to form a

cooling tower filling;

Figures 10-12 show schematically perspective detail views of parts of another embodiment of a packing element according to the present invention.

Detailed description of preferred examples of embodiment

[0014] With reference to the above figures, a packing panel designated as a whole by 100, is shown. The said panel has a structure having a basically parallelepipedal overall profile with one side of greater extension. The element or panel, which is generally also defined as «pack» and advantageously is obtained by injection moulding of plastic materials, is made up of two half-elements or «half-packs» 1, 2, which are separate, or else produced already connected together longitudinally at one of their end edges by means of a plastic film hinge 3, moulded so that it forms a single piece with the two half-packs (Figures 6-8).

[0015] The half-pack has a structure with ribbings or «folds» 4 in relief having a conformation which, in cross section, is substantially a half-lozenge structure throughout the width. The sides forming the lateral portions of the half-lozenges are preferably of a lattice-like form 6, as shown in Figure 5; in Figures 1, 4, 5 and 8, the reference numeral 4b refers to the whole lattice losenge sides, 4c refers to the crest parts of each ribbing 4, and 4d refers to the bottom parts of the ribbings 4.

[0016] Without departing from the scope of the present invention, it is also possible to provide a structure of the sides of the half-lozenges made of a thin (total or partial) wall, with or without holes for the passage of water through the wall: for example, each rectangle of the lattice structure (6) can be totally or partially closed with a thin wall, or just some of the lattice rectangles (6) can be closed with thin walls, so that closed rectangles alternate open rectangles in a chessboard-like or more irregular pattern.

[0017] Advantageously, the lozenges of a packing element 100 according to the invention may therefore be transformed into plastic films, by filling them in the moulding stage, and hence before their corresponding production, thus converting the packing in question into a wholly film type packing.

[0018] The vertex lines 4a (Figure 8 and 1) of the lozenges are inclined at an angle of between 15° and 75° with respect to the center plane of the panel, which, when set up, is generally but not necessarily vertical or, in other words, the vertex lines 4a of the lozenges are inclined at the aforesaid angles with respect to one of the two sides of lesser extension of the parallelepiped and, when the packing element is set up, the sides of greater extension of the half-elements are preferably set working in a substantially vertical position.

[0019] Just for example purposes, the dimensions chosen for each half-pack are 150 mm in depth (or width), 300 mm in height and 1200 mm in length, but

these dimensions may vary according to the needs of the specific design or system.

[0020] In the widest face of the half-packs, the latter are joined together so that they are set alongside one another; in this way, the packing is made up of the succession, without any discontinuity, of a plurality of elements or packs.

[0021] Since in each half-pack in the face 1200 x 300 mm the diagonals have inclinations which are opposite in the first/third and in the second part (respectively L, M and N in Figure 6), so that in each of the three aforesaid parts L, M and N the first pack will have a side whose diagonals are oriented in a certain direction, the next contiguous pack will have diagonals in the opposite direction, the third in the same direction as the first, and so forth, as required, according to the total dimensions of the cooling tower.

[0022] Due to the hinge-like connection existing between the two half-packs, during installation the pack may be easily reclosed or can be connected by means of bands or straps or other known means, such as snap fasteners, etc., to constitute a final pack of dimensions, which, during operation, leans on the side which forms the depth of the half-pack (Figures 6a, 6b, 9). Between the two half-packs, other types of connection equivalent to hinges may also be used.

[0023] In the generally preferred solution, this pack, longitudinally, is held together on one side by the hinge 3 and on the other by suitable snap-fastener system as shown in Figures 2 and 3, or an equivalent band or strap means, etc. In the case of the snap fasteners, this system is made up of a set of holes 7 provided at the end of one half-pack and of shanks or pins 8 arranged at the end of the other half-pack symmetrically opposite to the axis of the hinge. The assembly of the pack is normally carried on with no need to cut and join the pieces, but only using press-studs or some other equivalent fastening system.

[0024] The snap fastener 10 in Figure 5 is an alternative to the one shown in Figures 2,3.

[0025] Figures 6a and 6b show two preferred examples of film hinges 3; the film hinges of Figure 6b are separated from each other, while having a common hinge axis: the advantage of this embodiment is that it allows a quick and easy cleaning of the packing element from encrustings by repeatedly stretching and pressing the packing element like a concertina.

[0026] The film hinges 30 of Figure 6a also acts as a ribbing for stiffening the structure, which limits the mutual displacement of the diagonals and constitutes a stay in the case where the half-packs are fixed to one another, in that it absorbs the horizontal forces and the flexure deformations due to the action of the vertical loads on the pack, such as the weight of the packing itself, the weight of the water falling by gravity, the weight of an operator during installation/maintenance operations, etc. Preferably and more generally, the film hinges 30 are designed in such a way to be a reinforcement

against the flexure deformations of the packing element at least in a plane substantially containing the hinge axis and substantially passing nearest to the centers of gravity of the cross sections of closed packing element where said cross sections are according planes perpendicular to said hinge axis.

[0027] The packing element of Figure 6a can also be efficiently cleaned from encrustings: since the filling advantageously, as explained later, is made of a plurality of packing elements connected together simply by snap- or other mechanical fittings instead of being glued together as the known packing elements, the packing element according to the present invention can be removed from the rest of the filling and then cleaned from encrustings by repeatedly shaking or flexing.

[0028] In the vertical plane at the end opposite to the hinge advantageously another type of ribbing or elongated reinforcement 31 (Figure 6a) can be provided for stiffening purposes, which connects the individual rods end-to-end by means of press-studs or equivalent systems; preferably the elongated reinforcement (31) is parallel to the hinge axis and stiffens against the flexure deformations of the packing element at least in a plane substantially containing the hinge axis and said second elongated reinforcement (31).

[0029] In addition, the two parts on the left and right of the hinge preferably have horizontal rods 6a (Figure 5) staggered in such a way that, when the half-packs are set side by side, not all the rods 6a are at the same level, with a consequent better thermodynamic yield.

[0030] This advantage is maintained in the case where, as explained later, it is decided simply to fit a number of half-packs in succession one inside another.

[0031] Folding the two half-elements of a same packing element one onto the other around the hinges (3, 30), so that so that the bottom parts (4d) of the ribbings of a first half-element are set in contact with the bottom parts (4d) of the ribbings a second contiguous half-element, setting alongside each other a number of packs - so that the crest parts (4c) of the ribbings are set in contact with the crest parts (4c) of the ribbings (4) of another contiguous pack- and stacking then on top of each other in various ways creates the dispersion system as a whole, in accordance with the design calculation of the cooling tower. According to a preferred method, known per se, the packings are set alongside each other so that they form a layer as wide as the cooling tower section; after different layers are stacked together with perpendicular orientation from a layer to the adjacent ones, as shown in Figure 9.

[0032] In a first embodiment of the present invention, the packs are set alongside one another in such a way that the vertices 4c of the half-lozenge ribbings are in mutual contact and criss-cross one another.

[0033] In the set up phase, when two packs are set side by side, the diagonals have in fact a reverse direction, so as to create as far as possible a uniformity of air/water distribution and high mechanical resistance of

the filling system as a whole.

[0034] Figure 8 shows in detail how the two half-elements are folded about the hinge 3 for the final assembly, by rotating them in the direction of the arrow 9.

[0035] Figures 10-12 show details of another embodiment of a packing element according to the present invention: this latter embodiment differs from the other ones in the shape of the crest parts 4c: the losenge sides 4b have an angle or bend before connecting to the upper horizontal rod forming the top of the crest part 4c. Figure 10 shows the two half elements 1 and 2 folded one onto the other one, and the bottom parts 4d of the ribbings 4 of the first half element 1 contact the bottom parts 4d of the ribbings 4 of the half element 2.

[0036] The pack according to the present invention thus proves compact and highly resistant, and can also withstand the weight of operators, after wooden boards have previously been set in place to distribute the load and prevent any damage to the plastic profiles.

[0037] In a further embodiment of the present invention, it is possible to mount each individual half-pack fitted inside the one next to it so as to thicken the filling and increase thermodynamic efficiency. In fact, after first eliminating the hinge by breaking or cutting it, the half-packs may simply be positioned one inside another, with or without being fixed together with fastening means of the press-stud or pin type, straps or bands, etc.

[0038] In this way, both the diagonal rods, i.e., the ones having a thicker section as well as the ones having a thinner section, and the horizontal rods are staggered so as to guarantee an increased efficiency of heat exchange.

[0039] The fasteners themselves do not cause any possibility of withholding any solids eventually suspended in the water, and consequently prevent any risk of clogging.

[0040] Since the above-mentioned assembly is practically guided by the hinge that joins the two half-packs, it proves extremely fast and, moreover, does not entail any need to check whether the diagonal elements cross or any need to make them cross, and consequently may be carried out even by staff who are not expert in such operations.

[0041] The packs that make up the filling system described above are assembled during installation advantageously by means of snap fasteners or equivalent systems, with no need to use glue or the like, as it is necessary in the case of film fillings according to the known art.

[0042] Given the thickness of the plastic film of which it is made, the hinge may also be easily cut/broken in the case where single half-packs are required, which, in this case, may also be joined using known conventional means.

[0043] In addition, the dimensions of each half-pack may be varied, for example before sending it to the work-site or during installation on the work-site, given that the

half-pack may be easily cut.

[0044] According to an advantageous embodiment, the vertices of the lozenges, instead of being pointed, are truncated to form a plane surface. This surface may consist of a rod for reinforcing the structure of the half-packs.

[0045] Advantageously, the number and/or position of the diagonal rods 6b and horizontal rods 6a (Figures 5, 12), which may be varied, are appropriately chosen so as to optimize the ratio between thermodynamic efficiency and pressure drop, at the same time guaranteeing the uniformity of the air and water flow.

[0046] Once set working, the filling made up of the elements according to the present invention functions in such a way that the flow of the water coming down from the top part of the tower passes both through and over the network of rods that make up the filling, so operating both as a splash filling and as a film filling. This may be demonstrated also experimentally in that the heat exchange efficiency of this type of filling is greater than the one of any splash system.

[0047] The dimensions of the packs, i.e., the width, height and length, may be different according to the specific design of the cooling tower and the particular requirements.

[0048] The elements that make up the packs may moreover be stacked also during transportation since they have a compact structure that ensures a reduction in volume. In addition, their particular shape makes assembly more convenient, so guaranteeing greater ease and speed of installation.

[0049] A further fundamental advantage is that the filling according to the invention is self-cleaning and hence anti-clogging under normal operating conditions: the flow of water is sufficient to guarantee that any elements present in the water, for example, leaves, small stones, organic or saline deposits, etc., do not get withheld in the filling, thanks to the absence of any channels of small dimensions that might easily get obstructed, as occurs in standard film-type fillings.

[0050] From what has been said above, it is evident that the filling according to the invention combines the advantages of two types of filling for evaporative cooling towers, namely, fillings of the splash type and fillings of the film type. Of the splash type, the filling according to the invention presents the following advantages: anti-clogging characteristics, reduced overall volume prior to installation and during transportation, etc. Of the film type, it presents the following advantages: high surface for heat exchange between air and water, reduced overall volume after installation, ease of installation, and reduction in the corresponding time involved.

[0051] The packs according to the invention may be adopted in phases subsequent to the original installation, for example, when restoring the insides of cooling towers, when upgrading thermodynamic characteristics, etc., or else in the phase of initial installation, as a more resistant or efficient top layer, or else even as a

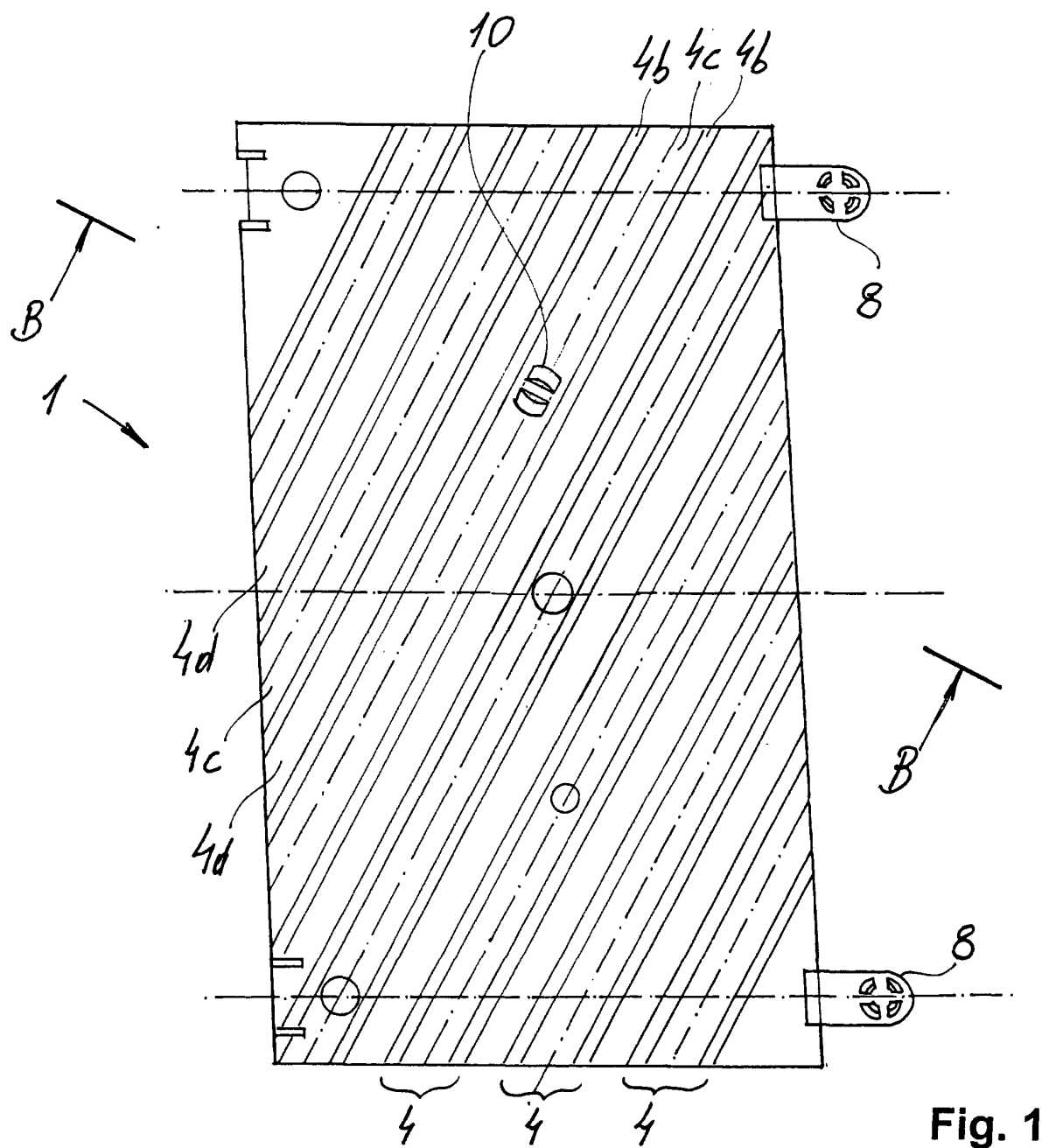
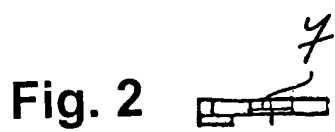
global filling.

[0052] Without departing from the scope of the present invention, the packing element above described can be modified in various manners; for example the crest parts 4c of the ribbings 4 can have rounded or angular shape; the crest or bottom parts (4c, 4d) of different half-elements can be set in contact in different planes rather than only in one contact plane; different packing elements (100) can be connected together when set working with snap fasteners (7, 8, 10), dovetail systems or other mechanical connecting means; the packing element (100) can be set working in a cooling tower or other suitable plant also with the bigger face of the parallelepiped in a horizontal position, or with the hinge axis in a vertical position.

Claims

1. A packing element (100) for evaporative cooling towers and for all the other applications in which contact between different fluids is necessary, comprising at least two half-elements (1, 2), with an overall profile of a substantially parallelepipedal shape with at least one side of greater extension and at least one side of smaller extension, said two half-elements (1, 2) being provided with ribbings (4) in relief on said at least one side of greater extension, said ribbings (4) being set substantially inclined with respect to the at least one side of smaller extension and comprising crest parts (4c) and bottom parts (4d), **characterised in that** said ribbings have a cross-sectional half-lozenge shape, the bottom parts (4d) of the ribbings of one of the half-elements can be set, after installation, in contact with the bottom parts (4d) of the ribbings of the other half-element, and the crest parts (4c) of said ribbings can be set, after installation, in contact with the crest parts (4c) of the ribbings (4) of another contiguous packing element (100).
2. A packing element (100) for evaporative cooling towers and for all the other applications in which contact between different fluids is necessary, comprising at least two half-elements (1, 2), with an overall profile of a substantially parallelepipedal shape, with one side of greater extension, the said two half-elements (1, 2) being provided with ribbings (4) in relief on said side of greater extension, the said ribbings (4) being set substantially inclined with respect to a median plane of the panel orthogonal to said side, **characterized in that** said ribbings have a cross-sectional half-lozenge shape, the vertex lines (4a) of said ribbings being set, after installation, in mutual contact on the plane of lie of the vertex lines of the ribbings (4) of contiguous panels.

3. A packing element according to Claim 1 or 2, **characterised in that** the sides (4b) of said half-lozenge-shaped ribbings are provided with through openings. 5
4. A packing element according to Claim 3, **characterised in that** said sides (4b) are made like a lattice (6). 10
5. A packing element according to Claim 1 or 2, **characterised in that** said half-elements (1, 2) are joined together by hinges (3, 30) forming a single piece with said half-elements. 15
6. Packing element according claim 5, **characterised in that** the hinges (30) form a first elongated reinforcement against the flexure deformations of the packing element at least in a plane substantially containing the hinge axis and substantially passing nearest to the centers of gravity of the cross sections of closed packing element where said cross sections are according planes perpendicular to said hinge axis. 20
7. Packing element according to claim 5, **characterised in that** it comprises at least a second elongated reinforcement (31) parallel to the hinge axis against the flexure deformations of the packing element at least in a plane substantially containing the hinge axis and said second elongated reinforcement (31). 25 30
8. A packing element according to Claim 5, **characterised in that** the half-elements are joined together, when set up, with reversible (7, 8) or else non-reversible means of mutual fastening. 35
9. A packing element according to Claim 8, **characterized in that** said means of mutual fastening (7, 8, 10) consist of elastically deforming snap fasteners. 40
10. A packing element according to Claim 9, **characterized in that** said means of mutual fastening consist of pins (8, 10) and holes (7). 45
11. A packing element according to Claim 1 or 2, **characterized in that** said at least two half-elements are set up, fitting one inside the next, with the vertex lines (4a) and/or crest parts (4c) of the half-lozenge ribbings set parallel to one another, so as to thicken the packing and increase its thermodynamic efficiency. 50
12. A packing element according to the Claim 1 or 2, **characterized in that** said ribbings are made over the whole surface of the widest of each half-element (1, 2). 55
13. Method for set working a packing comprising a plurality of packing elements (100) according to claim 1 or 2, **characterised in that** it comprises the following steps:
 - providing a plurality of packing elements (100) according to claim 1 or 2;
 - setting the bottom parts (4d) of the ribbings of a first half-element in contact with the bottom parts (4d) of the ribbings a second contiguous half-element, and setting the crest parts (4c) of said ribbings in contact with the crest parts (4c) of the ribbings (4) of a third contiguous half-element;
 - setting the half-elements with the at least one side of greater extension in a substantially vertical position.
14. Method according to claim 13, comprising the step of
 - providing a plurality of half-elements (1,2) according to claim 4;
 - folding a first half element (1 resp. 2) onto a second half element (2 resp. 1) of a same packing element (100) around one or more hinges (3, 30).



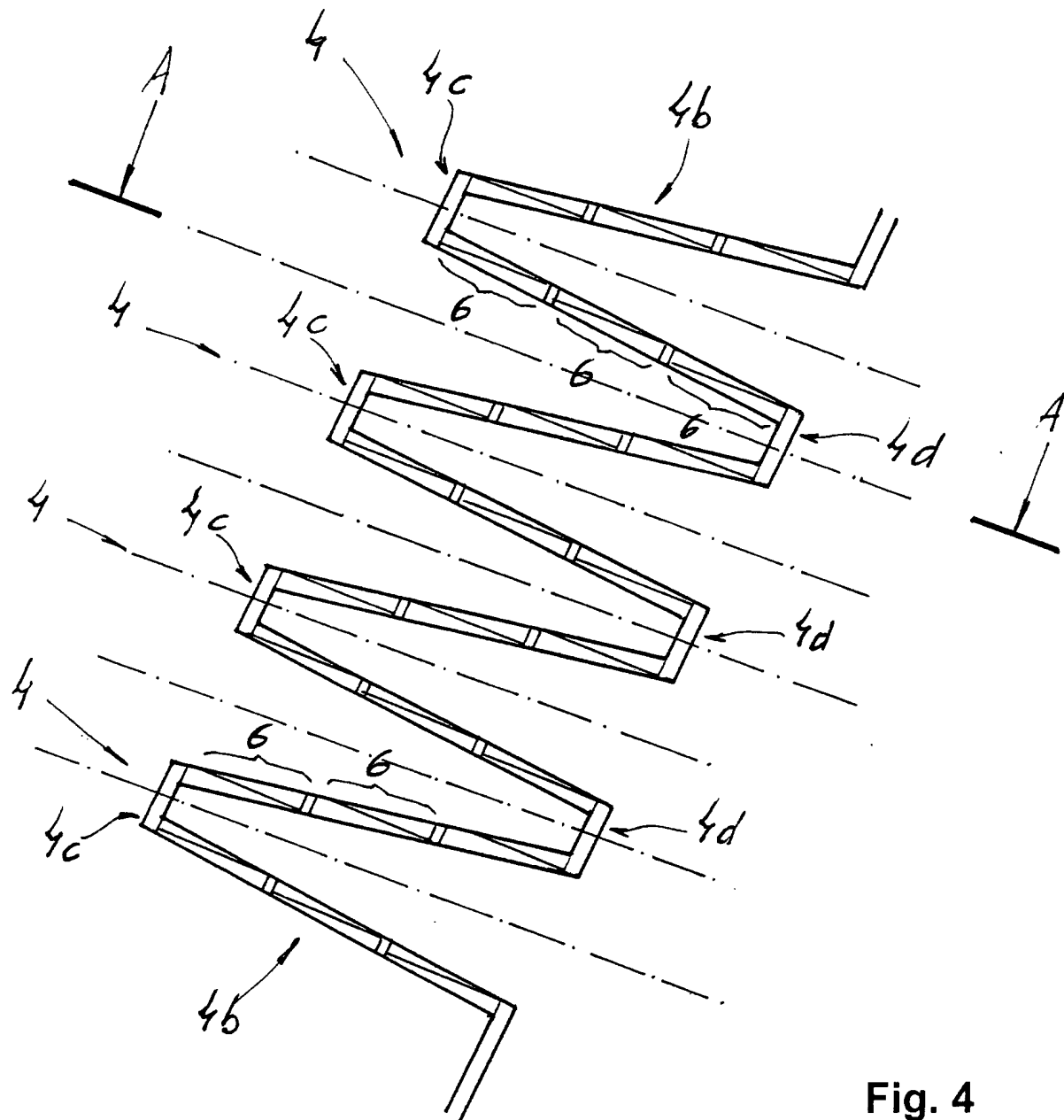


Fig. 4

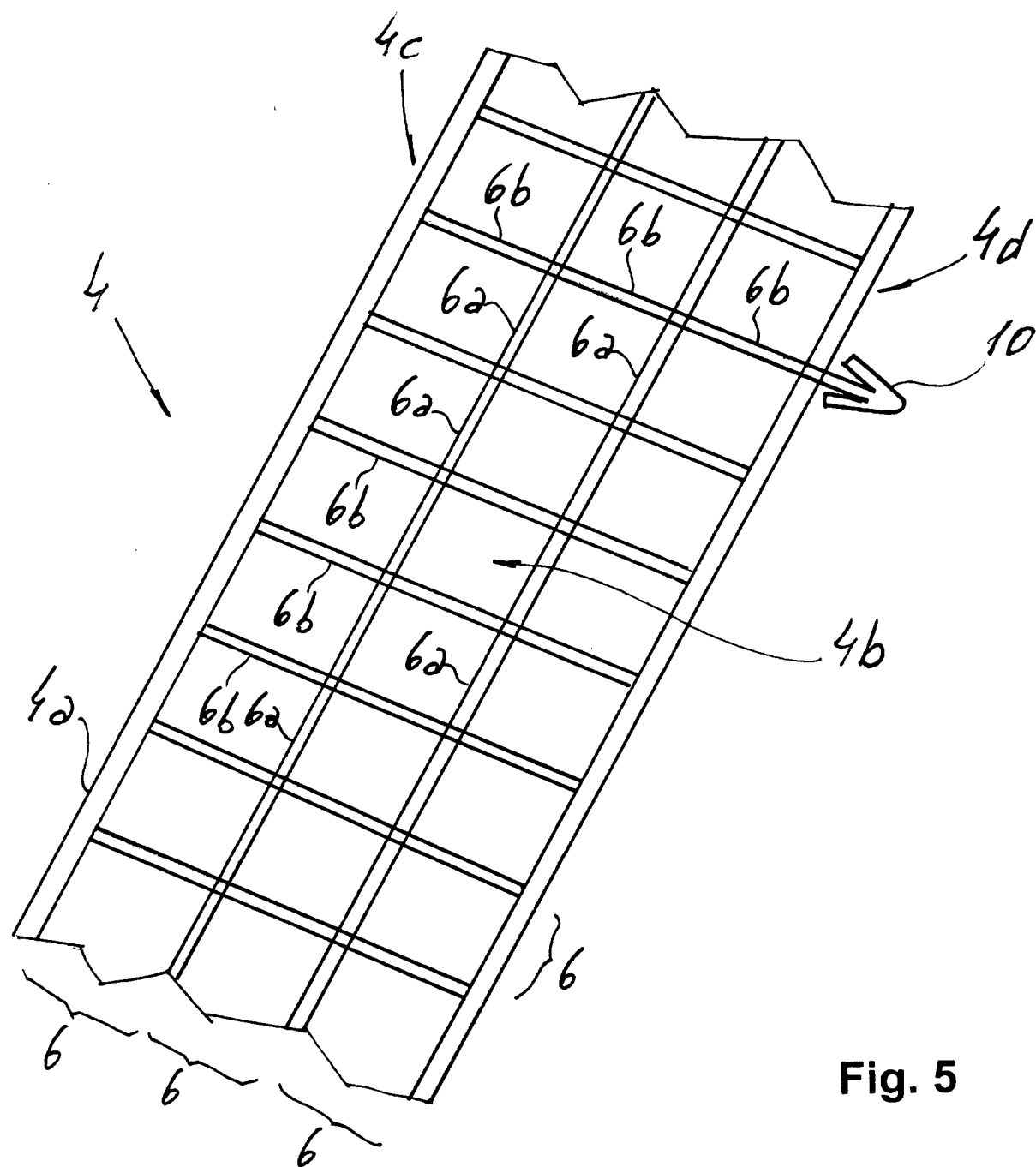


Fig. 5

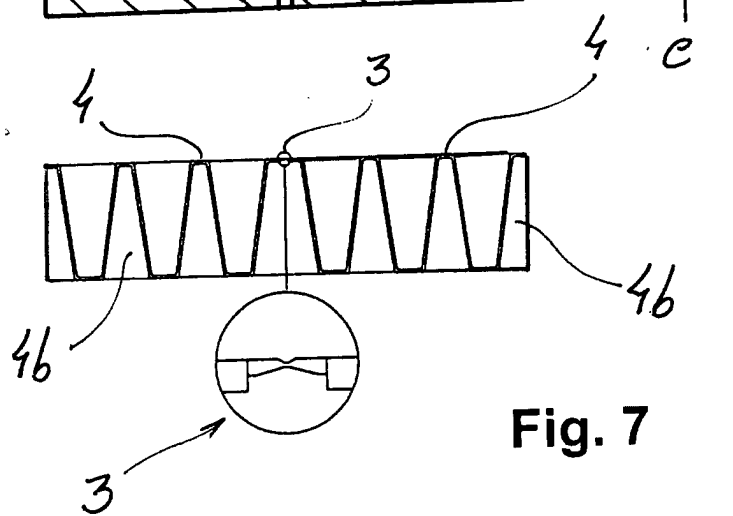
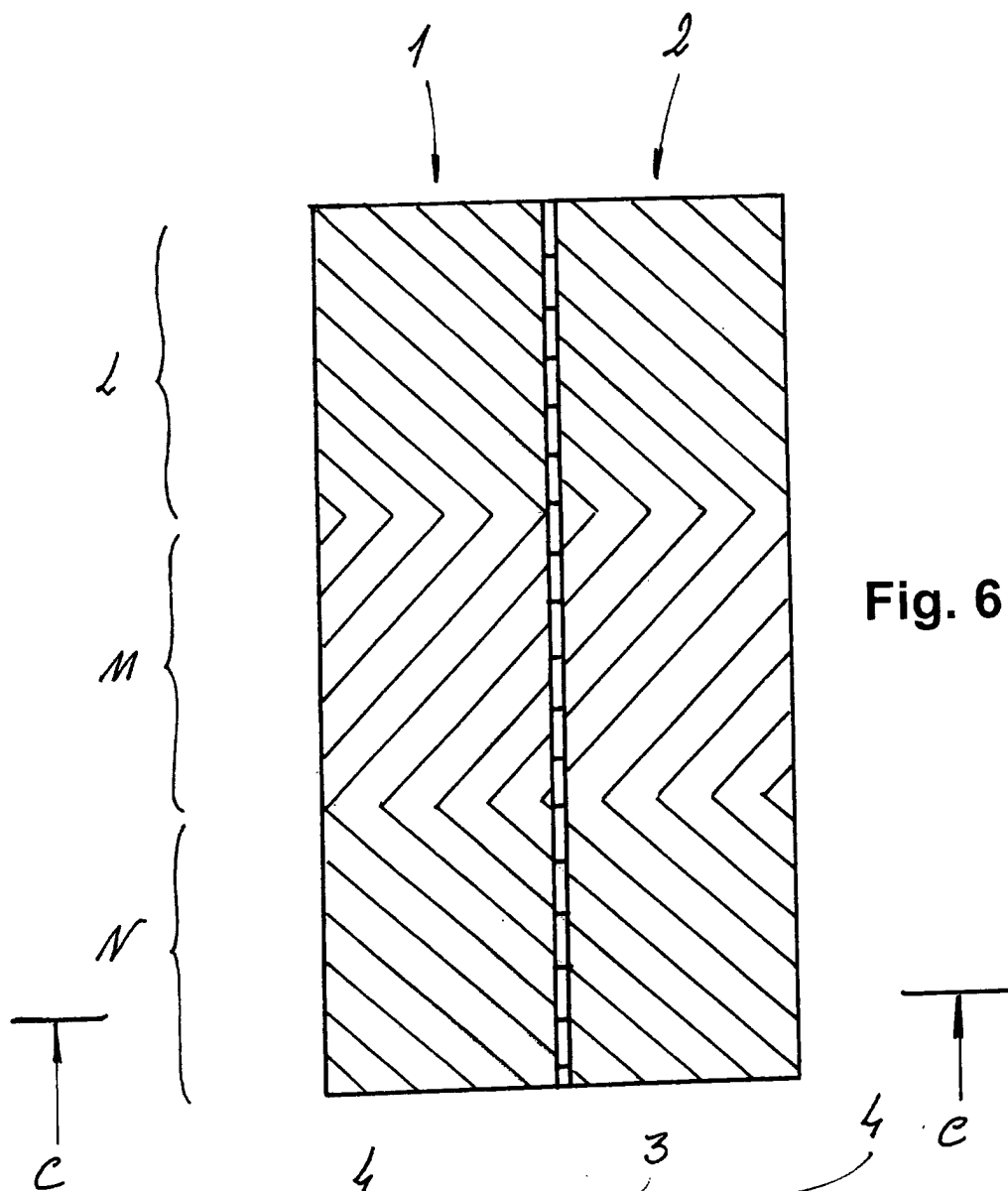


Fig. 6a

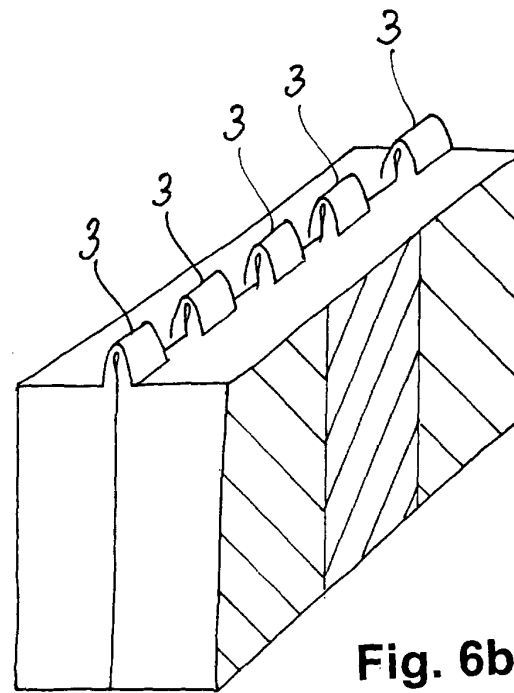
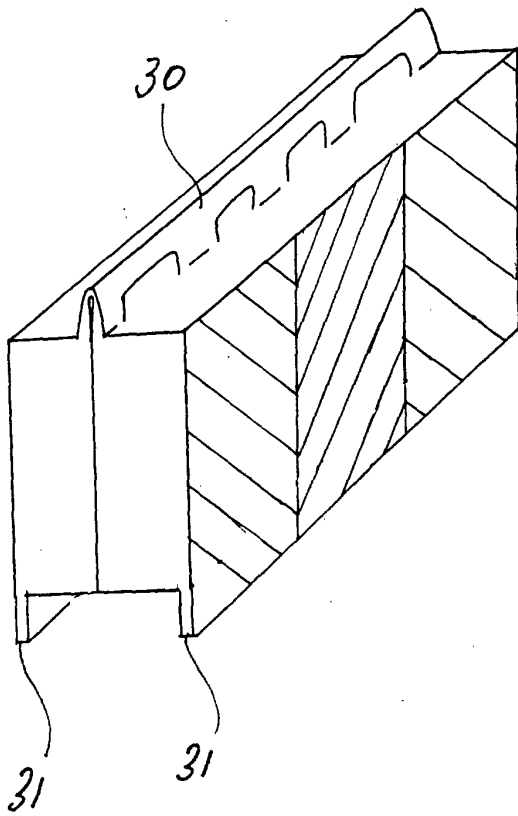


Fig. 6b

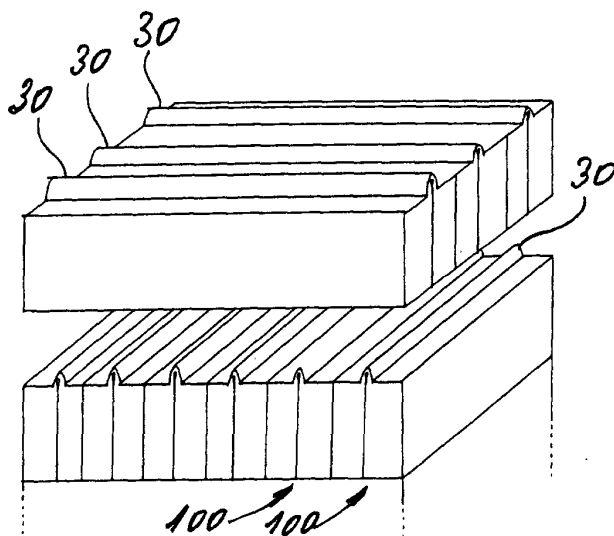
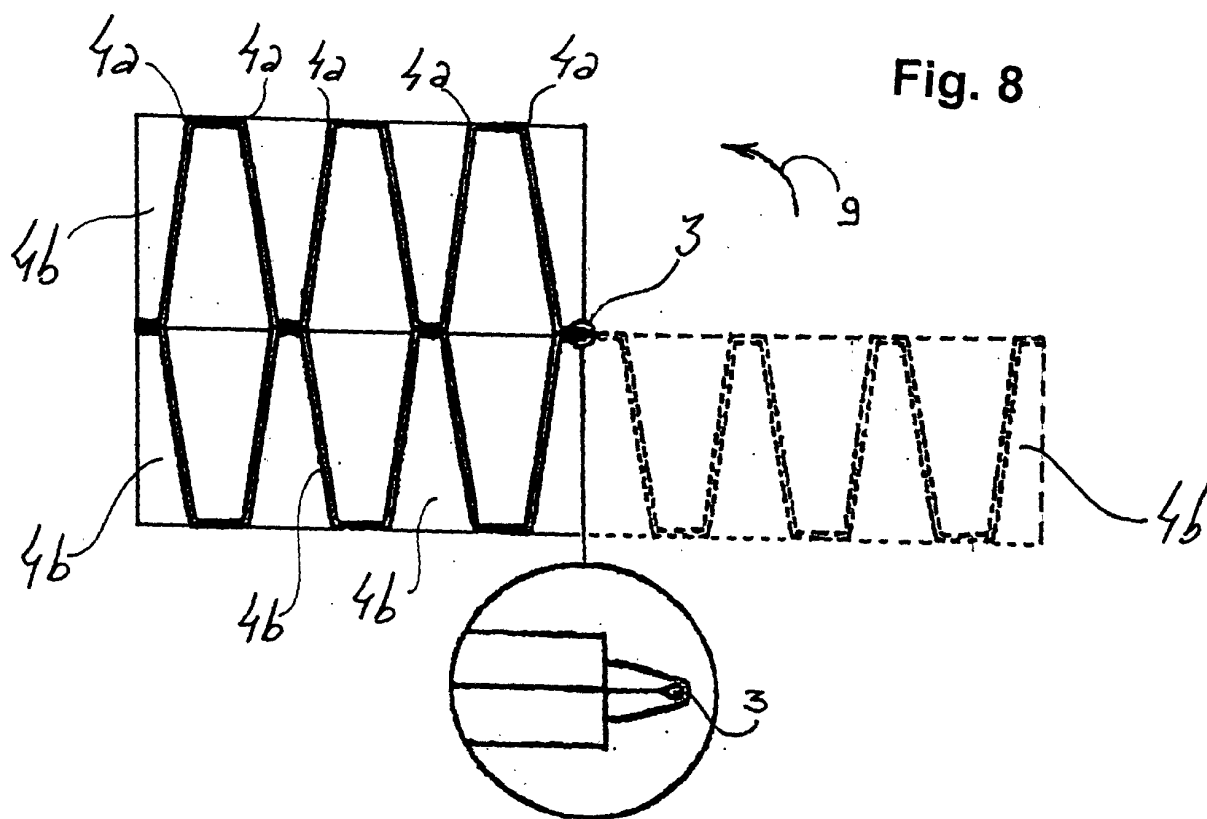
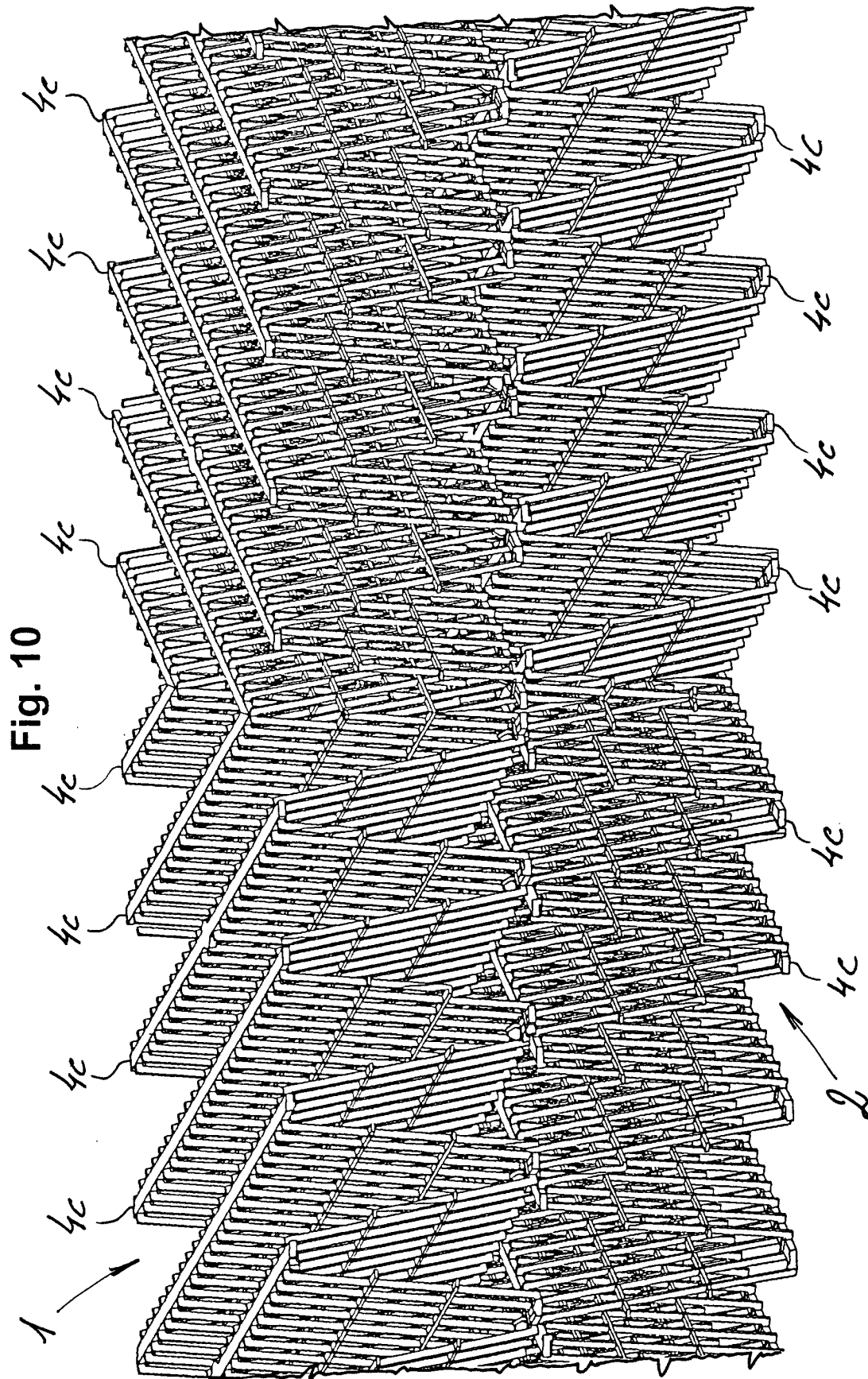


Fig. 9





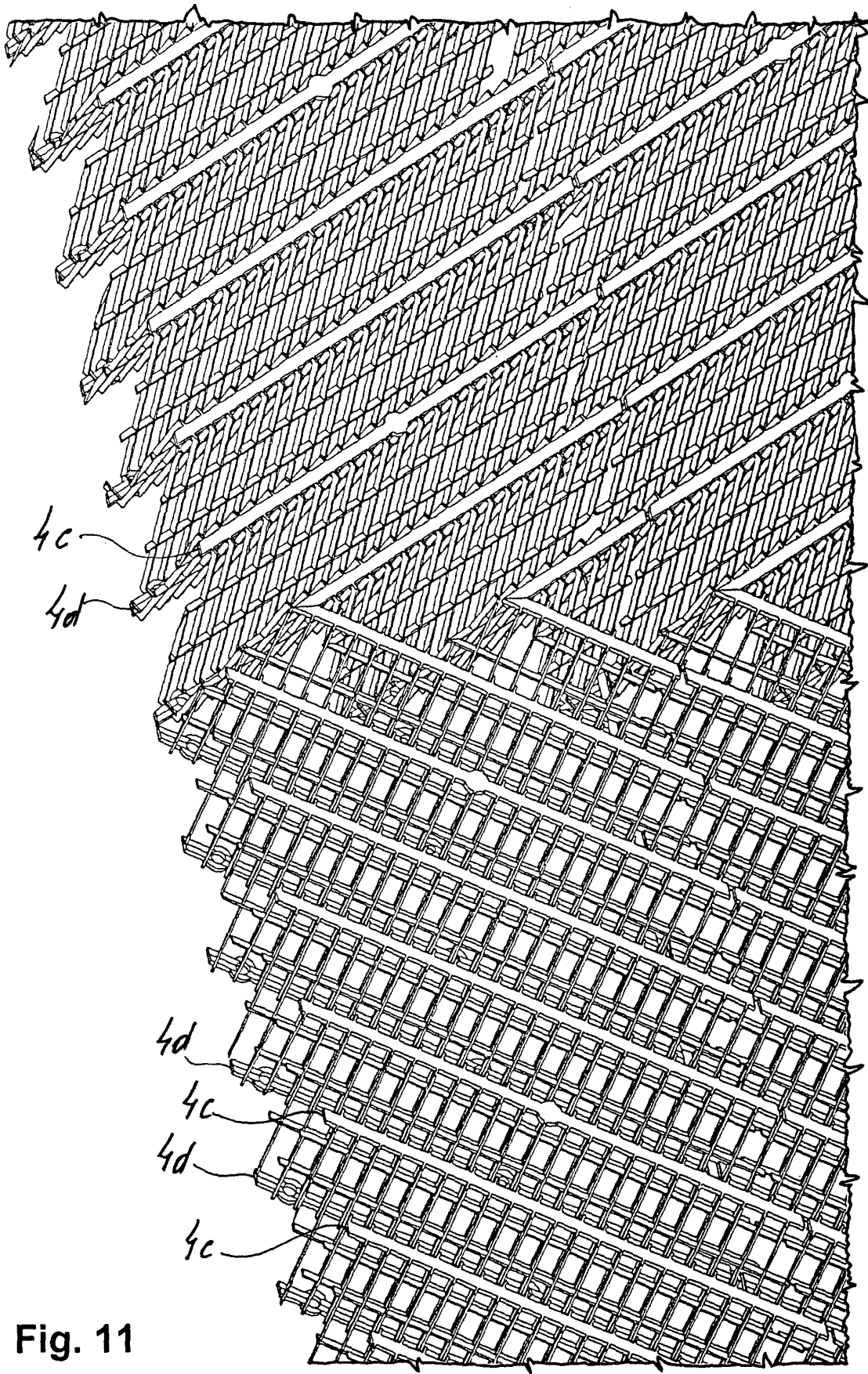


Fig. 11

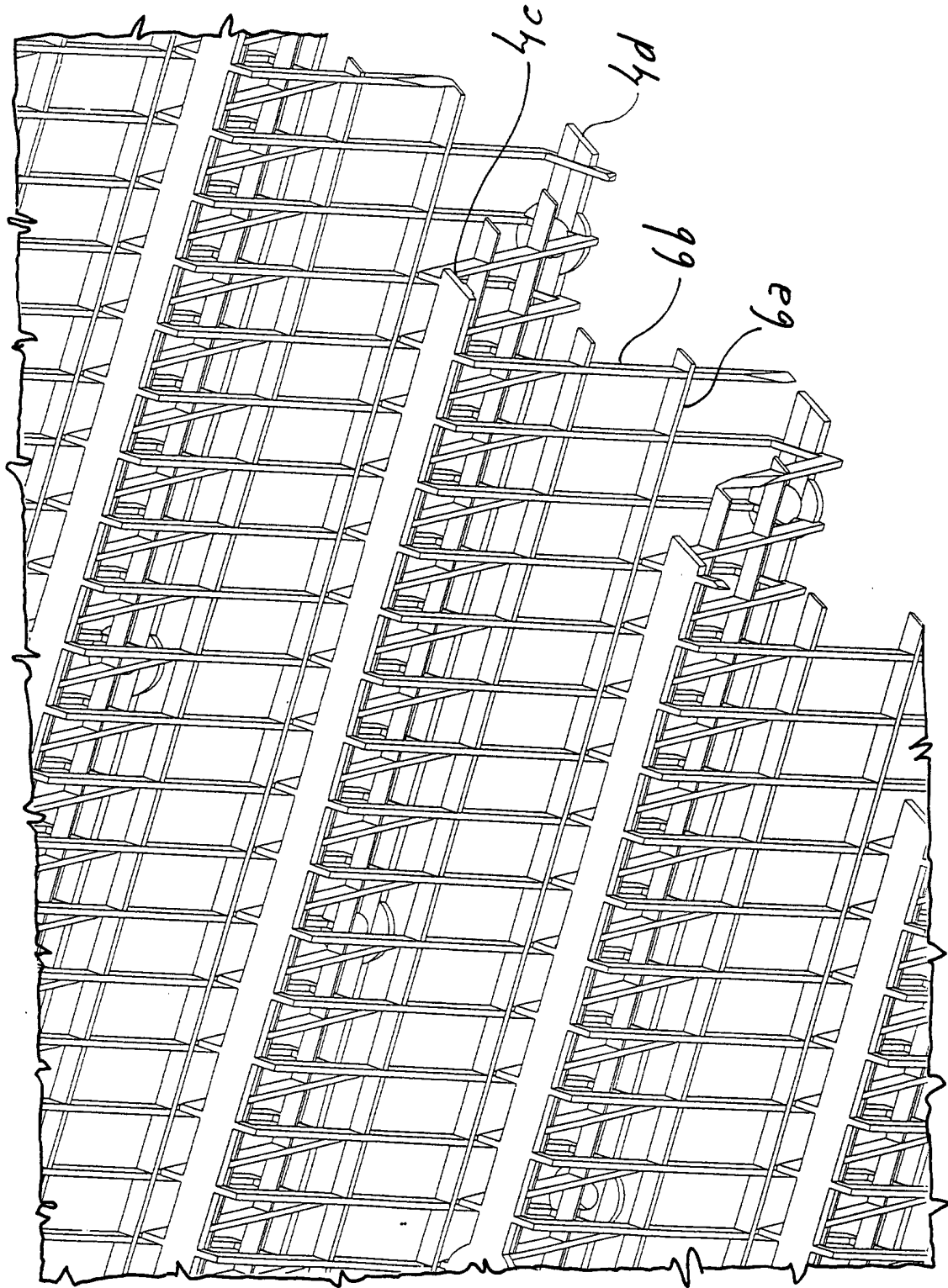


Fig. 12