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(54) **GASKET GROOVE FOR A PLATE HEAT EXCHANGER**

DICHTUNGSNUT FÜR EINEN PLATTENWÄRMETAUSCHER

RAINURE DE JOINT D'ÉTANCHÉITÉ POUR UN ÉCHANGEUR DE CHALEUR À PLAQUES

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Description

INTRODUCTION

[0001] The present invention relates to a heat exchanger of the kind where a plurality of plates is stacked and where they, due to surface structures, form flow paths between neighboring plates.

[0002] Particularly, the invention relates to a gasket plate heat exchanger where the plates define gasket holding wavy sections where a gasket is located and / or squeezed between two neighbouring heat exchanger plates.

[0003] Such a heat exchanger is known from DE-C-19540271 which discloses a heat exchanger according to the preamble of claim 1.

BACKGROUND OF THE INVENTION

[0004] A plate heat exchanger uses plates to transfer heat between two media, typically fluids flowing in separated first and second flow paths. Compared with a conventional heat exchanger, the fluids are exposed to a large surface area defined by the surfaces of the plates. This increases the exchange of thermal energy between the fluids.

[0005] Plate heat exchangers are common for hot water boilers, and particularly for instantaneous preparation of domestic hot water or for heating circuits etc.

[0006] The flow paths each connects to either a primary or a secondary fluid connection e.g. for supplying heating fluid or domestic hot water. The first and second flow paths are on opposite sides of the plates, and the plates come with a number of different structures such as fishbone or herringbone corrugations. When stacking fishbone heat exchanger plates, taken as an example, they are positioned such that they connect in crossing points of the corrugations and as the corrugations form relatively sharp pointed tops, the contact area between tops of adjacent plates becomes small and less well defined. In case the fluids are pressurized it results in concentrated contact forces leading to permanent deformations of the contact points.

[0007] An alternative design is the surface structures to be defined as dimple patterns making it possible to design contact areas with well-defined areas, and thus well-defined and optimized strength and hydraulic characteristics.

[0008] Due to the reduced speed variation of the media when passing through the heat exchanger profile, the profile height for the dimple pattern can be reduced by typically 30% compared to the traditional herring bone pattern and still maintaining the same pressure drop and heat transfer. The reduced profile height results in approximately twice the number of brazing points thus increasing the strength. Alternatively, thinner plates can be applied.

[0009] The invention is related to gasket exchangers where the stack of heat exchanger plates are held together by an external force, such as when located and / or squeezed between top and bottom plates being fixed by bolts, and is based on the discovery that the essential in realizing a strong heat exchanger is not the surface area if the tops respectively bottoms of the dimples, but rather the length of their circumference.

[0010] The heat exchanger plates may define inlets and outlets for the flow paths defined between neighboring plates, where these typically are formed as four corner openings connecting the fluid such that two openings connects a first fluid supply to an upper side of the plate by an inlet and an outlet and a second supply connecting to the two other openings on the lower side of the plate. Heat transferring areas then are formed in the flow paths from inlet to outlet by the surface structures. Opening areas are the areas in the circumference of the openings and usually comprises structures to support these. Further a transition zone may exist in the zone from the opening to the heat transferring areas for distributing the fluids to the full extent of the heat transferring area.

[0011] For gasketed heat exchangers a gasket, or packing, usually are positioned close to the rim of the heat exchange plates encircling the heat transfer area to seal it from the externals preventing the fluids to leak out of the flow paths between the plates. This sealing will be necessary for the flow paths at both sides of any of the plates and thus by placing the upper and lower gasket relative to a plate at the same position they will form a support to the heat exchanger plate and thus protecting it from deformations due to the pressures of the media or the pre-pressurization of the gasket.

[0012] Further as two of the openings are to communicate with the flow path formed at the upper side of a plate, and the other two to communicate with the flow path formed at the lower side, this means that two of the opening areas are to be sealed from the heat transferring area, meaning the one side of the plate relative to the other. Therefore the plates in these areas only will have a gasket at the one side and thus not being supported at the other side. One way to prevent the plates from deformations due to e.g. the media pressure or the pressurization of the gasket itself in this area is to introduce substantially thick plates. This however then leads to a reduction in the heat transfer, heavier heat exchangers and more use of raw materials.

DESCRIPTION OF THE INVENTION

[0013] It is an object of the invention to provide other means to make a section of the plate designed to contain a gasket with sufficient strength even for thinner plates such as at 0.5 millimeters, or 0.4 mm, or 0.3 mm or even less, depending of the pressure rating of the heat exchanger. This especially is essential for the gasket in the opening area where the gasket is unsupported from the opposite plate side. There is only a gasket located in every second flow channel. This is generally known as a weak section of the gasket heat exchanger.

[0014] This is solved by introducing a heat exchanger according to claim 1. Further advantageous embodiments of the invention are defined in claims 2-17.

BRIEF DESCRIPT OF THE DRAWINGS

[0015]

Fig. 1 illustrates a perspective view of a heat exchanger according to the invention;

Fig. 2 illustrates in a top view, a plate heat exchanger;

Fig. 3 illustrates a stack of plates in a sideview;

Fig. 4 illustrates a plate for a heat exchanger including an example of the gasket;

Figs. 5 illustrates two plates of the dimple type with an example of the gasket location inbetween, according to the invention;

Fig. 6 illustrates one plate of the dimple type with an example of a compresssed gasket located into the gasket groove, according to the invention;

Fig. 7 illustrates one plate of the dimple type with an example of a gasket geometry, according to the invention;

Fig. 8 illustrates one plate of the dimple type with an example of a gasket geometry including branches, according to the invention;

Fig. 9 illustrates one plate of the dimple type with an example of a gasket geometry including bending, according to the invention;

Fig. 10 illustrates one plate of the dimple type with an example of a gasket geometry, according to the invention;

Fig. 11 Illustrates one plate of the dimple type with an example of a gasket geometry, where some of the dimples reach trough the gasket, according to the invention;

Fig. 12 Illustrates one plate of the dimple type with an example of a gasket geometry, where some of the dimples reach trough the gasket itself including a branch;

Fig. 13 Illustrates one plate of the dimple type with an example of a gasket geometry, in an circular pattern;

Fig. 14 Illustrates one plate of the dimple type with an example of a gasket geometry, in curved pattern;

Fig. 15 Illustrates one plate of the dimple type with an example of a gasket geometry, where the top and bottom dimples have different size

Fig. 16 Illustrates one plate of the dimple type with an example of a gasket geometry, where the top and bottom dimples have different shape and size;

Fig. 17 Illustrates one plate of the dimple type with an example of a gasket geometry, where the top and bottom dimples have different shape and size;

Fig. 18 Illustrates a special version of positioning the gasket to seal off an opening.

DETAILED DESCRIPTION OF THE DRAWINGS

[0016] It should be understood that the detailed description and specific examples, while indicating embodiments of the invention, are given by way of illustration only, since various changes and modifications within the scope of the invention will become apparent to those skilled in the art from the detailed description.

[0017] Fig. 1 illustrates a plate heat exchanger 1 comprising a plurality of heat exchanger plates 2 which are stacked in a stacking direction visualized by the arrow 3. The heat exchanging plates are stacked with tops against bottoms.

[0018] Fig. 2 illustrates the heat exchanger in a top view of the dimple kind surface structure, this being the design of illustration, but the present invention may also apply to other designs such as fish bone. The heat exchanger plate has four corner openings 4, 5, 6, 7 for connecting to the fluid connections such that two openings 5, 7 connect a first fluid supply to an upper side of the plate by an inlet and an outlet - an overall flow direction from the inlet to outlet is illustrated by the solid arrow. A second supply is connected to the two openings 4, 6 on the lower side of the plate. An overall flow direction from the inlet to the outlet is illustrated by the slashed arrow. The flow is counter flow. Also cross-counter flow is an option, where 5+6 and 4+7 are connected. Alternatively parallel flow or parallel cross flow is an option.

[0019] A dimple structure with flat dimple tops and bottoms is illustrated by the white and black oval marks 9, 10 shown as an enlargement of a section 8 of the heat transfer area of the plate, where the dimples protrude in opposite directions. The plates could e.g. be made from a planar plate which is deformed by stamping to form the dimples extending in opposite directions relative to the central plane of the original planar plate.

[0020] Fig. 3 shows four plates 14, 15, 16, 17 where each plate forms a first set of dimples 12 having flat top areas 9 and a second set of dimples 13 having flat bottom areas 10. The first and second sets of dimples extend from a fictive central plane 11 (illustrated for plate 15) in opposite directions away from the central plane. The plates and thus the dimples can be manufactured by pressing a thin plate of metal, e.g. stainless steel, aluminum, cobber, brass or zinc or plastic into the desired shape, e.g. in a die. The plates can also be made by molding, e.g. by pressure molding of plastic in a mold or die.

[0021] The figure illustrates a side view and the dimples could have top surfaces of any shape, e.g. an elliptical shaped design of dimples according to the embodiment of illustration of the present invention. Other shapes may apply, e.g. super-elliptically, rectangular etc. as long as they have a well-defined extension in a first direction and a well-defined extension in a second direction being orthogonal to the first direction.

[0022] Further to be seen in the surface structure example of figure 3 is how dimple tops 12 are placed against dimple bottoms 13 of an upper neighboring plate and in the same manner that dimple bottoms 13 are connected to dimple tops 12 of the lower neighboring plate.

[0023] Fig. 3 also illustrates that the side walls of the dimples are roughly 45 degrees, c.f. the angle indication. In this way, the top and bottom dimples are as close as possible to each other. This leads to a higher number of dimples and to a higher strength. The angle of 45 degrees is limited by e.g. the maximum elongation of the stainless steel material. For practical reasons, e.g. due to tolerances of the pressing tools, a smaller angle is often applied. The walls are smoothly formed by free floating of the material without sharp edges and without flat or plane plate sections except from those appearing at the dimple tops and dimple bottoms, i.e. where one plate meet an adjacent plate.

[0024] Any such additional flat section would have created weak sections and could have allowed a pressure difference between fluids in the first and second paths to deform the plates - potentially, plates could bulge and crack at the edges. There is no pressure gradient over the connected tops and bottoms as the same fluids flow with the same pressures at the opposing sides of the connections.

[0025] The structure illustrated in Fig. 3 enables a reduced plate thickness. Due to the absence of edges and flat sections between dimple tops and bottoms the pressures are directed into the dimple walls in a manner where they are absorbed essentially without plastic deformation. Further, all the connections have enlarged contact areas relative to the fishbone structures and the pressure-forces are therefore distributed over a larger area.

[0026] One drawback is, however, that the relatively large contact areas reduce the thermal distribution from one path to the other. This drawback is counteracted by an increased convective heat transfer for a given pressure loss and the ability to reduce the plate thicknesses which again contributes to an increased heat transfer.

[0027] In the plate heat exchanger shown in Fig. 3 are arranged such that the dimples of the first set of dimples form a first contact face arranged against contact faces of an adjacent plate, and such that the dimples of the second set of dimples form a second contact face arranged against a contact face of an adjacent plate.

[0028] Fig. 4 is a further top view of a general heat exchanger plate illustrating a gasket part 30 positioned close to the rim of the plate sealing the heat transfer area 31 from the externals.

[0029] Further two parts of the gasket 32 are positioned to seal two of the openings 5, 7, or their opening areas 33, from the heat transfer area 31.

[0030] The gasket 32 traditionally are positioned in a gasket groove, or well, where the cross sections of groove and gasket often are shaped alike and the gasket groove usually has essentially flat bottoms, that if unsupported at the opposite side of the heat exchanger plate may risk to deform under e.g. media pressure or pre-pressurized gaskets by especially thin plates.

[0031] Fig. 5 illustrates one solution according to the present invention, where a heat exchanger plate 15 comprising at a first wavy section 34 aligned with a second wavy 35 section of a neighbouring plate 16 thus defing a gasket section 37 between them, where the wavy sections 34, 35 in the illustration of Fig. 5 is the area between the lines 36. The gasket section 37 is where a gasket 30, 32 is to be be positioned between the two plates 15, 16 and thus extends in a length direction being longer than its transverse direction, where the length direction may form a straight linear tajectory, such as illustrated in e.g. Figs.8-10 or a curvatured trajectory such as illustrated e.g. in Figs. 13 and 14. The transverse length may be constant or may be changing, such as illustrated e.g. in Fig. 7, or it may itself be wavy, regular or irregular.

[0032] The waves of the wavy sections 34, 35 may be waves in the plate 15, 16 surfaces and are in a first embodiment of the present invention such that the surface waves seen in the length direction, either with regular or irregular waves.

[0033] In an alternative or additional embodiment the waves in the wavy sections 34, 35 extend with waves in the transverse direction, such that the waves may be either, or such that surface of the plates waves in both the length and transverse directions of the wavy sections 34, 35, where one way to form this is by shaping the wavy sections 34, 35 with first sets of dimples 22 corresponding to dimple tops of the upper plate 15 having flat first surface areas 19 and dimple bottoms 23 of the neighboring lower plate 16 having flat second surface areas 20, and where the wall sections from the edges of the dimples 22, 23 comprises no edges or corners but may be curved or straightnor does it comprise any flat unsuported surface areas parallel to the imagiary plane 11. That the flat surface areas19, 20 are supported in the present context means they forms contact area to a flat surface opposite to the respective neighboring plate 16, 15. Unsupported in the same manner means it is not in contact with any such feature.

[0034] In the present context unsupportet flat surfaces

19, 20 refer to planes essential parallel to the fictive plane 11, the waves may comprise unsupported turning tops and bottoms of the wavy structures..

[0035] In the illustrated embodiment of example the waves are formed by dimples 22, 23where the flat first surface areas 19 within the first wavy section 34 forms a first contact face arranged against a contact face of a plane surface being upper to the plate 15, such as second surface areas 20 of dimple bottoms 23 of an upper plate.

[0036] Correspondingly the flat second surface areas 20 within the second wavy section 35 forms a second contact face arranged against a contact face of a plane surface being lower to the plate 16,such as first surface areas 19 of dimple tops 22 of a lower plate.

[0037] Fig.6 illustrate the same first wavy section 34 of the lower plate for the gasket section 37 Fig. 5 with a gasket 30, 32.

[0038] The uncompressed gasket height usually is larger than the maximum height within the gasket section 37 from a first surface area to a second surface area such as at least 110%, this usually being the doubble of the distance form a first flat surface area 19 to a second flat surface area 20 of a plate 15. The gasket 32 may have flat top and bottom suraces or may have a wavy topology reflecting the surface structures of the wavy first and second sections 34, 35 but with an factor of e.g. 1,1 larger that the height between the wawy sections 34, 35. When the plates are mounted in the frame, the gasket will be deformed.

[0039] In the illustrated embodiment the dimples within the wavy sections 34, 35 reach at the direction opposite to the gasket 30, 32, such as dimple tops 22 of the upper plate 15 and dimple bottoms 23 of the lower plate 16, but each of the plates 15, 16 further may comprise respectively dimples 23a, 22a, reaching in the direction towards the gasket 30, 32 forming contact faces against the other of the respective of the two neighboring plates15, 16, in the same manner as illustrated in e.g. Fig. 3 where first set dimples 22 of lower plate 15 forms contact faces agains second set dimples 23 of the upper plate 16. Since these will be positioned outside but at the edges of the wavy sections 34, 35 they forms edge dimples to the gasket section 37 helping both to strengthen it but also to confine and fix the gasket 30, 32 within the gasket section 37.

[0040] Especially given the sloped sides of the side dimples 23a, 22a (such as but not limited to roughly 45 degrees) in the circufirence of the dimples the gaskets experience wavy 'sides' just as they lean against sloping sides. All of this assists in keeping the gasket firmly in position,

[0041] Due to the volume preservation of the gasket material, when compressed the gasket material needs room for the thanslocated gasket material, and due to the construction with edge dimples 22a, 23a, there is space available between these along the gasket sides for expansion to compensate for the compression due to squezzing of the gasket between the wavy sections 34, 35. Furthere this allows expansion in relation to thermal elongation of the gasket 30, 32.

[0042] The dimples 22, 23 may in one embodiment be special to the wavy sections 34, 35 different from the surface structures such as in the heat transfer area 31, either differently designed dimples or a quite different design such as fish bone.

[0043] In another embodiment the whole of, or at least a section of the heat transfer area 31, and / or the opening area 33 and / or an optional transition zone therebetween comprises dimples 22, 23, the gasket simply being positioned in sections between the dimples.

[0044] Figs. 7-18 illustrates a number of different embodiments of the present invention where all the figures illustrate a top view of a plate 15, 16 the white shapes 22 representing eiher a first or a second set of dimples and the black shapes correspondingly representing the other of either the first or second kind of dimples 23.

[0045] Fig. 7 thus illustrates a top view of a further embodiement of the present invention where the gasket is shaped to reach out of the openings formed between connected edge dimples 22a, 23a. This gasket design has the advangage of being more stable and to give an easier fixation during mounting. Fig. 8 illustrates a top view of an embodiment where the gasket may comprise branches extending in different directions.

[0046] Fig. 9 illustrates a top view of an embodiment where the gasket may bend in different directions.

[0047] Fig. 10 is an embodiment where the gasket changes direction and fig. 10 is an embodiment combining the embodiments of fig. 8 and 9 and further forming a sealed enclosure encircling e.g. a opening 4, 5, 6, 7. Fig. 11 illustrates a further embodiment where the wavy sections 34, 35 not only comprises dimples 22, 23 extending opposite to the gasket, but also a set of opposite directed dimples 22b, 23b extending towards the gasket just as the dimples at the sides of the wavy sections 34, 35, thus reaching through the gasket section 37 forming contact faces to the dimples of the other plate within the gasket section 37.The gasket 30, 32 in this gasket section 37 then will be shaped to allow the flat surface areas 19, 20 of the dimples 22b, 23b to contact, such as comprising openings 38 through the gasket 30, 32, or being essentially S-shaped making a slalom kind of trajectory around the the dimples 22b, 23b being in contact within the gasket section 37.

[0048] Fig. 12 illustrates an embodiment combining the featuers of figs. 8 and 11.

[0049] Fig. 13 illustrate an embodiment with cicular arranged wavy sections 34, 35 possible encircling an opening 4, 5, 6, 7, and in the illustrated embodiment having larger edge dimples 22a, 23a at the outside edge 39 than at the inner edge 40, though the opposite may also be the situation, or the outer and inner edge dimples being of the same size. In one embodiment the inner and outer edge dimples has different forms such as curvature of the walls or shape of the top and bottom surface areas.

[0050] In general in relation to any of the embodiments the edge dimples 22a, 23 at the one side of the wavy sections 34, 35 may be differently shaped or differently sized relative to the edge dimples 22a, 23a at the other side. Fig. 14 illustrate an alternative embodiment with curved wavy sections 34, 35 spiralling away from a center section such as but not limited to an opening 4, 5, 6, 7, but any other curvatures of the trajectory of the wavy sections 34, 35 also applies to the present invention. Fig. 15 illustrate another alternative embodiment where the dimple tops 19, 20 are differently sized to the dimple bottoms 20, 19, the plates thus positioned with the large dimples 23, 22 being top at one plate and the small dimples 22, 23 being bottoms, but vice verca at the neighboring plates, thus that dimples of essentially the same sizes and shapes forms the flat contact surfaces.

[0051] Fig. 16 illustrate an alternative embodiment to that of Fig. 15, but where the opposing dimples 22, 23 are of different size and shapes, such as respectively elliptical and circular.

[0052] Fig. 17 illustrate an alternative embodiment to that of Fig. 15, but where the opposing dimples 22, 23 are of different size and shapes, such as respectively elliptical and rectangular.

[0053] Looking at fig. 18 illustraing a top view of a further embodiement of the present invention, the dimples 22, 23 are positioned in a lattice structure where each of the dimples 22 of the first set are neighboured by four dimples 23 of the second set and vice versa. In this embodiment the dimples 22, 23 could represent any of the dimples such as those forming the surface structures in the heat transfering area, in the opening area and / or in the transition zone between the opening and the heat transfering areas.

[0054] In such a lattice structure rows 41 of lines of sight extends in a 45 degrees angle relative lattice directions given by arrows 42 and 43. These lines of sight forms natural wavy sections 34, 35 according to the present invention and could therefore in one embodiment of the present invention be used as gasket section 37, such as by sealing an opening area from the heat transfering area by connecting two egde parts 30 of the gasket with a part 32 extending at a 45 degrees angle relative to the lattice directions 42, 43 sealing off an opening 4, 5, 6, 7.

[0055] In this and most of the illustrated previous embodiments all or some of the different dimples 12, 13, 22, 23, 22a, 22b, 23a, 23b may be similar shaped and sized.

Claims

1. A heat exchanger comprising plurality of stacked plates (14, 15, 16, 17) that due to surface structures forms flow paths between neighbouring plates, where at least one plate (15) comprises at a first wavy section (34) aligned with a second wavy section (35) of a neighbouring plate (16), where in a gasket (30, 32) is positioned between the first and second wavy sections (34, 35), thus defining a gasket section (37) wherein the waves are formed in a length direction to the trajectory of the gasket section (37), **characterized in that** the waves of the first wavy section (34) are formed by a first set of dimples (22) with flat first surface areas (19), and the waves of the second wavy section (35) of the neighbouring plate (16) are formed by a second set of dimples (23) protruding in the opposite direction relative to the first set of dimples (22) and having flat second surface areas (20), and where said first flat surface area (19) of each dimple of the first set of dimples (22) forms a first contact face arranged against a contact face of a flat surface area (20) of a dimple of an adjacent plate, and said flat surface area (20) of each dimple of the second set of dimples (23) forms a second contact face arranged against a contact face of a flat surface area of a dimple of an adjacent plate.

2. A heat exchanger according to claim 1 or 2, wherein the waves are formed in a transverse direction to the trajectory of the gasket section 37.

3. A heat exchanger according to claim 4 where all flat areas in said first and second wavy sections are aligned with neighbouring plates.

4. A heat exchanger according to claim 4 or 5, where the first and second wavy sections form a regular pattern of waves.

5. A heat exchanger according to claim 4 or 5, where the first and second wavy sections form a changing pattern of waves.

6. A heat exchanger according to claim 7, where the first and second wavy sections form a irregular pattern of waves.

7. A heat exchanger according to any of the preceding claims, where the uncompressed gasket height is larger than the height from a first surface area to a second surface area.

8. A heat exchanger according to claim 9, where the uncompressed gasket height is at least 110% of that of the height from a first surface area to a second surface area.

9. A heat exchanger according to any of the preceding claims where the gasket between said first and second wavy sections are positioned to separate a section of a plate comprising a port hole from the rest of the plate comprising a heat exchange area.

10. A heat exchanger according to any of the preceding claims where gaskets only are positioned at one side the wavy sections of the plates

11. A heat exchanger according to any of the claims 1-11, where gaskets are positioned at both sides of the wavy sections of the plates.

12. A heat exchanger according to any of the preceding claims where the gaskets have flat upper and lower surfaces but are deformed when positioned between the first and second wavy sections

13. A heat exchanger according to any of the preceding claims, where each plate comprises both first and second sets of dimples in the first and second wavy sections where the first sets of dimples of the first wavy section contacts second set of dimples of the second set of dimples through openings in the gasket.

14. A heat exchanger according to any of the preceding claims, where dimples of the first wavy section contacts dimples of the second wavy section through openings in the gasket.

15. A heat exchanger according to any of the preceding claims, where each of the first and second wavy sections comprises both first and second sets of dimples and where the gasket are squeezed between first sets of dimples of the first wavy section and second sets of dimples of the second wavy section and where second sets of dimples of the first wavy section contacts first set of dimples of the second wavy section through holes in the gasket.

16. A heat exchanger according to any of the preceding claims where the surface structures forming the flow paths in the heat transferring sections of the plates also are formed by two sets of dimples protruding at the opposing sides of each plate and having flat surface areas forming contact faces arranged against contact faces of an adjacent plate.

17. A heat exchanger according to claim 16 where the first and second sets of dimples of the first and second wavy sections are part of the two sets of dimples.

Patentansprüche

1. Wärmetauscher, der mehrere gestapelte Platten (14, 15, 16, 17) aufweist, die aufgrund von Oberflächenstrukturen Strömungswege zwischen benachbarten Platten bilden, wobei mindestens eine Platte (15) einen ersten wellenförmigen Abschnitt (34), der mit einem zweiten wellenförmigen Abschnitt (35) einer benachbarten Platte (16) ausgerichtet ist, aufweist, wobei eine Dichtung (30, 32) zwischen dem ersten und zweiten wellenförmigen Abschnitt (34, 35) positioniert ist, wodurch ein Dichtungsabschnitt (37) definiert ist, wobei die Wellen in einer Längsrichtung zur Bahn des Dichtungsabschnitts (37) gebildet sind, **dadurch gekennzeichnet, dass** die Wellen des ersten wellenförmigen Abschnitts (34) durch einen ersten Satz von Vertiefungen (22) mit flachen ersten Oberflächenbereichen (19) und die Wellen des zweiten wellenförmigen Abschnitts (35) der benachbarten Platte (16) durch einen zweiten Satz von Vertiefungen (23) gebildet sind, die in die entgegengesetzte Richtung relativ zum ersten Satz von Vertiefungen (22) vorstehen und flache zweite Oberflächenbereiche (20) haben, wobei der erste flache Oberflächenbereich (19) jeder Vertiefung des ersten Satzes von Vertiefungen (22) eine erste Kontaktfläche bildet, die an eine Kontaktfläche eines flachen Oberflächenbereichs (20) einer Vertiefung einer daneben liegenden Platte angeordnet ist, und der flache Oberflächenbereich (20) jeder Vertiefung des zweiten Satzes von Vertiefungen (23) eine zweite Kontaktfläche bildet, die an eine Kontaktfläche eines flachen Oberflächenbereichs einer Vertiefung einer daneben liegenden Platte angeordnet ist.

2. Wärmetauscher nach Anspruch 1 oder 2, wobei die Wellen in Querrichtung zur Bahn des Dichtungsabschnitts (37) gebildet sind.

3. Wärmetauscher nach Anspruch 4, wobei alle flachen Bereiche im ersten und zweiten wellenförmigen Abschnitt mit den benachbarten Platten ausgerichtet sind.

4. Wärmetauscher nach Anspruch 4 oder 5, wobei der erste und zweite wellenförmige Abschnitt ein regelmäßiges Muster von Wellen bilden.

5. Wärmetauscher nach Anspruch 4 oder 5, wobei der erste und zweite wellenförmige Abschnitt ein sich änderndes Muster von Wellen bilden.

6. Wärmetauscher nach Anspruch 7, wobei der erste und zweite wellenförmige Abschnitt ein unregelmäßiges Muster von Wellen bilden.

7. Wärmetauscher nach einem der vorhergehenden Ansprüche, wobei die unkomprimierte Dichtungshöhe größer als die Höhe von einem ersten Oberflächenbereich zu einem zweiten Oberflächenbereich ist.

8. Wärmetauscher nach Anspruch 9, wobei die unkomprimierte Dichtungshöhe mindestens 110 % derjenigen der Höhe von einem ersten Oberflächenbereich zu einem zweiten Oberflächenbereich beträgt.

9. Wärmetauscher nach einem der vorhergehenden Ansprüche, wobei die Dichtung zwischen dem ersten und zweiten wellenförmigen Abschnitt derart positioniert ist, dass sie einen Abschnitt einer Platte, die eine Durchgangsöffnung aufweist, vom Rest der Platte, die eine Wärmetauschfläche aufweist, trennt.

10. Wärmetauscher nach einem der vorhergehenden Ansprüche, wobei Dichtungen nur an einer Seite der wellenförmigen Abschnitte der Platten positioniert sind.

11. Wärmetauscher nach einem der Ansprüche 1 bis 11, wobei Dichtungen an beiden Seiten der wellenförmigen Abschnitte der Platten positioniert sind.

12. Wärmetauscher nach einem der vorhergehenden Ansprüche, wobei die Dichtungen flache obere und untere Flächen haben, aber verformt sind, wenn sie zwischen dem ersten und zweiten wellenförmigen Abschnitt positioniert sind.

13. Wärmetauscher nach einem der vorhergehenden Ansprüche, wobei jede Platte sowohl erste als auch zweite Sätze von Vertiefungen in dem ersten und zweiten wellenförmigen Abschnitt aufweist, wobei der erste Satz von Vertiefungen des ersten wellenförmigen Abschnitts den zweiten Satz von Vertiefungen des zweiten Satzes von Vertiefungen durch Öffnungen in der Dichtung berührt.

14. Wärmetauscher nach einem der vorhergehenden Ansprüche, wobei Vertiefungen des ersten wellenförmigen Abschnitts Vertiefungen des zweiten wellenförmigen Abschnitts durch Öffnungen in der Dichtung berühren.

15. Wärmetauscher nach einem der vorhergehenden Ansprüche, wobei jeder des ersten und zweiten wellenförmigen Abschnitts sowohl erste als auch zweite Sätze von Vertiefungen aufweist und wobei die Dichtung zwischen den ersten Sätzen von Vertiefungen des ersten wellenförmigen Abschnitts und den zweiten Sätzen von Vertiefungen des zweiten wellenförmigen Abschnitts zusammengedrückt ist und wobei der zweite Satz von Vertiefungen des ersten wellenförmigen Abschnitts den ersten Satz von Vertiefungen des zweiten wellenförmigen Abschnitts durch Löcher in der Dichtung berührt.

16. Wärmetauscher nach einem der vorhergehenden Ansprüche, wobei die Oberflächenstrukturen, die die Strömungswege in den wärmeübertragenden Abschnitten der Platten bilden, auch durch zwei Sätze von Vertiefungen gebildet sind, die an den entgegengesetzten Seiten jeder Platte vorstehen und flache Oberflächenbereiche haben, die Kontaktflächen bilden, die an Kontaktflächen einer daneben liegenden Platte angeordnet sind.

17. Wärmetauscher nach Anspruch 16, wobei der erste und zweite Satz von Vertiefungen des ersten und zweiten wellenförmigen Abschnitts Teil der zwei Sätze von Vertiefungen sind.

Revendications

1. Échangeur de chaleur comportant une pluralité de plaques empilées (14, 15, 16, 17) qui, du fait de structures de surface, forme des passages d'écoulement entre plaques voisines, au moins une plaque (15) comportant, au niveau d'une première section ondulée (34) alignée avec une deuxième section ondulée (35) d'une plaque voisine (16) dans laquelle un joint (30, 32) est positionné entre les première et deuxième sections ondulées (34, 35), définissant ainsi une section (37) de joint où les ondulations sont formées dans une direction longitudinale de la trajectoire de la section (37) de joint, **caractérisé en ce que** les ondulations de la première section ondulée (34) sont formées par un premier ensemble de cuvettes (22) dotées de zones (19) de premières surfaces plates, et **en ce que** les ondulations de la deuxième section ondulée (35) de la plaque voisine (16) sont formées par un deuxième ensemble de cuvettes (23) faisant saillie dans le sens opposé par rapport au premier ensemble de cuvettes (22) et dotées de zones (20) de deuxièmes surfaces plates, ladite zone (19) de première surface plate de chaque cuvette du premier ensemble de cuvettes (22) formant une première face de contact disposée contre une face de contact d'une zone (20) de surface plate d'une cuvette d'une plaque adjacente, et ladite zone (20) de surface plate de chaque cuvette du deuxième ensemble de cuvettes (23) formant une deuxième face de contact disposée contre une face de contact d'une zone de surface plate d'une cuvette d'une plaque adjacente.

2. Échangeur de chaleur selon la revendication 1 ou 2, les ondulations étant formées dans une direction transverse à la trajectoire de la section (37) de joint.

3. Échangeur de chaleur selon la revendication 4, toutes les zones plates dans lesdites première et deuxième sections ondulées étant alignées avec des plaques voisines.

4. Échangeur de chaleur selon la revendication 4 ou 5, les première et deuxième sections ondulées formant un motif régulier d'ondulations.

5. Échangeur de chaleur selon la revendication 4 ou 5, les première et deuxième sections ondulées formant un motif changeant d'ondulations.

6. Échangeur de chaleur selon la revendication 7, les première et deuxième sections ondulées formant un motif irrégulier d'ondulations.

7. Échangeur de chaleur selon l'une quelconque des revendications précédentes, la hauteur du joint non comprimé étant plus grande que la hauteur d'une zone de première surface à une zone de deuxième surface.

8. Échangeur de chaleur selon la revendication 9, la hauteur du joint non comprimé valant au moins 110% de la hauteur d'une zone de première surface à une zone de deuxième surface.

9. Échangeur de chaleur selon l'une quelconque des revendications précédentes, le joint entre lesdites première et deuxième sections ondulées étant positionné de façon à séparer une section d'une plaque comportant une lumière du reste de la plaque comportant une zone d'échange de chaleur.

10. Échangeur de chaleur selon l'une quelconque des revendications précédentes, des joints n'étant positionnés que d'un côté des sections ondulées des plaques.

11. Échangeur de chaleur selon l'une quelconque des revendications 1 à 11, des joints étant positionnés des deux côtés des sections ondulées des plaques.

12. Échangeur de chaleur selon l'une quelconque des revendications précédentes, les joints présentant des plates surfaces supérieure et inférieure mais étant déformés lorsqu'ils sont positionnés entre les première et deuxième sections ondulées.

13. Échangeur de chaleur selon l'une quelconque des revendications précédentes, chaque plaque comportant à la fois des premier et deuxième ensembles de cuvettes dans les première et deuxième sections ondulées, le premier ensemble de cuvettes de la première section ondulée touchant le deuxième ensemble de cuvettes du deuxième ensemble de cuvettes à travers des ouvertures dans le joint.

14. Échangeur de chaleur selon l'une quelconque des revendications précédentes, des cuvettes de la première section ondulée touchant des cuvettes de la deuxième section ondulée à travers des ouvertures dans le joint.

15. Échangeur de chaleur selon l'une quelconque des revendications précédentes, chacune des première et deuxième sections ondulées comportant à la fois des premier et deuxième ensembles de cuvettes et le joint étant serré entre des premiers ensembles de cuvettes de la première section ondulée et des deuxièmes ensembles de cuvettes de la deuxième section ondulée et des deuxièmes ensembles de cuvettes de la première section ondulée touchant un premier ensemble de cuvettes de la deuxième section ondulée à travers des trous dans le joint.

16. Échangeur de chaleur selon l'une quelconque des revendications précédentes, les structures de surface formant les passages d'écoulement dans les sections de transfert de chaleur des plaques étant également formées par deux ensembles de cuvettes faisant saille sur les côtés opposés de chaque plaque et dotées de zones de surfaces plates formant des faces de contact disposées contre des faces de contact d'une plaque adjacente.

17. Échangeur de chaleur selon la revendication 16, les premier et deuxième ensembles de cuvettes des première et deuxième sections ondulées faisant partie des deux ensembles de cuvettes.

Fig. 1

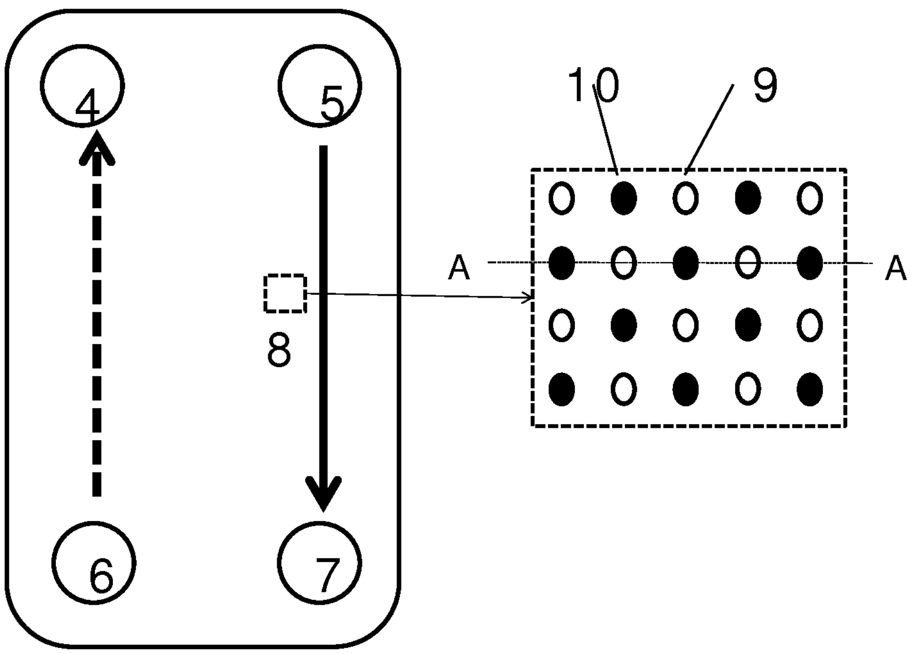

Fig. 2

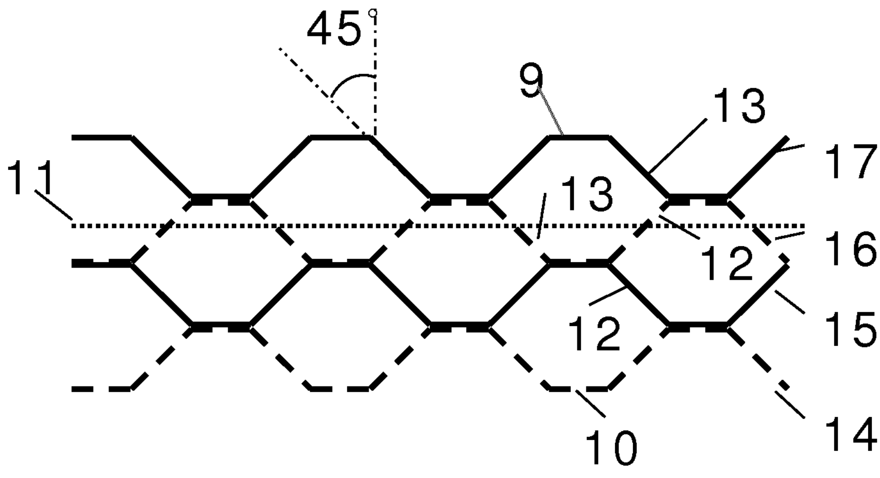

Fig. 3

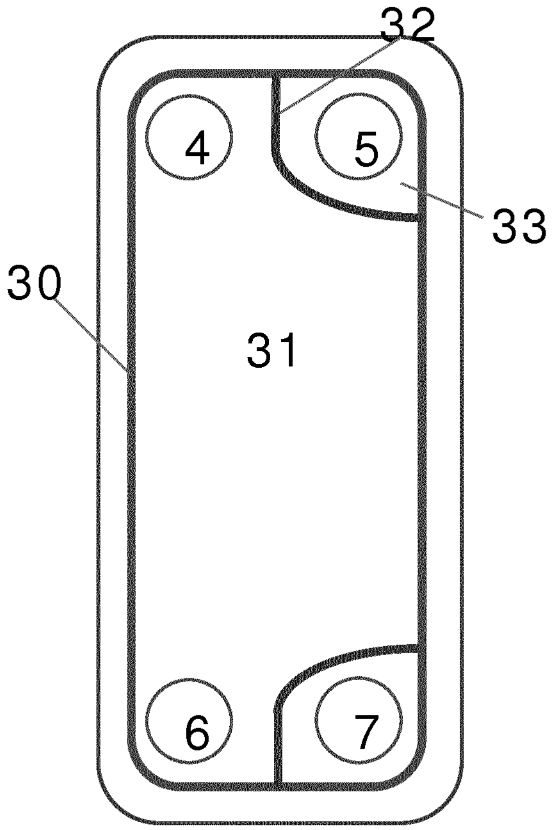

Fig. 4

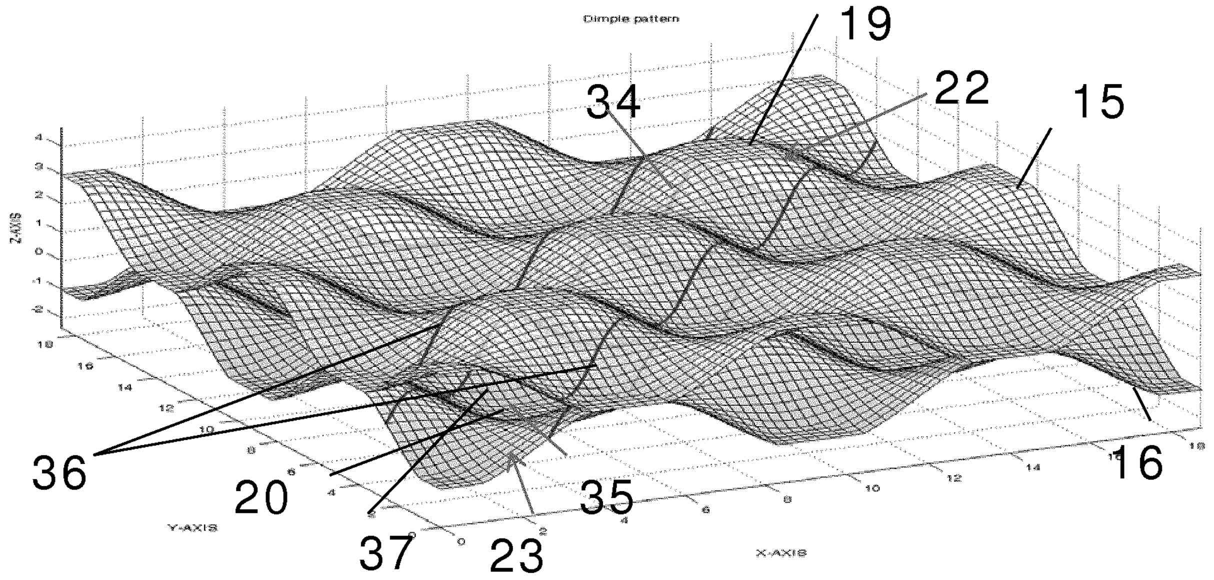
Dimple pattern
19
34
22
15
Z-AXIS
36
20
37
23
35
16
Y-AXIS
X-AXIS

Fig. 5

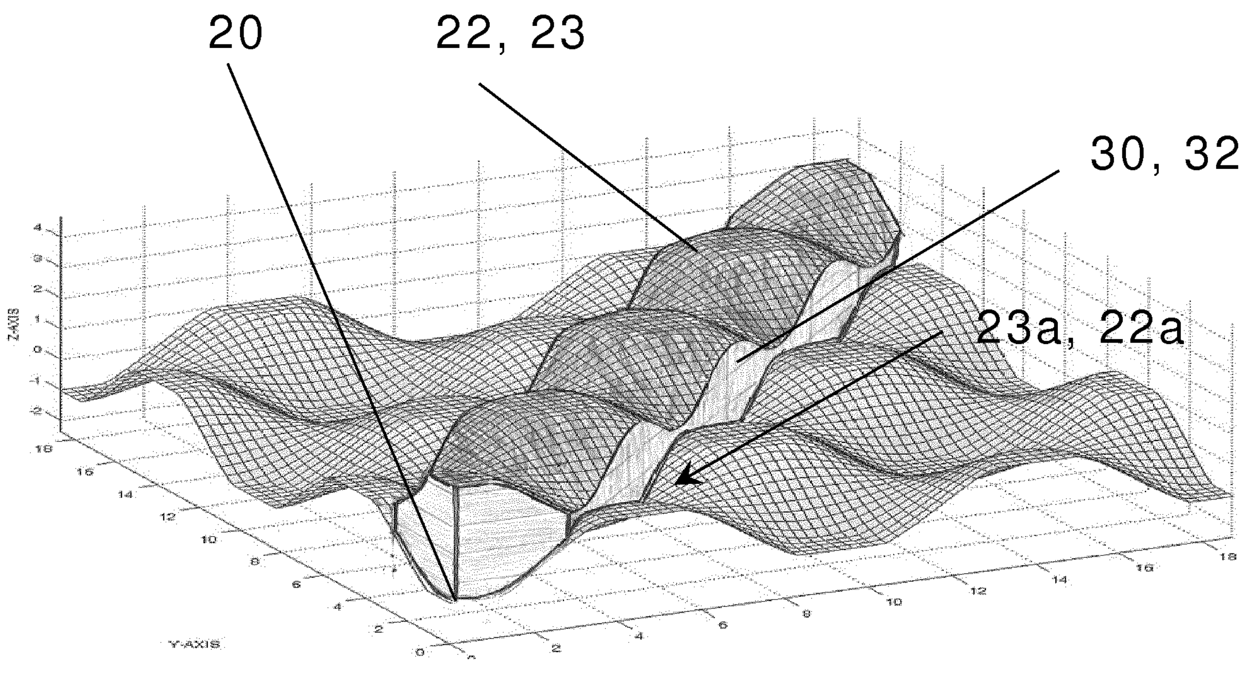
20
22, 23
30, 32
23a, 22a
Z-AXIS
Y-AXIS

Fig. 6

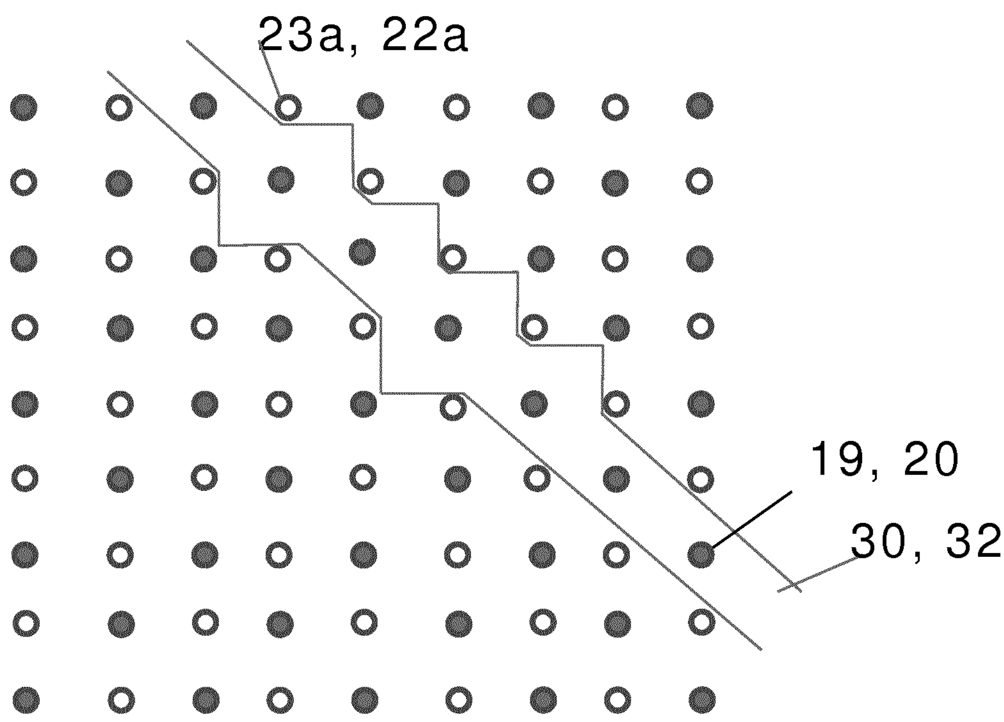

Fig. 7

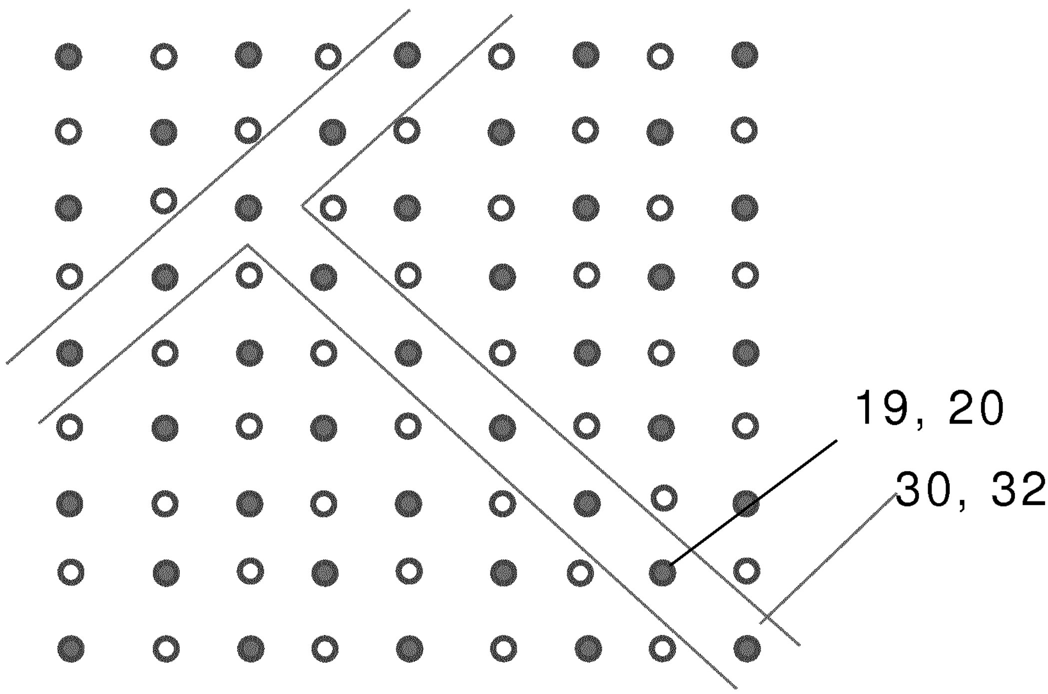

Fig. 8

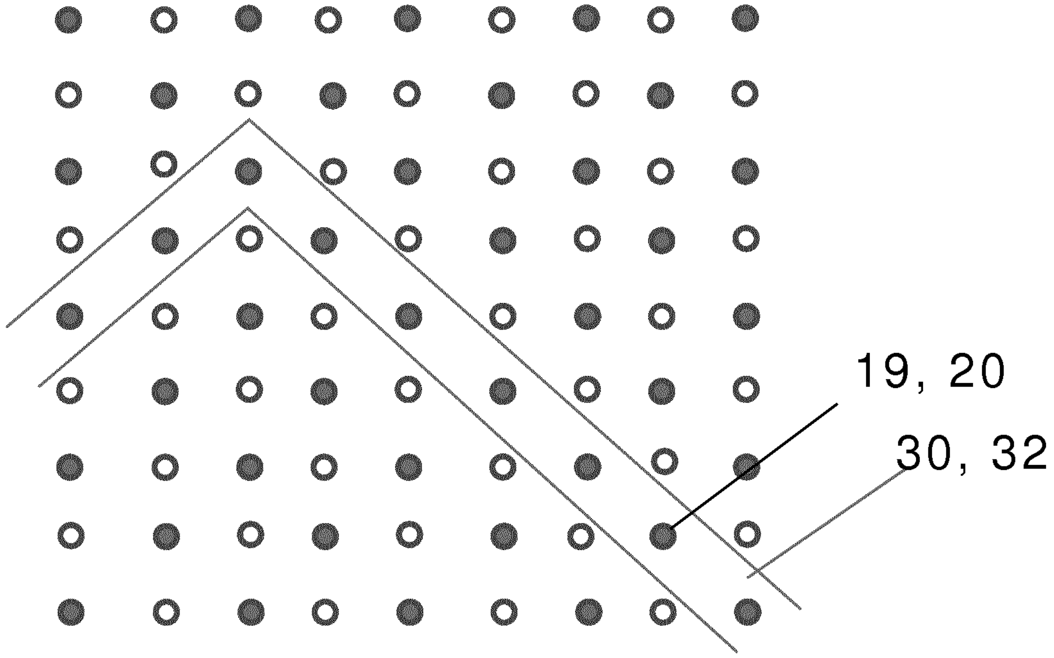

Fig. 9

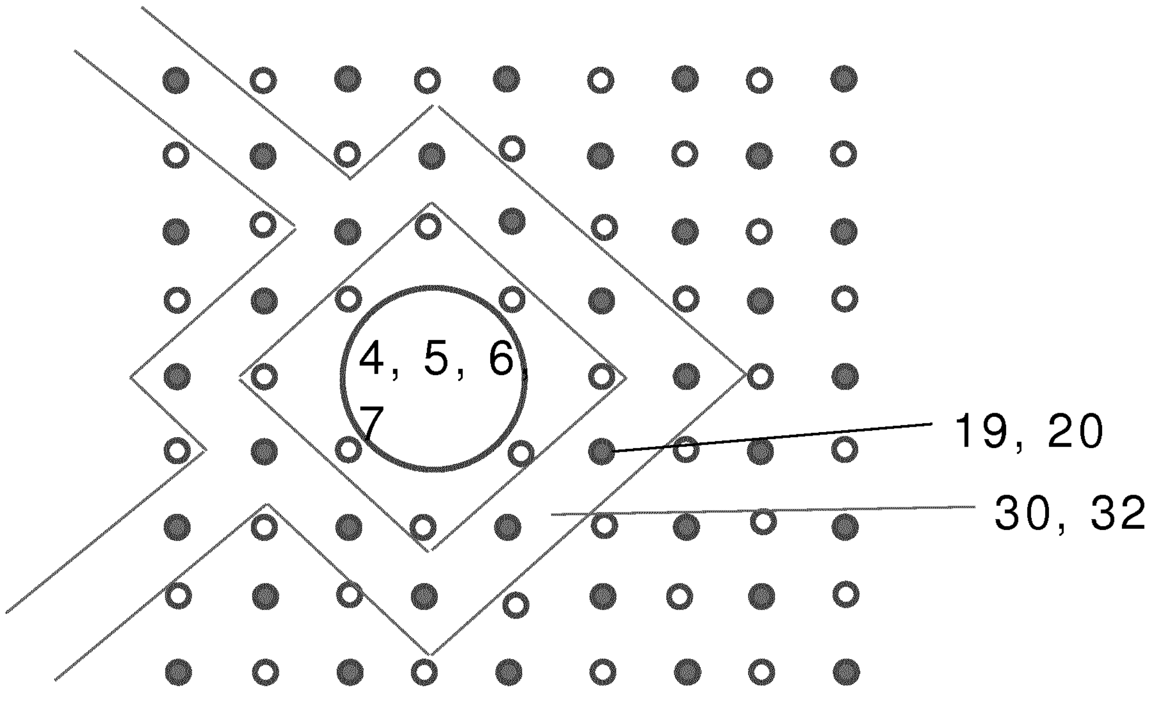

Fig. 10

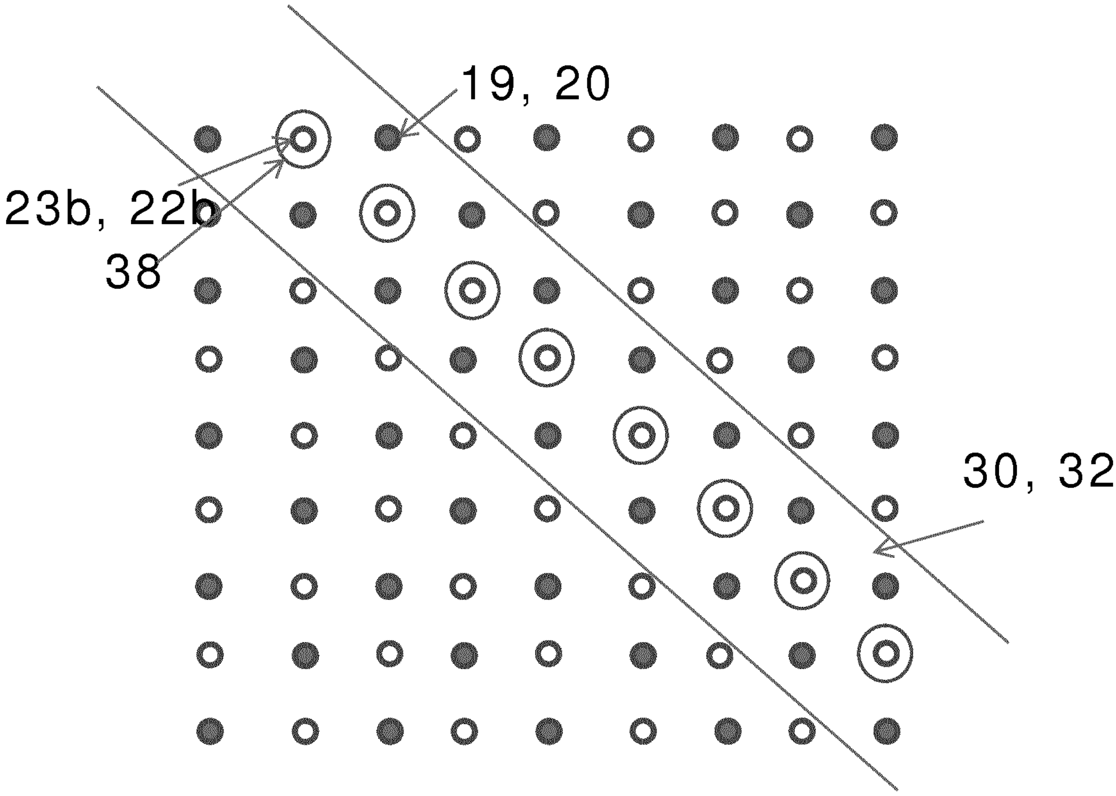

Fig. 11

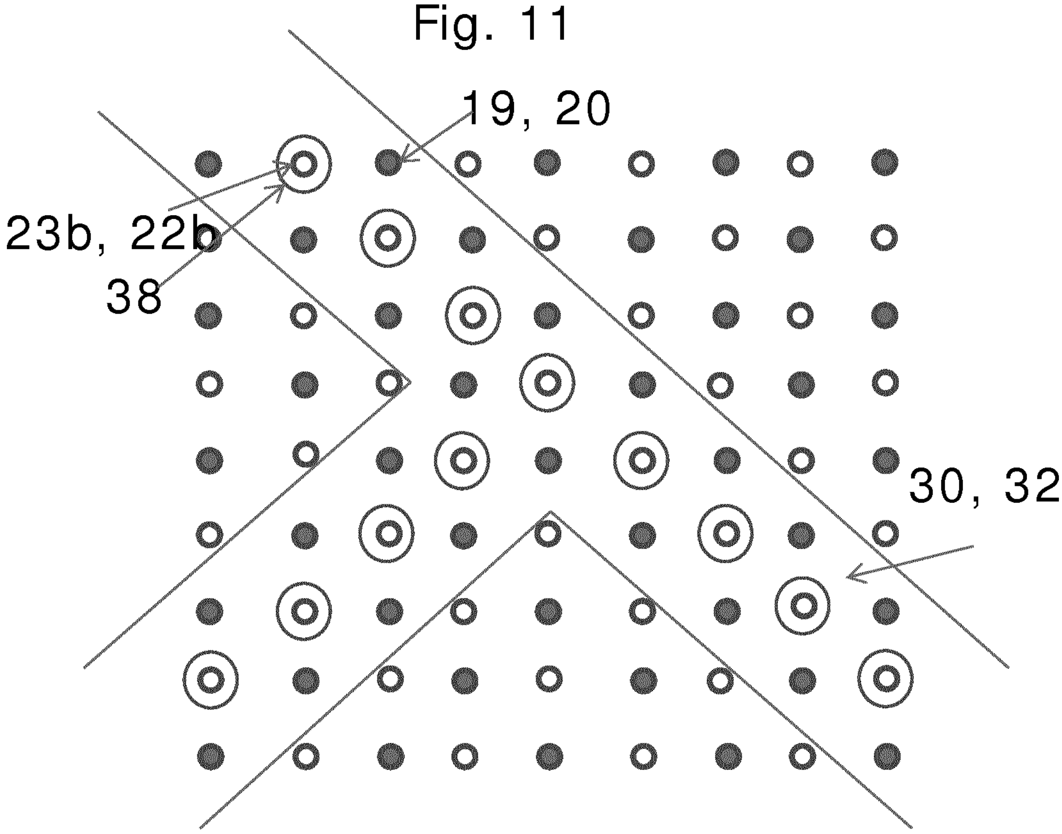

Fig. 12

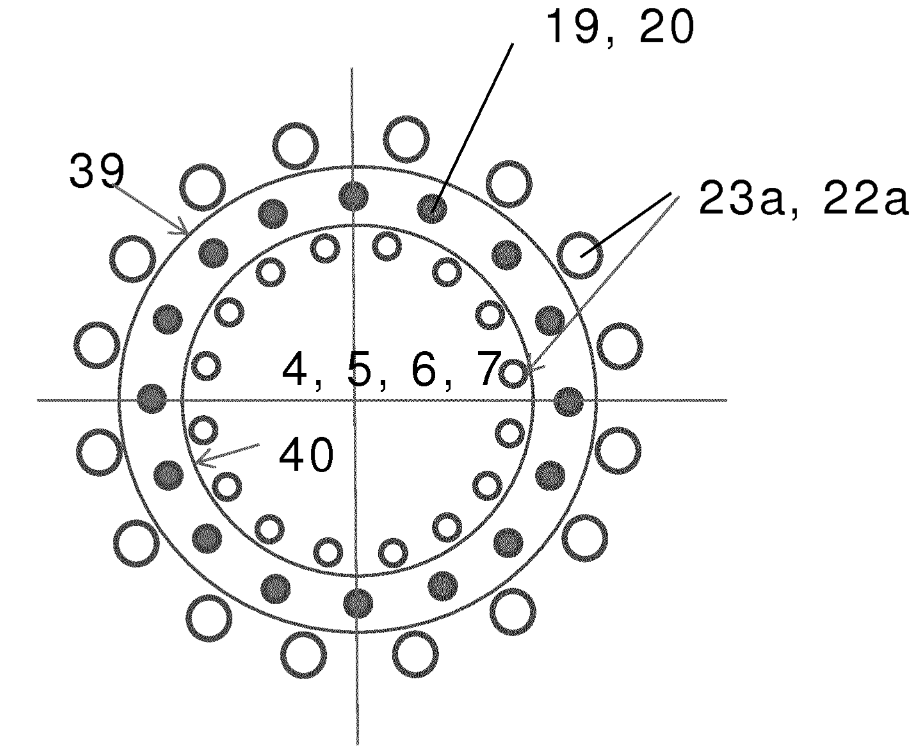

Fig. 13

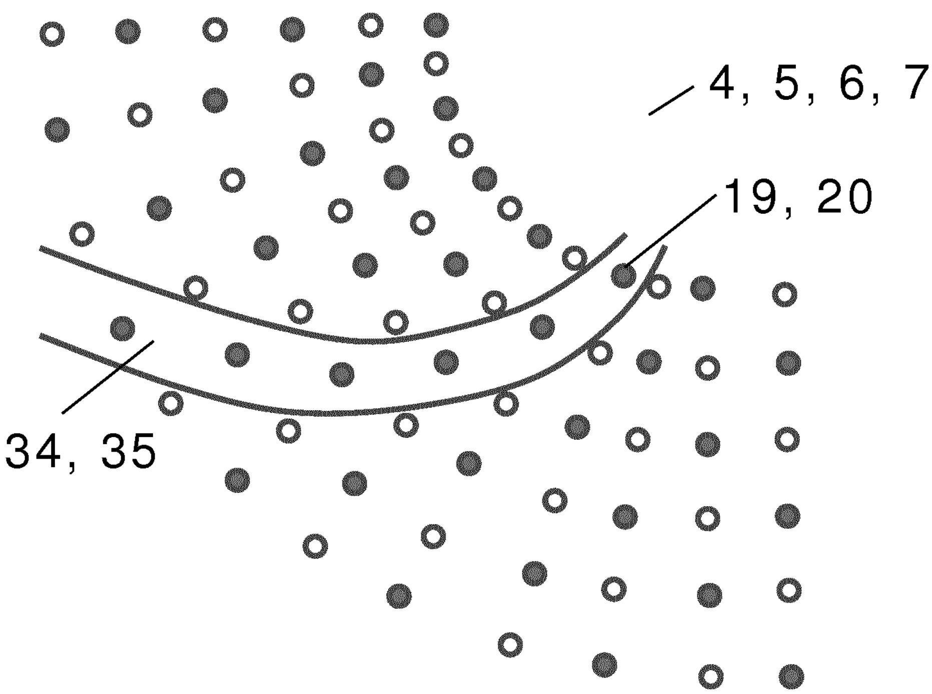

Fig. 14

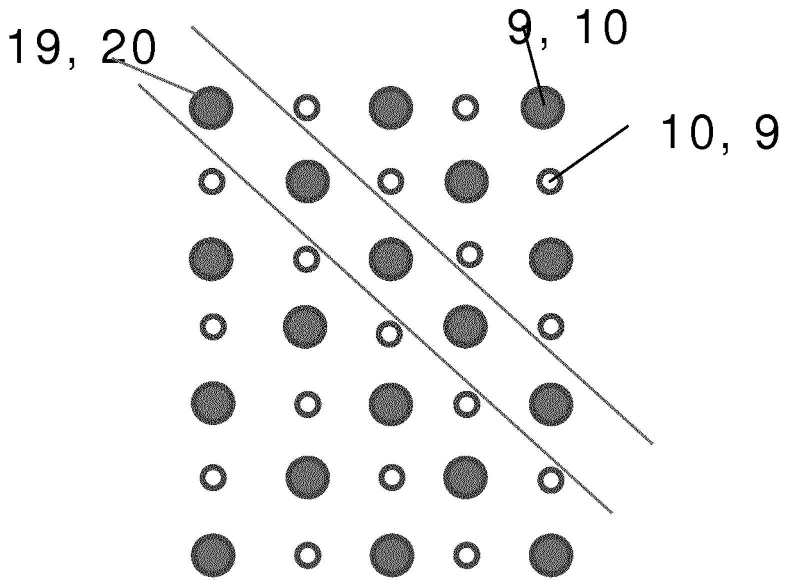

Fig. 15

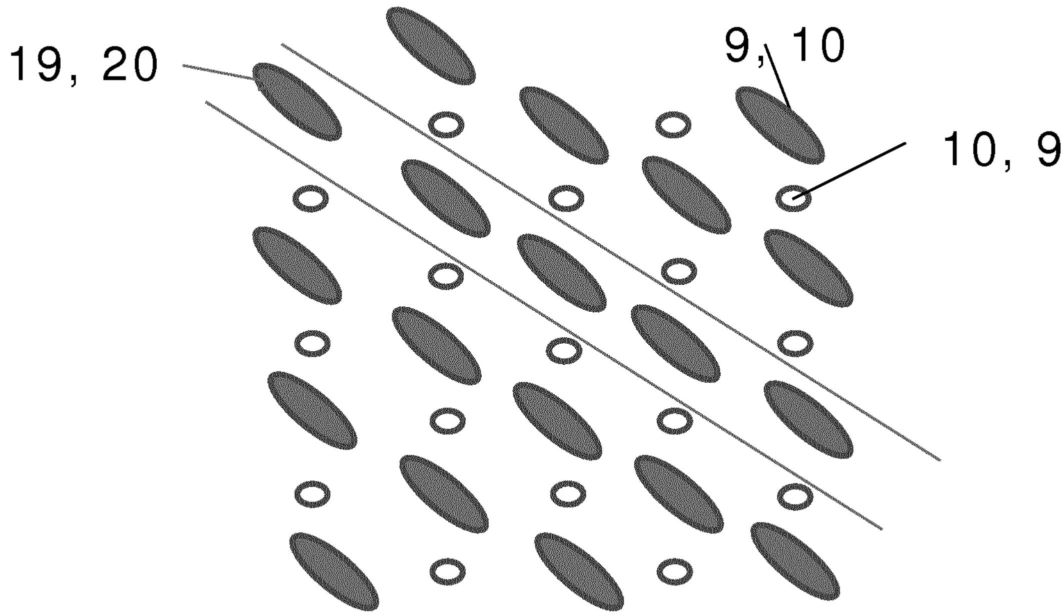

Fig. 16

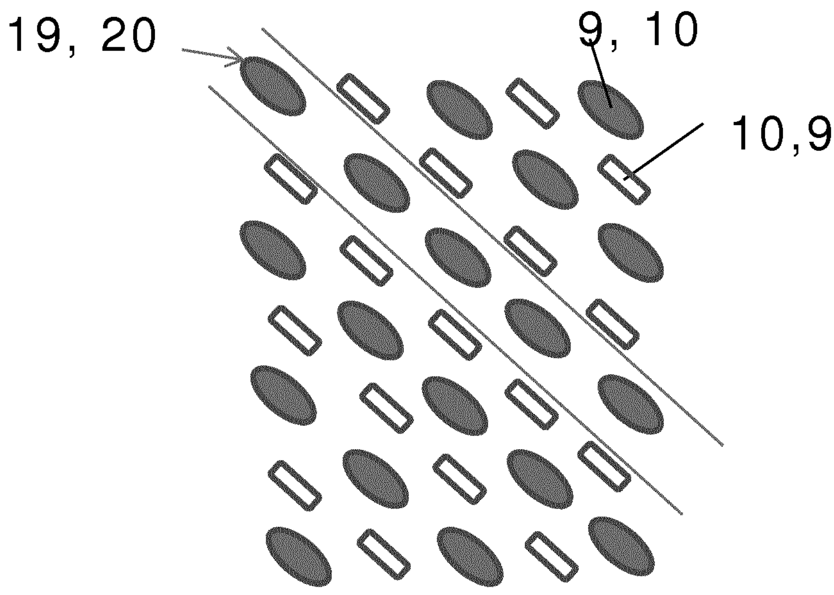

Fig. 17

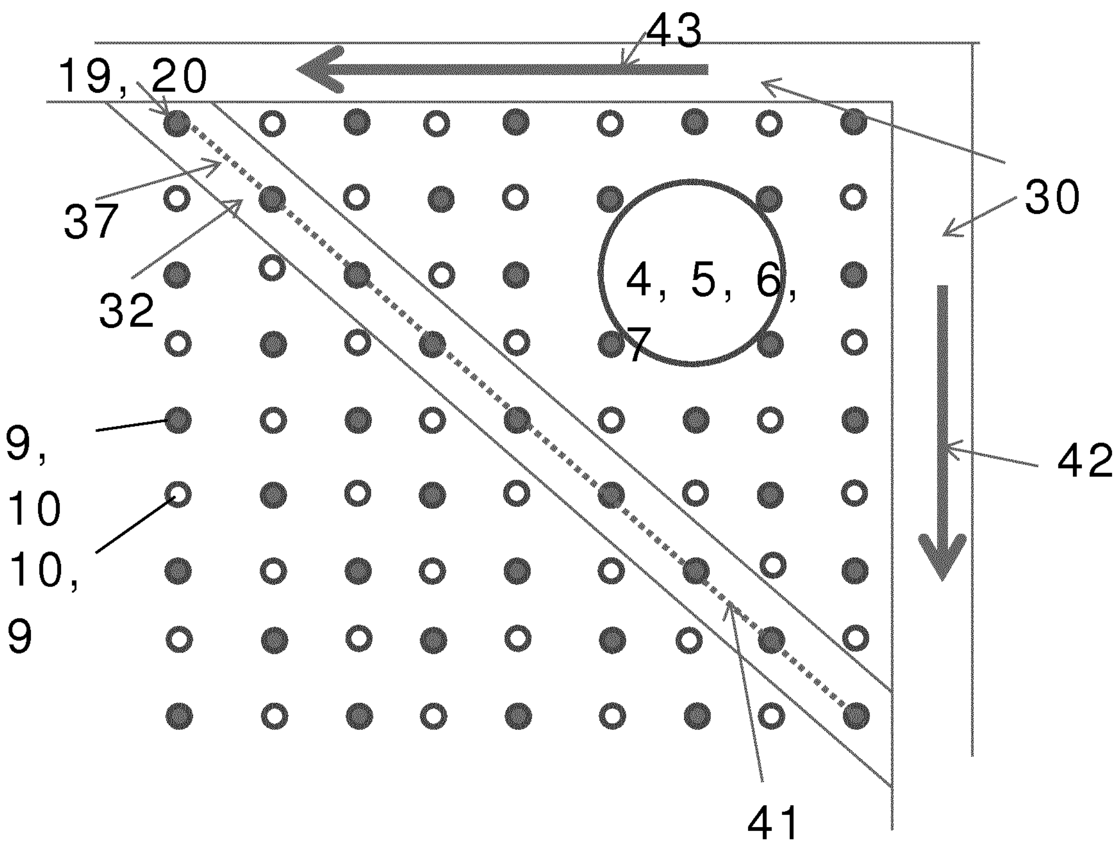

Fig. 18

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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