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(54) **METHOD FOR ELECTROFORMING A STUDED PLATE**

VERFAHREN ZUM GALVANOFORMEN EINER NOPPENPLATTE

PROCEDE D'ELECTROFORMAGE D'UNE PLAQUE A CRAMPONS

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Description

[0001] A first aspect of the present invention relates to a method for electroforming a plate having a working side which is provided with separate elevations.

[0002] A plate of this type, which is also referred to in this description as a studded plate, can be used, inter alia, as a conveyor surface for conveying substrates, such as sheets of paper, where a small contact surface area between the conveyor surface and the substrate is desirable. A studded plate of this type can also be used as a component of a mould for forming in particular three-dimensional objects.

[0003] A plate with a working side which is provided with separate elevations are known. A plate of this type is generally produced by machining or deforming a surface of a flat plate so as to form the elevations. One significant drawback of the studded plate produced in this way is that the elevations are not all of the same height with respect to the surface of the plate obtained by machining, which is undesirable.

[0004] US-A1-2002/063061 is directed to various methods of reproducing a die by means of electroforming. In one embodiment thereof a brass plate is provided with a concavities/convexities pattern on one surface thereof by means of cutting, thereby obtaining a so-called mother die. The surface provided with said concavities/convexities pattern can be protected against damage by a plated layer. A so-called organic exfoliation layer may be applied in order to enhance separation between the respective dies. In another embodiment the mother die is obtained by electroforming from a master die. The stamper dies can be used for manufacturing lenses.

[0005] US-A-3543362 discloses an abrading device or a file and a method for production thereof. An active sheet metal layer is formed by electrolytic deposition on a plating matrix. The plating matrix is formed from a plate, preferably made of metal, having a pattern of parallel insulating strips and intermediate strip-shaped recesses. A pattern may be obtained by printing or by photographic means. When such patterned plate is treated in an electrolytic bath, or galvanized, a metal deposit forms initially on the recesses, grows laterally, and then projects over the insulating strips. The process of electrodeposition is interrupted when the spacing between the electrodeposits is in the order of 20 microns. Then the layer which permits removal of a galvanic deposit is formed on the surface of the plating matrix. The final step in forming the sheet metal layer of a file is forming a galvanic deposit of sufficient thickness on the matrix. This surface is then treated with cementous material to be bonded to a substratum of a file.

[0006] US-A1-2002/0117799 discloses a non-planar single sheet separator wall. The carrying surface thereof consist of a plurality of longitudinally generally upwardly extending sheet contacting rails, preferably made of moulded Teflon loaded plastic.

[0007] EP0152363 discloses a device for purring out

and stacking flat objects, in particular mail items, in a container out from a sorting machine. The main surface consists of a perforated plate coated with a plastic or metallic film. Thereby a multitude of small air reservoirs is provided in the main surface in order to limit the adhesion force between the mail objects and the surface. These air reservoirs can be obtained by stamping of cells in metal sheet constituting the main surface.

[0008] US5807227 discloses a folder apparatus comprising a product guiding surface formed by arrangement of multidirectional bristles which are affixed to a backing support using for example, mounting screw holes. The bristles are of a certain stiffness so that the products are prevented from whipping upon acceleration.

[0009] US20020070495 discloses a sheet feeder used in an image recording machine such as printer, comprising a mechanism that separates a top sheet from a stack and feeds one sheet to a process station. A sheet stacker comprises a support member having a working surface with plurality of protrusions integrally formed thereon by pressing.

[0010] Therefore, there is a demand for a plate with a working side provided with separate elevations which are of uniform height with respect to the remainder of the surface of the working side of the plate, and for a method for the production thereof.

[0011] A first object of the present invention is to satisfy this demand.

[0012] The method for electroforming a conveyor surface comprising a plate having a working side which is provided with separate elevations according to the invention to this end comprises the steps of:

providing a flat conductive electroforming die with insulating regions that are separated from one another;
electrolytically depositing a screen layer, which comprises a network of dykes, which dykes delimit screen openings, of metal on the electroforming die, the dykes, as seen in section, having at least one convex surface part;
passivating the uncovered surface of the screen layer;
electrolytically depositing a continuous metal layer on the passivated surface of the screen layer, in such a manner that at least the screen openings of the screen layer are filled and the passivated surface of the screen layer is completely covered, separating the continuous metal layer having a working side provided with separate elevations, which elevations, when seen in section, have at least one concave surface part, as the studded plate from the screen layer.

[0013] In the method according to this aspect of the invention, the first two steps correspond to a standard electroforming method for the production of flat screen material. This involves the use of an electroforming die

which is provided with insulating regions. An electroforming die with insulating regions of this type can be produced, for example, by applying insulating regions to a flat conductive electroforming die, so that the insulating regions form small elevations with respect to the conductive surface of the die. Insulating regions of this type are often formed by applying a photosensitive resist material to the flat die, followed by exposing it through a film, which film is provided with a generally regular pattern of the insulating regions to be formed. After the exposure step, the unexposed photoresist parts are removed, so that insulating regions of photoresist material remain behind on the electroforming die. Insulating regions of this type are also known as resist islands. Another possible option is for insulating regions to be arranged in recesses (for example etched recesses) formed in the surface of the electroforming die, so that the latter has a flat surface without elevations. Then, the electroforming die is placed in an electroplating bath of an electroformable metal or metal alloy and connected as electrode (cathode). In this way, metal from the electroplating bath is deposited on the conductive parts of the electroforming die. This deposition of the screen layer is continued until the screen layer deposited in this way has reached the desired thickness. The result is a screen layer of metal which comprises dykes that delimit screen openings. Consequently, the dykes, as seen in section, have at least one convex surface part which delimits the screen openings. In the context of the present description, the term "in section" means a section taken in the thickness direction of the plate, corresponding to the height direction of the elevations or recesses.

[0014] When producing a normal screen e.g. for use in screenprinting, this screen layer can then be removed from the electroforming die as a basic skeleton, which basic skeleton is then grown further, or this screen layer can continue to be grown on the electroforming die itself until it reaches the desired thickness and then removed from the die. By contrast, in the method according to the invention, the screen layer is not removed from the electroforming die, but rather a passivation layer is provided on the uncovered surface of the screen layer. Examples of suitable passivating agents include potassium dichromate, potassium permanganate, chromium or gold.

[0015] After this passivation step has been carried out, the electroforming die with the passivated screen layer on it is placed in an electroplating bath again, which bath contains an electroformable metal or metal alloy. This metal or alloy may optionally be identical to the metal or metal alloy forming the first screen layer. As a result, a subsequent metal layer is deposited on the passivated surface of the screen layer, with the conditions, such as duration, being selected in such a way that a continuous metal layer is deposited, completely filling at least the screen openings and completely covering the passivated surface, preferably until a planar uncovered surface, also known as the growth front, is achieved. In a final step, the continuous metal layer which has been formed is re-

moved, as the intended studded plate, from the first screen layer. On account of the use of the electroforming method explained above, the metal parts of the continuous metal layer which have filled the screen openings form the elevations of the studded plate, which on the one hand are of a uniform height and on the other hand have a characteristic surface. Specifically, this characteristic surface comprises a concave surface part, as seen in section. This may be a continuous surface without sharp transitions at one or more corners, primarily depending on the shape and dimensions of the insulating regions. The elevations of the studded plate form a direct reproduction of the recesses or screen openings in the screen layer. The studded plate obtained in this way has a working side with elevations, the tops of which are at the same height. The regions of the studded plate between the elevations are planar.

[0016] In the first method step, the insulating regions will usually be arranged as islands of identical dimensions and often also in a fixed pattern, for example hexagonally, orthogonally or the like. The elevations which are ultimately formed in the studded plate are then arranged in the same pattern.

[0017] A convex surface part of a dyke of the screen layer more preferably comprises a part of a circle of constant radius, as a result of ideal growth of the first screen layer.

[0018] After the second continuous metal layer has been removed, the fourth and fifth steps of the method according to the invention described above can be repeated in order to produce a subsequent studded plate. The electroforming die with the screen layer of which the surface has been passivated is, however, fragile, and consequently there is a not inconsiderable risk of it being damaged.

[0019] To avoid this drawback, one provides for the production of a copy die for the production of a studded plate. This copy die comprises a plate with a top side which is provided with separate recesses, which recesses, as seen in section, comprise at least one convex surface part. These recesses correspond to the intended elevations in the studded plate. The underside of the copy die is generally planar. The method to this end comprises the steps of electrolytically depositing a metal layer on an electrically conductive plate with conductive separate elevations, which elevations, as seen in section, comprise at least one concave surface part, after which the deposited metal layer, as the copy die, is separated from the said plate. The said electrically conductive plate is preferably the product of the method in accordance with the first aspect of the invention. The copy die preferably also has recesses, of which the wall parts defining the recesses comprise a convex surface part as part of a circle of constant radius.

[0020] This copy die can then in turn be used to produce studded plates. For this purpose, a method for electroforming a studded plate of this type comprises the following steps: passivation of the surface of the copy die

obtained as above, followed by electrolytic deposition of a further metal layer on the passivated surface of the copy die, in such a manner that at least the recesses are filled and the passivated surface is completely covered, and separating the further metal layer, as the said studded plate, from the copy die. In this way, it is easy for the original die to be kept as a "master", while the actual production of the studded plates is carried out using a copy die.

[0021] As has already been explained above, the metal from which the screen layer, the continuous metal layer and the further metal layer are obtained may be any electroformable metal or metal alloy, in particular copper and preferably nickel. Suitable galvanic baths comprise nickel-containing or copper-containing baths. Controlling the bath composition allows the studded plate to be produced with a smooth surface or a rougher surface. By way of example, an undoped nickel bath, i.e. a nickel bath without brightener, can produce a rougher product compared to a product produced from a nickel bath doped with brightener.

[0022] A further aspect provides an electroforming die for producing a copy die, which comprises an electrically conductive plate having a top side provided with separate elevations, which elevations, as seen in section, have at least one concave surface part, and preferably a planar underside.

[0023] Yet another aspect relates to a copy die for producing a plate having a working side provided with separate elevations, which copy die comprises an electrically conductive plate having a top side provided with recesses, which recesses, as seen in section, comprise at least one convex surface part. The copy die can therefore be used as an electroforming die producing the said studded plates. Another use is for the injection-moulding or press-moulding of products made from plastic, in which case the studded plate is used as part of the mould.

[0024] One important difference compared to screen materials is that the studded plates according to the invention do not have any screen openings, but rather have a continuous surface.

[0025] The products are electroformed from an electroformable metal or metal alloy. The separate elevations or separate recesses are of virtually uniform height or depth, with a tolerance of the order of magnitude of one micrometre. The elevations or recesses can be arranged in a regular pattern, although an irregular (stochastic) pattern can also be used.

[0026] In a preferred embodiment, the insulating regions are circular in cross section. The result of this is that the elevations are of virtually ideal circular cross section at any height. Other cross sections, such as rectangular, triangular, hexagonal, elliptical, are also conceivable.

[0027] Preferably, the separate elevations are dots, advantageously dots having dimensions in the order of magnitude of e.g. about one to several tens of micrometres, more preferably spaced apart at a regular distance.

The relatively small dots spaced apart at regular intervals, provide a small contact area in comparison with for example linear ridges extending over the whole surface of a plate.

[0028] Another aspect of the invention relates to a conveyor surface as per claim 6 for conveying substrates, such as sheets of paper, the conveyor surface comprising a plate having a working side provided with separate elevations, which elevations, as seen in section, have at least one concave surface part.

[0029] The invention is explained below with reference to the appended drawings, wherein:

Figure 1 shows an example of an electroforming die with a regular pattern of insulating regions of photoresist;

Figure 2 shows an insulating photoresist island in detail;

Figure 3 shows an embodiment of a studded plate obtained using the electroforming die shown in Figure 1;

Figure 4 shows a detail of an elevation of the studded plate illustrated in Figure 3;

Figures 5-10 show a number of steps of a method according to the invention for the production of a studded plate; and

Figures 11-13 show a number of steps of a method according to the invention for the production of a copy die.

[0030] Figure 1 shows a planar electroforming die 10 on which insulating photoresist islands 12 with a circular cross section are arranged. The photoresist islands 12 are arranged in an orthogonal pattern. The section through the photoresist islands is, for example, in the range from 75 to 100 micrometres, for example 85 micrometres. The height of the photoresist islands is in the range from a few micrometres to about ten micrometres, for example 5 micrometres, while the distance between two adjacent photoresist islands of a basic form of the orthogonal pattern is of the order of magnitude of 150 to a few hundred micrometres, for example 200 micrometres.

[0031] Figure 2 shows a detail of a photoresist island 12 of this type, having a diameter d_r and a height h_r .

[0032] Figure 3 shows a plan view of the studded plate 20 which can be produced with the aid of the electroforming die 10 illustrated in Figures 1 and 2, as will be explained in more detail below. The elevations 22, indicated by dots in Figure 3, are arranged in a pattern which corresponds to the orthogonal pattern of the insulating regions 12 of the electroforming die 10 used.

[0033] Figure 4 shows an elevation 22 in detail. The elevation 22 has a circular base 24 and, as seen in section, a concave outer surface 26. This concave outer surface 26 describes part of a circle of constant radius r_p . The diameter d_t of the planar top 28 of the elevation 22 is, for example, 15 micrometres, for a base diameter of

85 micrometres and a height of 35 micrometres. In other words, growth radius r_p is likewise 35 micrometres.

[0034] Figures 5-10 show the steps involved in the production of a studded plate of this type by means of a preferred method according to the invention.

[0035] Figure 5 shows a plan view of part of an embodiment of an electroforming die 10. The electroforming die 10 comprises a planar plate 14 of electrically conductive material, on which circular regions 12 of insulating material, such as photoresist, are provided, i.e. in this embodiment the regions 12 form elevations of a low height on the plate 14.

[0036] Figure 6 shows the electroforming die 10 from Figure 5 in section.

[0037] The electroforming die 10 is connected as cathode in an electroplating bath, for example of nickel. When electric current is passed through the electroplating bath, first of all metal is deposited between the insulating regions 12 on the uncovered conductive tracks 16 of the electroforming die 10, and then the insulating regions 12 are also partly overgrown.

[0038] Figure 7 shows the electroforming die 10 with resist islands 12 and screen layer 18 deposited thereon. The screen layer 18 comprises a network of dykes 30 which delimit screen openings 32. The dykes 30 have partly grown over the insulating regions 12.

[0039] After the uncovered surface of the screen layer 18 has been passivated, metal, such as nickel, is once again deposited on top of the screen layer 18, with the electroforming die 10 with screen layer 18 being placed in an electroplating bath and connected as cathode. In this way, a continuous metal layer is formed as studded plate 20 on the screen layer 18, filling the screen openings 32 and covering the entire surface. This deposition is continued until the desired thickness has been reached, and generally a flat growth front has been formed. Cf. Fig. 8.

[0040] Fig. 9 shows this continuous metal layer in section as studded plate 20 with a planar underside 50, and with a working side 52 after it has been separated from the screen layer 18, while Figure 10 shows a plan view of this product. The elevations 22 are of the shape shown in detail in Fig. 4, with a concave surface 26.

[0041] Figures 11-13 show steps involved in producing a copy die using the product of Figure 9. After the studded plate 20 has been passivated, for example using chromium, metal is deposited in an galvanic bath, so that the recesses 38 between the elevations 22 in the product 20 are completely filled and also the elevations 22 themselves are covered. After separation, cf. Figure 13, an electrically conductive copy die 40 is obtained, the shape of the deposition surface 42 of this copy die 40, with recesses 44, corresponding to the deposition surface of the assembly of electroforming die, photoresist islands and screen layer, as illustrated in Figure 7. This copy die 40 can be used in the same way as the above-described assembly for the production of studded plates.

Claims

1. Method for electroforming a conveyor surface comprising a plate having a working side and a top side provided with separate elevations, which method comprises the steps of:

providing a flat conductive electroforming die (10) with insulating regions (12) that are separated from one another;
electrolytically depositing a screen layer (18), which comprises a network of dykes (30), which dykes (30) delimit screen openings (32), of metal on the electroforming die (10), the dykes (30), as seen in section, having at least one convex surface part;
passivating the uncovered surface of the screen layer (18);
electrolytically depositing a continuous metal layer (20) on the passivated surface of the screen layer (18), in such a manner that at least the screen openings (32) are filled and the passivated surface is completely covered, separating the continuous metal layer (20) having a working side (52) provided with separate elevations (22), which elevations, when seen in section, have at least one concave surface part (26), as the said plate, from the screen layer (18).

2. Method according to claim 1, in which a convex surface part comprises a part of a circle of constant radius.
3. Method according to one of the preceding claims, wherein the separate elevations, being structures that provide a small contact area, are dots.
4. Method according to one of the preceding claims, wherein the regions between the elevations are planar.
5. Method according to one of the preceding claims, in which the electrolytic deposition is carried out in a bath liquid which comprises nickel and brightener.
6. Conveyor surface for conveying substrates, such as sheets of paper, the conveyor surface comprising a plate having a working side (52) provided with separate elevations (22) being dots which elevations (22), as seen in section, have at least one concave outer surface part (26), wherein the conveyor surface is obtained by an electroforming method according to one of the preceding claims 1 to 5.

Patentansprüche

1. Verfahren zum Galvanoformen einer Fördererober-

fläche, die eine Platte mit einer Arbeitsseite und einer Oberseite aufweist, die über getrennte Erhebungen verfügen, wobei das Verfahren die Schritte umfasst:

- Bereitstellen einer flachen, leitenden Galvanoform-Form (10) mit isolierenden Bereichen (12), die voneinander getrennt sind;
elektrolytisches Abscheiden einer Schablonenschicht (18) aus Metall auf der Galvanoform-Form (10), die ein Netzwerk aus Dämmen (30) aufweist, deren Dämme Schablonenöffnungen (32) abgrenzen, wobei die Dämme (30) im Schnitt betrachtet mindestens einen konvexen Oberflächenteil aufweisen;
Passivieren der unbedeckten Oberfläche der Schablonenschicht (18);
elektrolytisches Abscheiden einer durchgängigen Metallschicht (20) auf der passivierten Oberfläche der Schablonenschicht (18), derart, dass zumindest die Schablonenöffnungen (32) gefüllt sind und die passivierte Oberfläche vollständig bedeckt ist; und
Abtrennen der durchgängigen Metallschicht (20), die eine mit getrennten Erhebungen (22) vorgesehene Arbeitsseite (52) aufweist, deren Erhebungen im Schnitt betrachtet mindestens einen konkaven Oberflächenteil (26) aufweist, als die obige Platte von der Schablonenschicht (18). 5 10 15 20 25 30
2. Verfahren nach Anspruch 1, wobei ein konvexer Oberflächenteil einen Teil eines Kreises mit konstantem Radius aufweist. 35
3. Verfahren nach einem der vorstehenden Ansprüche, wobei die getrennten Erhebungen die Strukturen sind, die über eine kleine Kontaktfläche verfügen, Punkte sind. 40
4. Verfahren nach einem der vorstehenden Ansprüche, wobei die Bereiche zwischen den Erhebungen eben sind. 45
5. Verfahren nach einem der vorstehenden Ansprüche, wobei das elektrolytische Abscheiden in einer Badflüssigkeit ausgeführt wird, die Nickel und Aufheller aufweist. 50
6. Fördereroberfläche zum Fördern von Substraten, wie z.B. Bögen von Papier, wobei die Fördereroberfläche eine Platte mit einer Arbeitsseite (52) aufweist, die Arbeitsseite (52) über getrennte Erhebungen (22) verfügt, die Punkte sind, deren Erhebungen (22) im Schnitt betrachtet mindestens einen konkaven äußeren Oberflächenteil (26) aufweisen, wobei die Fördereroberfläche durch ein Galvanoformungsverfahren gemäß einem der vorstehenden Ansprüche 1 bis 5 erhalten ist. 55

Revendications

1. Procédé d'électroformage d'une surface de transporteur comprenant une plaque présentant un côté de travail et un côté supérieur pourvu d'élévations séparées, lequel procédé comprend les étapes consistant à :
fournir une matrice d'électroformage conductrice plate (10) avec des régions d'isolation (12) qui sont séparées les unes des autres ;
déposer électrolytiquement une couche de tamis (18), qui comprend un réseau de digues (30), lesquelles digues (30) délimitent des ouvertures de tamis (32), de métal sur la matrice d'électroformage (10), les digues (30), telles qu'observées en coupe, présentant au moins une partie de surface convexe ;
passiver la surface non couverte de la couche de tamis (18) ;
déposer électrolytiquement une couche de métal continue (20) sur la surface passivée de la couche de tamis (18), de sorte qu'au moins les ouvertures de tamis (32) soient remplies et que la surface passivée soit complètement couverte, séparer la couche de métal continue (20) présentant un côté de travail (52) pourvu d'élévations séparées (22), lesquelles élévations, telles qu'observées en coupe, présentent au moins une partie de surface concave (26), en tant que dite plaque, à partir de la couche de tamis (18). 5 10 15 20 25 30
2. Procédé selon la revendication 1, dans lequel une partie de surface convexe comprend une partie d'un cercle de rayon constant. 35
3. Procédé selon l'une des revendications précédentes, dans lequel les élévations séparées, qui sont des structures qui fournissent une petite zone de contact, sont des points. 40
4. Procédé selon l'une des revendications précédentes, dans lequel les régions entre les élévations sont planes. 45
5. Procédé selon l'une des revendications précédentes, dans lequel le dépôt électrolytique est réalisé dans un bain de liquide qui comprend du nickel et un azurant optique. 50
6. Surface de transporteur permettant de transporter de substrats, tels que des feuilles de papier, la surface de transporteur comprenant une plaque présentant un côté de travail (52) pourvu d'élévations séparées (22) qui sont des points, lesquelles élévations (22), telles qu'observées en coupe, présentent au moins une partie de surface externe concave (26), dans laquelle la surface de transporteur est ob-

tenue par un procédé d'électroformage selon l'une
des revendications précédentes 1 à 5.

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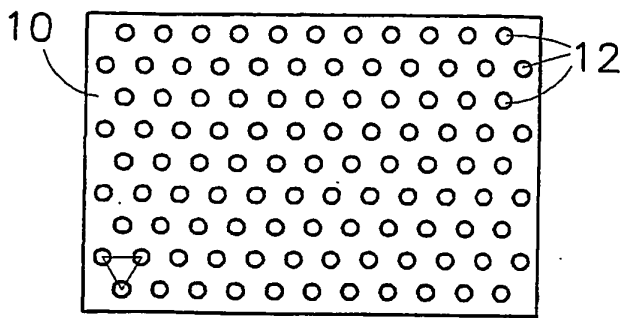


Fig 1

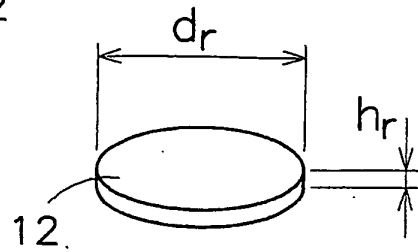


Fig 2

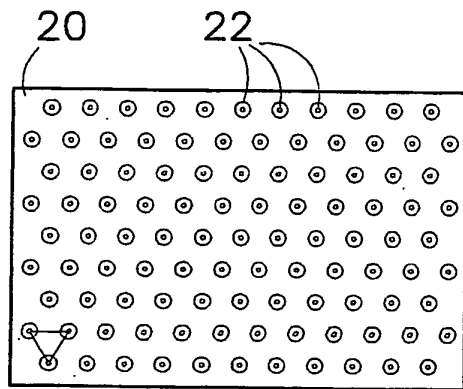


Fig 3

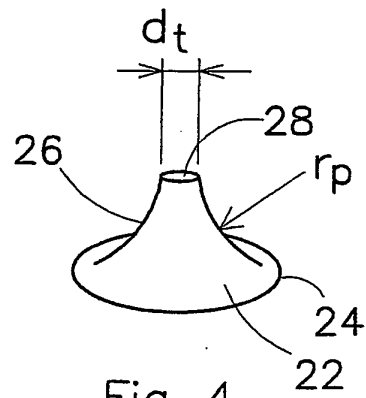


Fig 4

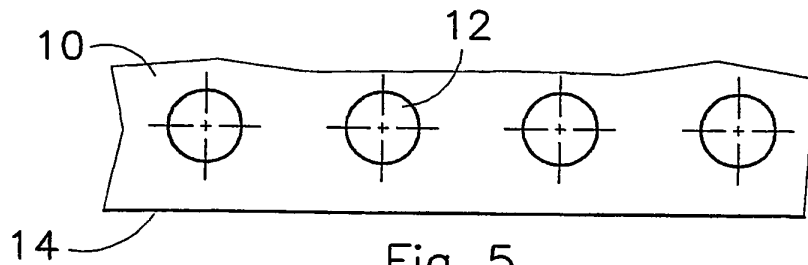


Fig 5

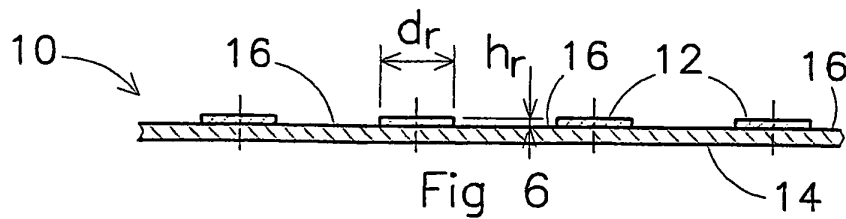


Fig 6

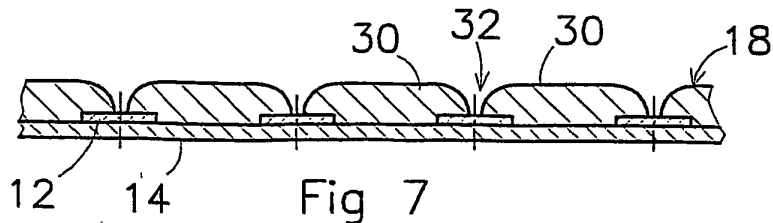
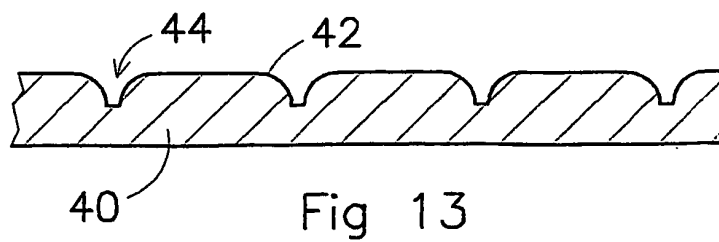
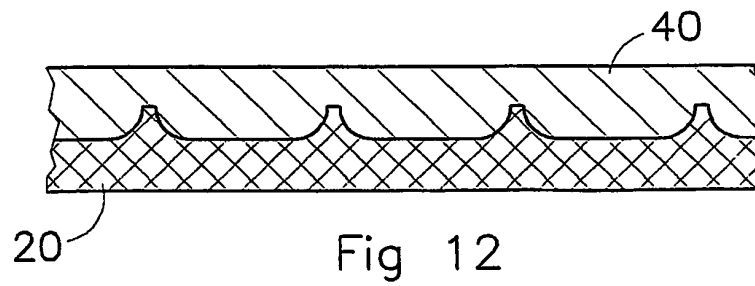
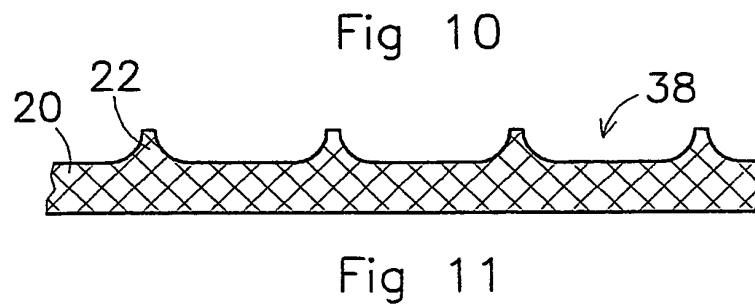
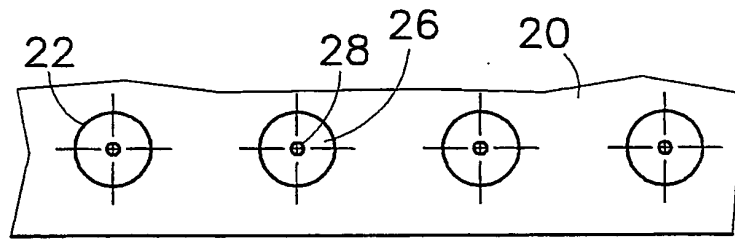
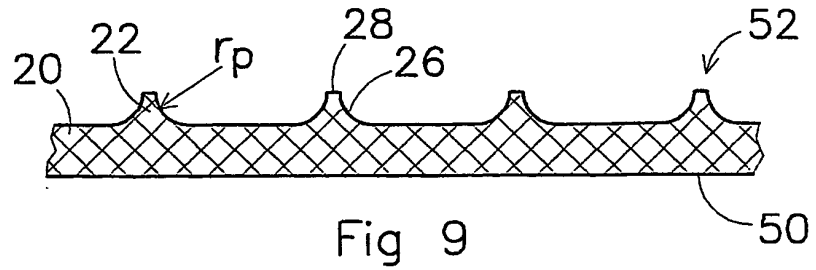
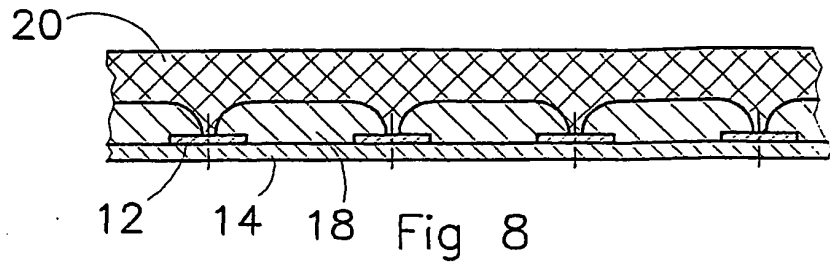


Fig 7



REFERENCES CITED IN THE DESCRIPTION

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