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(54) Wear-resistant screen product and method for manufacturing thereof.

(57) A screen product is described which consists of metal and in which a plurality of perforations (1) are present which are separated from each other by metal (2); the screen product comprises two planes (6, 7) which are essentially parallel to one another. In order to, on the one hand, make the screen product resistant against mechanical wear effects and, on the other hand, impart to it excellent adhesion for photoresists applied in pattern-forming, that side (7) of the screen product, which comes into contact with a squeegee to be used in screen printing, is clad with a wear-resistant layer (4), while the metal in or near the plane (6) opposite thereof remains free of such wear-resistant material.

There is also described a method for manufacturing such a screen product which therefore, on one side, comprises a wear-resistant layer (4) and on the other side is free of such a layer.

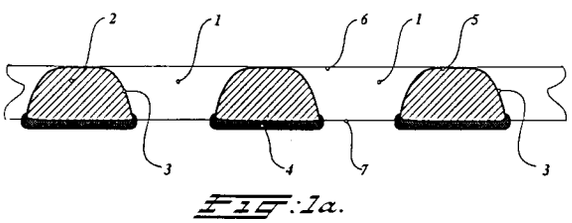

Fig. 1a.

EP 0 603 966 A1

The invention relates to a screen product comprising a plurality of perforations which are separated from one another by metal, the metal which surrounds the perforations defining two planes which are essentially parallel to one another, and each of the perforations extending from the one to the other of the two planes, while each of the perforations has a side wall in common with the metal of the screen product.

A screen product of this type is disclosed, for example, by the American Patent publication, US-A-2,226,384. In many cases, a screen product of this type is manufactured from nickel which is deposited by electroplating.

A nickel screen product of this type is widely used, for example, in flat-screen printing or rotary-screen printing. To this end, the screen material is provided, in a known manner and with the use of a photoresist composition, with a sealing pattern, leaving free the perforations through which in a printing process printing paste is conveyed by means of a squeegee from the one side of the screen product to the other side thereof and there is deposited on a substrate material which is in contact with the screen product.

A screen product of this type should have such a surface quality that the photosensitive materials employed have excellent adhesion on that side of the screen product which is in contact with the material to be printed. In the conventional screen products such adhesion is excellent in the case of the conventional photosensitive materials.

Such a conventional screen product has the drawback that, in contact with the squeegee means commonly used in the screen-printing industry, it has a tendency to wear which is related to the difference in hardness between the frequently employed squeegee means (for example stainless steel), and the material of the screen product (for example nickel).

Said wear phenomenon may in some cases manifest itself as a local colouration of the printing paste and thus become visible in the printed image.

The object of the present invention is to provide a solution for said wear problem, which solution, however, at the same time retains the capability of providing adequate adhesion for the photoresist materials employed. To this end, the screen product according to the present invention is characterized in that the metal in or near one of the two planes parallel to one another is masked with a layer of a wear-resistant material and said wear-resistant material extends, over the side wall of each of the perforations, at most as far as the other of the two planes parallel to one another.

It was found that a screen product which is provided at one side (especially the side in contact with the squeegee means) with a wear-resistant material and in which the other side of the screen material is free of such a material, provides a product which, on the one hand, shows excellent wear resistance on the squeegee side and, on the other hand, has excellent adhesion capability for the conventionally used photoresists.

Within the meaning of wear-resistant materials are included materials which have not only a good mechanical resistance as well as materials having a good chemical resistance (especially against the print media used) or materials showing both properties, i.e. wear-resistance and corrosion resistance.

It will be understood that within the scope of the invention furthermore materials having a good wear-resistance and an excellent adhesion capability can be employed.

In the above, mention has been made, by way of example, of a screen product made of nickel; other metals are obviously also possible, and the following may be mentioned: copper, iron and alloys of such materials.

As indicated earlier, the screen product can be used in both flat- and rotary-screen printing. In the case of rotary-screen printing, the wear-resistant layer should in each case be located on the inside of the seamless cylindrical metal screen such as, for example, a nickel stencil. The screen materials may be of varying fineness; frequently used finenesses are from 50 to 500 mesh (the mesh number indicates the number of holes per lineal inch equal to 25.4 mm); other finenesses are not excluded. The thickness of such a screen product may vary from 50 micrometres to 300 micrometres; usual thicknesses are from 150 to 250 micrometres. In particular, the wear-resistant material is chosen from metallic and ceramic material.

Examples of metallic materials which may be mentioned are: metals or metal alloys such as chromium, tin-nickel and tungsten. Ceramic wear-resistant materials which may be mentioned are silicon carbide, tungsten carbide, titanium nitride, tin oxide and boron nitride.

If desired other suitable wear-resistant materials may be employed. Examples thereof include various polymer materials, like rubbers, or other organic coatings.

The various wear-resistant materials are applied, depending on their nature, by electroplating or vacuum techniques; of the latter, vapour deposition, cathode sputtering, plasma spraying and the like may be mentioned.

The polymer materials can, for example, be applied by conventional electrostatic or electrophoretic coating techniques.

The invention further relates to a screen product comprising a plurality of perforations which are

separated from one another by metal, the metal which surrounds the perforations defining two planes which are essentially parallel to one another, and each of the perforations extending from the one to the other of the two planes, while each of the perforations has a side wall in common with the metal of the screen product, characterized in that the metal over both parallel planes and the side wall of each of the perforations is provided with a cladding layer of wear-resistant material and then a chosen plane and, if required, a portion of the side wall of each perforation emanating from that plane is provided with a coating layer of material having good adhesion properties.

Such a screen product will show all characteristics of the screen product mentioned above.

Throughout the specification a cladding layer is to be understood as a coating layer of metal, plastic material, rubber material, ceramic or any other material which provides the screen product with a wear resistant character; wear-resistance in this case should be understood to comprise also corrosion resistance.

The invention furthermore relates to a method for making wear-resistant a screen product comprising a plurality of perforations which are separated from one another by metal, the metal which surrounds the perforations defining two planes which are essentially parallel to one another, and each of the perforations extending from the one to the other of the two planes, while each of the perforations has a side wall in common with the metal of the screen product, and in which one of the parallel planes and, if required, a portion of the side wall of each perforation emanating from that plane is provided with a cladding layer of wear-resistant material.

In the method according to the invention, a layer of wear-resistant material is therefore deposited on one of the two planes, which are essentially parallel to one another, of the screen product while leaving free the other plane of the screen product; if required, a portion of the side wall of each of the perforations may likewise be provided with a cladding layer.

On the one hand, the wear-resistant material can be deposited on a plane while the other plane of the screen product and, if required, a portion of the side wall of each of the perforations, emanating from that other plane, of the side wall of each of the perforations is shielded.

On the other hand, the wear-resistant material can be applied to the screen product in a completely enveloping manner, whereafter the wear-resistant material is removed selectively from that plane of the screen product which is to remain free of said wear-resistant material.

The techniques available for applying the wear-resistant material are, in general, electroplating or vacuum application techniques, while any removal, if required, of the wear-resistant material from a portion of the screen product can be carried out by etching or by machining such as grinding or abrading. Finally, according to claim 10 the screen product, in a first step, can also be clad on all sides (i.e. including the side walls of each perforation) with a wear-resistant material, followed by applying, to one plane and, if required, a portion, emanating from that plane, of the side wall of each perforation emanating from that plane, a material which has good adhesion for a medium to be applied later, such as photoresist. A cladding on all sides with chromium may, for example, be partly masked with adhering copper in order to provide a good resist base there locally.

The invention will now be described in more detail with reference to the schematic drawing in which:

- Figure 1A shows, in cross-section, a portion of a screen product which in one plane is provided with a wear-resistant coating,
- Figure 1B is a cross section of a dam between two perforations of a screen product of a second type according to the invention,
- Figure 1C shows, in cross section, another embodiment of a screen product of the second type,
- Figure 1D is a cross section of a dam between two perforations of a screen product of still another type according to the invention,
- Figure 2 shows, diagrammatically, a set-up for removing, by means of etching, a portion of a wear-resistant cladding, applied on all sides, of a previously formed cylindrical screen product by means of etching;
- Figure 3 shows a set-up as in Figure 2, for a flat screen product;
- Figure 4 shows a set-up for plating a cylindrical screen product on the inside.

Figure 1A shows, in diagrammatic form, a section in which the perforations of the screen product are designated by 1 and the metal surrounding the perforations is indicated by 2. The side wall of each of the perforations is designated by 3, while 4 indicates a wear-resistant cladding mainly disposed in the plane 7. The other plane 6, which is defined by the portions 5 of the screen product, is left free of wear-resistant coating. It can be seen that the wear-resistant coating 4 extends, over a short distance, across the side wall 3 of each of the perforations.

Figure 1B shows schematically a second embodiment of the screen product of the invention. For convenience only one dam is shown in this figure. The base metal 2 is provided with a wear-

resistant cladding over the whole surface. On the convex-side a layer material 8 having good adhesion properties is deposited.

Figure 1C shows diagrammatically another embodiment of the screen product of the invention. As in figure 1B the base metal is clad with a wear-resistant material, for example chromium, over the surface thereof. Instead of providing a layer material having good adhesion properties the chromium layer 4 is locally, on the convex side of the base metal, converted into a chromate layer 8 using any suitable method. The chromate layer 8 has excellent properties as required for adhesion of photoresists.

In figure 1D still another embodiment of the screen product according to the invention is shown, wherein the surface of the chromium layer 4 is totally converted to a certain depth thereof into a chromate layer 8. When using such a screen product the chromate layer 8 upon coming into contact with a squeegee will rapidly wear away, usually within a few strokes in flat-screen printing or a few rotations in rotary-screen printing, so that afterwards the underlying wear-resistant layer will come in contact with the squeegee, while on the other side the chromate layer 8 with good adhesion capability is present for adhesion enhancement of a photoresist pattern (not shown) which was formed in a separate step.

Figure 2 indicates diagrammatically that a screen product 20 is subjected to a selective etching operation whose purpose is to remove a wear-resistant cladding, which in an earlier operation had been applied on all sides to the screen product, from the outside of the cylindrical screen product 20. In order to provide for the selective etching operation, a rubber bag 21, which is attached to flanges 24 and 25 which are arranged on a shaft 22, is brought to bear against the inside of the cylindrical seamless screen product 20 and, by means of a valve (not shown) in one of the flanges, is pressurized with gas, so that an intimate contact is achieved between the rubber bag 21 and the inside of the screen product 20. The assembly thus formed can be introduced into a conventional etching bath or possibly a gas etching device, in order to be subjected to an etching operation in which a previously applied wear-resistant layer is removed selectively from the outer face of the cylindrical material as well as from the side walls which bound the perforations, as far as the inner surface of the screen material which bears against the wall of the rubber bag. The etching operation will in general be carried out by means of an etchant which is able to dissolve the wear-resistant material; in the case of chromium, use will as a rule be made on iron chloride, hydrochloric acid, sulphuric acid; lye (electrolytic etching). Etching in the case of the last-mentioned three etchants is essentially material-selective, in the case of a chromium layer on a nickel base, for example, the chromium being etched away.

Figure 3 shows a situation wherein the screen product 30 is a flat screen product; the roller 31 indicated diagrammatically, with a lining of rubber or another flexible plastic material 32, has the same function as the rubber bag 21 from Figure 2. Reference number 33 indicates diagrammatically a bath containing etching fluid, while the etching fluid is designated with 34. The assembly of screen product 30 and roller 31 with the flexible coating 32 is submerged in the etching fluid 34 in such a way that sufficient submersion depth below the liquid surface 35 is obtained. The material 30 to be etched selectively, which is thus provided with a wear-resistant, completely enveloping layer (not shown) is kept in intimate contact with the flexible layer 32 of the roller 31; if required, the screen material can be unwound from a magazine roll (not shown) and, with synchronous rotation of the roller 31, etched in the bath 34 and can be wound up again on a reel on the other side. During submersion and etching, the screen material 30 bears on the lining 32 under tension.

The set-up shown in Figure 3 is also eminently usable for selective plating of a screen product to be provided locally with a wear-resistant layer, by inverting the screen product in the situation shown in Figure 3, so that the convex side of the dams comes to be in intimate contact with the flexible layer 32. By connecting the metal screen product as the cathode and arranging a suitable anode in the bath 33, while the fluid 34 is a metal bath fluid, it is possible to provide, on one side of the screen product (here the plane defined by the set of the non-convex locations of the metal) with a suitable wear-resistant layer such as made of chromium, phosphor nickel, tin-nickel or tungsten.

In order to plate a seamless or seam comprising cylindrical screen material, as shown diagrammatically in Figure 2, selectively on the inside of the cylinder, a set-up can be employed which is similar to the set-up from Figure 3, a plating bath being placed within the circumference of the cylinder and a roller 41 lined with rubber or another soft plastic being in intimate contact with the screen product 40, in order to ensure, during the plating process in the bath 46, shielding of the outside of the cylindrical material 40. Guidance of the screen material is ensured by the guide rollers 42 to 45.

In a specific illustrative embodiment, a cylindrical seamless screen product consisting of nickel and having a circumference of approximately 64 centimetres and a fineness of 150 mesh (= 150 perforations per lineal inch) was provided on the

inside with a chromium cladding having a thickness of from 0.5 to 15 micrometres, in particular from 3.0 to 6.0 micrometres. The use of such a stencil which on the inside is provided with a wear-resistant layer, for rotary-screen printing, led to a considerably improved useful life of the stencil and to the complete absence of undesirable colouration of the printing paste used and thus to the absence of undesirable streaks in the printed image.

In the figures 2, 3 and 4 discussed hereinabove, masking of portions not to be etched or to be plated is accomplished in a mechanical manner. Naturally masking can also be accomplished using special masking layers made of organic coatings and, in particular, with suitable etch resists and plate resists. The known photoresists can likewise be used effectively for this purpose.

Where, in the above, mention was made of cladding with a layer of metal such as chromium, it is to be understood that, for adhesion purposes, a thin copper layer is often applied to the screen product made of, for example, nickel, before the chromium layer is deposited. A thin copper layer furthermore has a function as a barrier layer against diffusion of hydrogen to the base metal, e.g. Ni, during the application of a chromium layer or similar wear-resistant electroplated layer. Such adhesion layers may also be advantageous for other layers to be applied.

Claims

1. Screen product comprising a plurality of perforations (1) which are separated from one another by metal (2), the metal (2) which surrounds the perforations (1) defining two planes (6, 7) which are essentially parallel to one another, and each of the perforations (1) extending from the one (6) to the other (7) of the two planes (6, 7), while each of the perforations (1) has a side wall (3) in common with the metal (2) of the screen product, characterized in that the metal in or near one of the two planes (6, 7) parallel to one another is masked with a layer (4) of a wear-resistant material and said wear-resistant material extends, over the side wall (3) of each of the perforations (1), at most as far as the other (6) of the two planes (6, 7) parallel to one another.

2. Screen product according to claim 1, characterized in that the wear-resistant material is chosen from metallic and ceramic material.

3. Screen product according to claim 1 and 2, characterized in that the wear-resistant material is chosen from metals or metal alloys such as chromium, tin-nickel and tungsten.

4. Screen product according to claim 1 and 2, characterized in that the wear-resistant material is chosen from ceramic material such as silicon carbide, tungsten carbide, titanium nitride, tin oxide, boron nitride, aluminium oxide and chromium aluminium nitride.

5. Screen product comprising a plurality of perforations (1) which are separated from one another by metal (2), the metal (2) which surrounds the perforations (1) defining two planes (6, 7) which are essentially parallel to one another, and each of the perforations (1) extending from the one (6) to the other (7) of the two planes (6, 7), while each of the perforations (1) has a side wall (3) in common with the metal (2) of the screen product, characterized in that the metal over both parallel planes (6, 7) and the side wall (3) of each of the perforations (1) is provided with a cladding layer (4) of wear-resistant material and a chosen plane (6) and, if required, a portion of the side wall (3) of each perforation (1) emanating from that plane is provided with a coating layer (8) of material having good adhesion properties.

6. Screen product comprising a plurality of perforations (1) which are separated from one another by metal (2), the metal (2) which surrounds the perforations (1) defining two planes (6, 7) which are essentially parallel to one another, and each of the perforations (1) extending from the one (6) to the other (7) of the two planes (6, 7), while each of the perforations (1) has a side wall (3) in common with the metal (2) of the screen product, characterized in that the metal over both parallel planes (6, 7) and the side wall (3) of each of the perforations (1) is provided with a cladding layer (4) of wear-resistant material and each of the parallel planes (6, 7) and, if required, the side wall (3) of each perforation (7) or a portion thereof is provided with a coating layer (8) of material having good adhesion properties.

7. Method for making wear-resistant a screen product comprising a plurality of perforations (1) which are separated from one another by metal (2), the metal (2) which surrounds the perforations (1) defining two planes (6, 7) which are essentially parallel to one another, and each of the perforations (1) extending from the one (6) to the other (7) of the two planes (6, 7), while each of the perforations (1) has a side wall (3) in common with the metal (2) of the screen product, and in which one of the parallel planes (7) and, if required, a portion of

the side wall (3) of each perforation (1) emanating from that plane (7) is provided with a cladding layer (4) of wear-resistant material.

8. Method according to claim 7, characterized in that
the wear-resistant material is deposited by coating on the relative plane (7) while the other plane (6) and, if required, a portion of the side wall (3) of each of the perforations (1) emanating from that other plane (6) is shielded.

9. Method according to claim 7, characterized in that
the wear-resistant material is deposited on both planes (6, 7) as well as on the side wall (3) of each of the perforations (1), while this material is then removed selectively from that plane (6) and from that portion of the side wall (3) of each of the perforations (1) which must remain free of the cladding of wear-resistant material.

10. Method according to claim 8 or 9, characterized in that the wear-resistant material is deposited by means of electroplating or vacuum application techniques and that any removal is carried out by etching.

11. Method for making wear-resistant a screen product comprising a plurality of perforations (1) which are separated from one another by metal (2), the metal (2) which surrounds the perforations (1) defining two planes (6,7) which are essentially parallel to one another, and each of the perforations (1) extending from the one (6) to the other (7) of the two planes (6, 7), while each of the perforations (1) has a side wall (3) in common with the metal (2) of the screen product, characterized in that the screen product is provided, over both parallel planes (6, 7) and the side wall (3) of each of the perforations, with a cladding layer (4) of wear-resistant material and then a chosen plane (6) and, if required, a portion of the side wall (3) of each perforation emanating from that plane (6) is provided with a coating layer (8) of material having good adhesion properties.

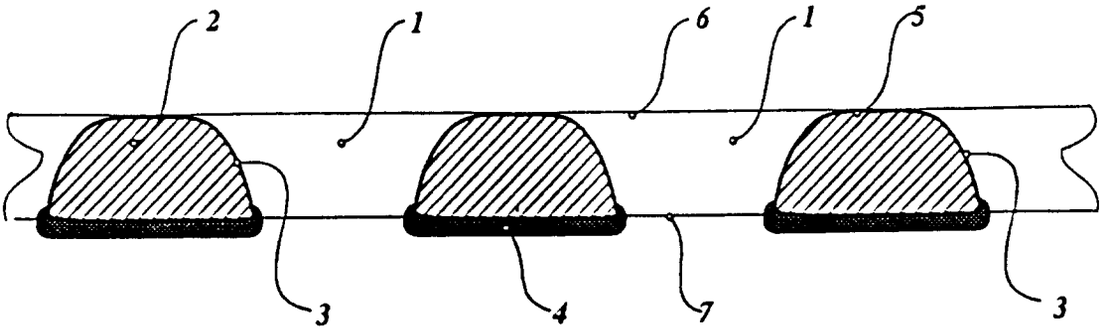

Fig.1a.

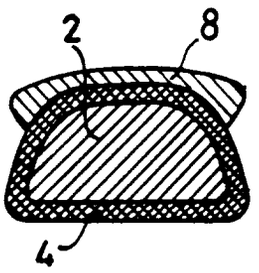

Fig.1b.

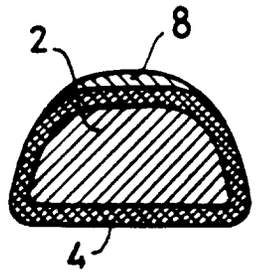

Fig.1c.

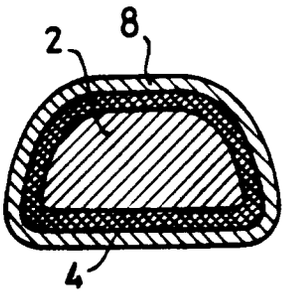

Fig.1d.

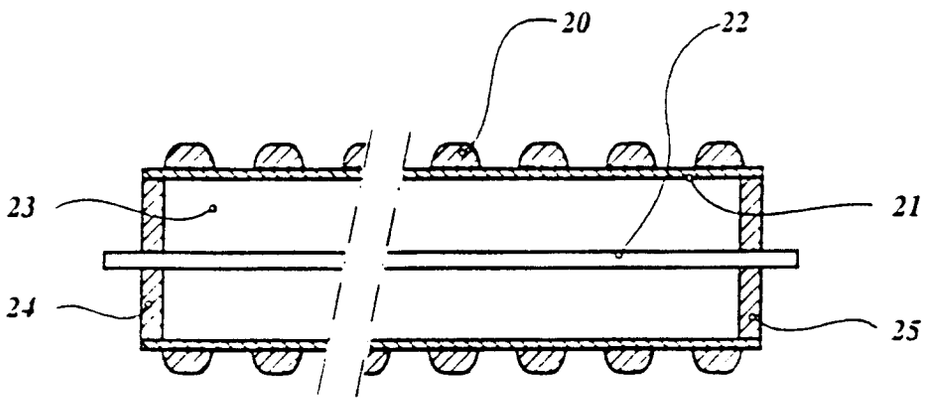

Fig.2.

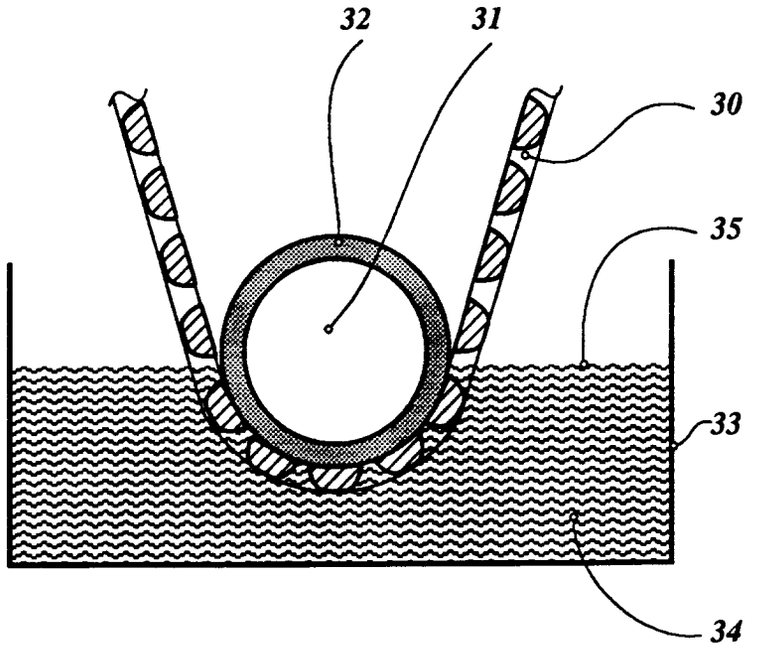

Fig. 3.

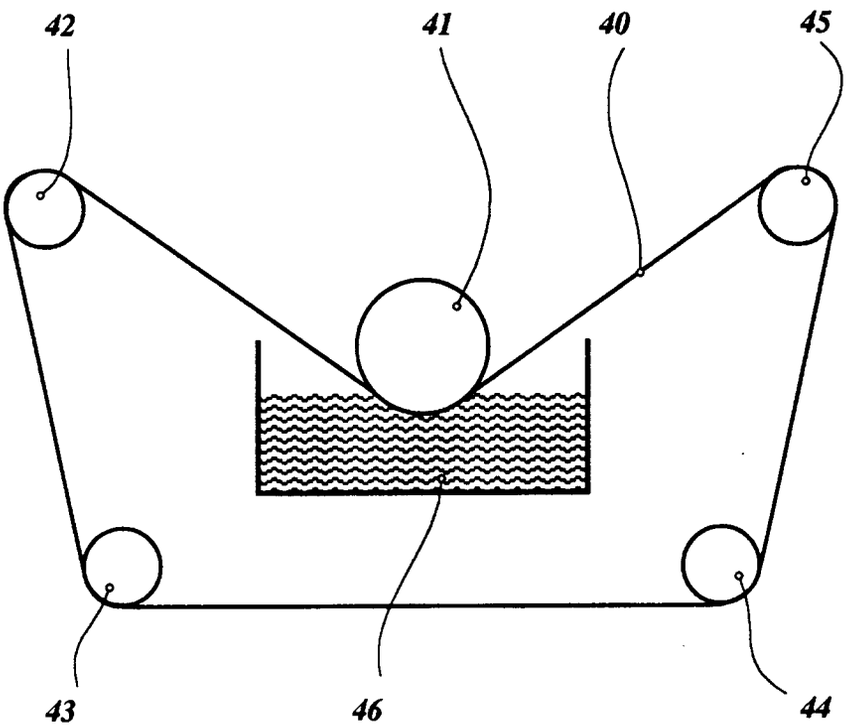

Fig. 4.

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EUROPEAN SEARCH REPORT

Application Number
EP 93 20 3599

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	EP-A-0 252 545 (STORK SCREENS B.V.) * claims *	1-3,5-9	B41C1/14 C25D1/08
X	EP-A-0 049 022 (VECO BEHEER B.V.) * page 4, line 25 - line 27; claims; figures 4-10 *	1-3,5-9	
A	EP-A-0 110 463 (STORK SCRENS B.V.) * page 3, line 7 - line 21; claims *	1-9	
A	DE-A-25 44 603 (KABEL- UNF METALWERKE GUTEHOFFNUNGSHÜTTE AG.) * page 6, line 2 - line 15 *	1-9	
A	WO-A-91 13762 (STORK SCREENS B.V.) * page 5, line 15 - line 31; claims *	3,4,8	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

B41C
C25D
B41N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18 March 1994	Rasschaert, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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