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(54) Title: METHOD OF PRODUCING NONWOVEN FABRICS (57) Abstract A method of forming apertured webs is provided comprising the steps of: a) forming a foraminous member comprising gross foramina and fine foramina wherein the gross foramina define a patterned design superimposed on the fine foramina by means of applying and curing a photosensitive resin onto a foraminous element comprising fine foramina in order to form elevated portions on the fine foramina defining the gross foramina; b) providing a layer of fibers on said foraminous member; and c) applying fluid streams to said layer of fibers such that the fibers are randomly entangled in regions interconnected by fibers extending between adjacent entangled regions in a pattern determined by the pattern of the gross foramina of the foraminous member to form an apertured web.		

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METHOD OF PRODUCING NONWOVEN FABRICS

BACKGROUND OF THE INVENTION

The present invention relates to methods of producing nonwoven fabrics
10 generally, and more specifically to improved methods of producing apertured webs having a patterned design by means of a hydroentanglement process.

A variety of methods for producing apertured webs are known in the art. According to some methods air or liquid streams are employed to deposit fibers on a web surrounding solid protuberances which are used create apertures in the fibrous
15 web. Kalwaites, U.S. Patent No. 2,862,251 relates to hydroentanglement methods for production of nonwoven products wherein the application of fluid forces rearranges a layer of fibrous material, such as a web of fibers into a foraminous unitary nonwoven fabric structure comprising spaced, interconnected packed fibrous portions of the starting material, and openings arranged in a predetermined pattern
20 which are separated by the interconnected packed portions. Specifically, a layer of fibrous material such rayon or cotton fibers is positioned between rigid means defining spaced apertures arranged in a pattern such as an apertured plate and tensioned flexible means defining foramina smaller than the apertures such as a fine woven screen. According to one embodiment, the impingement of fluid projected
25 from fluid jets through the apertured plate onto the fibrous layer displaces the fibers laterally away from the apertures to form an apertured nonwoven fabric having apertures corresponding with the apertures of the apertured plate.

Griswold, U.S. Patent No. 3,025,585 discloses hydroentanglement processes wherein a layer of irregularly arranged fibers is placed upon the free ends of a group
30 of tapered projections arranged in a predetermined pattern upon a permeable backing member with interconnected fiber accumulating spaces between them. Streams of water are then directed against the layer and the fibers are deflected to produce a nonwoven fabric having apertures corresponding to the tapered projections. According to some embodiments of this invention, the tapered projections are
35 attached to a permeable screen. According to other embodiments a single wire of a woven wire screen forms tapered projections as it passes over and under successive cross wires. Variations upon these embodiments utilizing woven screens are widely used in hydroentanglement procedures for use in production of nonwovens.

Evans, U.S. Patent No. 3,485,706 discloses a nonwoven fabric having a
40 pattern of apertures produced by a hydroentanglement process wherein fibers are deposited on an apertured patterning member such as a fine-wire screen or

5 perforated plate and liquid is jetted at high pressure onto the fibrous layer to entangle the fibers in a pattern determined by the supporting member. The patent further discloses use of patterning members having apertures of random location, size and/or shape for production of non-woven fabrics which do not have regular patterns. Such patterning members are prepared by bonding grains of sand of varying sizes and
10 shapes together so as to leave apertures between the grains. The patent further discloses treating a screen with resin to provide an arrangement of raised lines, filled holes or partially-filled holes, which may be non-repeating for a considerable distance or completely random.

Disclosures of other types of hydroentanglement processes include those of
15 Gilmore et al., European Patent Application Publication No. 418,493 which relates to a nonwoven fabric which is produced by directing high velocity jet streams of water onto a web of fibers using a perforated drum as an aperturing member. The drum can be a cylinder having predetermined diameter and length with a repeating pattern of projections and a plurality of perforations for drainage. The projections
20 are configured such that apertures may be formed in the web of fibers with high efficiency and the nonwoven fabric may be readily peeled off.

Phillips et al., U.S. Patent No. 5,204,158 disclose an irregularly patterned nonwoven fabric. According to the method of producing the fabric, a fibrous web is caused to be displaced out of registry with the forming member between fluid
25 impacts by hydroentanglement jets.

Despite the variety of hydroentanglement processes known to the art the processes are typically limited in one manner or another such as by cost, poor bonding, lack of aperture clarity and the like. Methods for production of hydroentanglement fiber webs involving metal rollers with projections as
30 impingement substrates are limited in that the projections must be tapered thus limiting the size/spacing combinations possible. Moreover, certain complex apertured nonwoven designs may be impractical given current machining capabilities. Hydroentanglement processes making use of conventional woven screens are limited by both the patterns and surface topography of the woven filaments. Because the
35 raised "knuckles" on woven screens are not sharply defined the definition of the resulting apertures is similarly and further degraded. In addition, the utility of conventional filament and filament-type screens is limited with respect to the patterns which can be generated. Specifically, when using woven filament screens, aperture size, distance between apertures and total open area of the apertures are dependent
40 variables. This is because thicker filaments or wires result in increased aperture size,

5 but also result in increased distance between individual apertures and a net decrease in aperture area in the resulting nonwoven web.

Accordingly, there remains a desire in the art for efficient methods of producing apertured nonwoven materials characterized by improved flexibility in aperture patterning including increased aperture size and area. Apertured webs
10 characterized by the combination of large closely spaced apertures would prove useful as topsheets in absorbent articles in providing for rapid fluid transfer of materials such as runny bowel movements. Runny bowel movement leakage in baby diapers represents a specific problem in the baby diaper art. The problem is particularly significant in the smaller sizes. Accordingly, there exists a need in the art
15 for improved methods of producing apertured webs by means of hydroentanglement processes.

Of interest to the present invention are the disclosures of Johnson et al., U.S. Patent No. 4,514,345, Smurkoski et al., U.S. Patent No. 5,098,522 and Trokhan, U.S. Patents Nos. 4,528,239 and 5,245,025 which disclose methods for making
20 foraminous members, the foramina of which form a preselected pattern. The Johnson patent generally discloses taking a foraminous element such as a screen and using photosensitive resins to construct about and in the foraminous element a solid, polymeric framework which delineates the preselected pattern of gross foramina. Specifically, the method comprises supplying three solid, usually planar, usually
25 continuous materials; a foraminous element such as a woven screen; a backing film such as a thermoplastic sheet; and a mask provided with transparent and opaque regions, the opaque regions of which define the desired, preselected pattern of gross foramina. A fourth material is a liquid photosensitive resin which cures under the influence of light of a particular activating wavelength to form a relatively insoluble,
30 relatively durable, polymeric solid. A coating of the liquid photosensitive resin is applied to the foraminous element, the mask is juxtaposed in contacting relation with the surface of the liquid photosensitive resin and the resin is exposed through the mask to light of an activating wavelength. Curing, as evidenced by solidification of the resin, is induced in those regions of the coating which are exposed to the
35 activating light. Following exposure to light, the backing film and the mask are stripped away from the composite comprising the foraminous element and the resin. Finally, the uncured, still liquid photosensitive resin is removed from the composite by washing leaving behind the desired foraminous member the gross foramina of which define the desired preselected pattern. The patent discloses that the
40 foraminous member produced by the process of the invention may be used in the production of an improved paper web utilizing a Fourdiner Wire paper making

5 apparatus such that the paper making fibers in the embryonic paper web are deflected into the gross foramina of the foraminous member and the resulting paper web is a continuous web characterized by a plurality of protuberances. Of interest is the disclosure in Fig. 4 of the Johnson patent of a "negative" foraminous pattern defined by discontinuous cured resin forms.

10

SUMMARY OF THE INVENTION

The present invention relates to improved methods of producing nonwoven apertured webs using a hydroentanglement process whereby fibers are applied to a foraminous member having a patterned design and fluid streams are applied to entangle the fibers and form a hydroentangled web. Specifically, the method comprises the steps of (a) forming a foraminous member comprising gross foramina and fine foramina wherein the gross foramina define a patterned design superimposed on the fine foramina. The foraminous member is formed by means of applying a photosensitive resin onto a foraminous element comprising fine foramina, curing the photosensitive resin by photoactivation in a pattern selected such that the cured resin forms solid elevated portions on said fine foramina defining the gross foramina, and removing all uncured photosensitive resin from the foraminous member. The method further comprises the steps of (b) providing a layer of fibers on the foraminous member; and (c) applying fluid hydroentanglement streams to the layer of fibers such that the fibers are randomly entangled in regions interconnected by fibers extending between adjacent entangled regions in a pattern determined by the pattern of the gross foramina of the foraminous member to form an apertured web.

According to preferred methods of the invention, the apertured web is produced from polyester fibers. Such fibers preferably have a cut length between about 0.5 and about 1.0 inches and are applied at a basis weight between about 15 and about 100 grams per square yard.

The use of a foraminous member having gross foramina in a patterned design produced by means of curing a photo-polymerized resin provides the advantages of selection of a wide variety of custom designed aperture patterns and use of foraminous members having sharply defined edges defining the gross foramina. The ability to more precisely define the edges of the gross foramina allows for the production of apertures having extremely fine resolutions. The ability to custom design aperture patterns avoids the limitations of woven screens wherein aperture sizes, spacings and total aperture area were dependent variables. The use of foraminous members produced by curing of photosensitive resins in selected patterns allows formation of apertured webs having any combination of aperture sizes,

5 shapes, and patterns limited only by the functional demands of the products in which the apertured webs are used. The ability to provide apertured webs having larger, and more closely spaced apertures than could be produced by means of hydroentanglement processes utilizing woven screens is of particular value in the production of absorbent articles such as diapers and other sanitary products where
10 there exists a desire to provide an absorbent article topsheet allowing for rapid fluid transfer to absorbent layers within the article.

Numerous additional aspects and advantages of the invention will become apparent to those skilled in the art upon consideration of the following detailed description of the invention which describes presently preferred embodiments
15 thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 depicts a foraminous member used according to the methods of the invention;

20 Fig. 2 is a simplified schematic depicting an apparatus for producing the apertured webs of the invention; and

Fig. 3 is a photomicrograph of an apertured web of the invention.

DETAILED DESCRIPTION OF THE INVENTION

25 The present invention provides improved methods of forming nonwoven apertured webs by use of an improved foraminous member in a hydroentanglement process. The methods of the invention call for use of a foraminous member comprising gross and fine foramina wherein the gross foramina define a patterned design superimposed on a fine foramina. As used herein, "gross foramina" refers to
30 the openings in the foraminous member which, because of their size and shape and distribution, form the preselected pattern with which the foraminous member is provided. Gross foramina are provided in the foraminous member through the manipulation of the photosensitive resin as described herein. It is within the gross foramina of the foraminous member that the fibers making up the nonwoven web are
35 consolidated by the hydroentanglement process. If the foraminous member of this invention were a stencil screen, the gross foramina would define the design or pattern the screen would be used to print. "Fine foramina" is the term used herein to describe the openings present in the foraminous element about which the foraminous member is constructed. While fine foramina are usually present in some particular
40 pattern, it is not their pattern which is referred to as the "patterned design" in the description of the foraminous member above. The "patterned design" is the pattern

5 of the gross foramina. Typically, a fine foramen is only a fraction of the size of a gross foramen. The design defined by the gross foramina corresponds as a photographic negative to the apertures of the nonwoven fabric to be formed on the foraminous member according to the methods of the invention. Specifically, the open areas of the gross foramina are those areas on which fibers are consolidated and
10 entangled in the course of the hydroentanglement process. The solid projections which define the gross foramina therefore correspond to the apertures of the nonwoven webs. The invention contemplates that the solid projections comprising the photopolymer may be continuous or discontinuous with the resulting effects on the pattern of apertures on the nonwoven fabric.

15 The foraminous member is formed by means of applying a photosensitive resin onto a foraminous element comprising fine foramina such as a screen formed of fine metal or polymeric filaments. The photosensitive resin is then cured by photoactivation in a pattern selected to produce the desired gross foramina. Specifically, a photo mask is provided which comprises transparent areas
20 corresponding to the areas of the foraminous member where resin is to be cured and opaque areas which correspond to the gross foramina. Johnson et al., U.S. Patent No. 4,514,345, the disclosure of which is hereby incorporated by reference discloses methods suitable for preparation of the foraminous members of the present invention which involve using a photosensitive resin to construct in and about a foraminous
25 element a solid, polymeric framework which delineates the preselected pattern of the gross foramina of the foraminous member. Specifically, this patent teaches a method of preparing a foraminous member comprising the steps of: (a) applying a backing film to the working surface of a forming unit; (b) juxtaposing a foraminous element to the backing film so that the backing film is interposed between the foraminous
30 element and the forming unit; (c) applying a coating of liquid photosensitive resin to the surfaces of the foraminous element; (d) controlling the thickness of the coating to a preselected value; (e) juxtaposing in contacting relationship with the coating of photosensitive resin a mask comprising both opaque and transparent regions where the opaque regions define a patterned design; (f) exposing the liquid photosensitive
35 resin to light having an activation wavelength through the mask thereby inducing curing of the photosensitive resin in those regions which are in register with the transparent regions of the mask; and (g) removing from the foraminous element substantially all the uncured photosensitive resin.

The foraminous element is the material about which the foraminous member is
40 constructed. Suitable foraminous elements include screens having mesh sizes of from about 6 to about 75 filaments per centimeter in either the machine direction

5 (MD) or the cross machine direction (CD) and constructed of metal or polymeric filaments with polyester filaments being preferred. Square weave screens are suitable as are screens of other more complex weaves. Single or multiple layer designs are suitable. Filaments having either round or oval cross sections are preferred. In addition to screens, foraminous elements can be provided by woven and nonwoven
10 fabrics, thermoplastic netting and the like.

Suitable photosensitive resins can be readily selected from the many which are commercially available. Preferred resins are polymers which cure or cross-link under the influence of radiation such as ultraviolet (UV) light. Particularly preferred liquid photosensitive resins include those disclosed in U.S. Patent No. 4,514,345 including
15 those in the Merigraph™ series of resins available from Hercules Incorporated, Wilmington, Delaware.

In preparing the foraminous members for use with the present invention the photosensitive resin is applied to the foraminous element at a thickness selected to produce projections of a desired height on the foraminous member. The height of
20 the projections ("overburden") which define the gross foramina depends on the thickness of apertured web to be produced, the type of fibers used in its preparation and other factors which would be apparent to those of skill in the hydroentanglement art with such heights generally ranging from about 0.1 mm to about 3 mm and preferred thicknesses ranging from about 0.5 mm to about 2.5 mm with thicknesses
25 of from about 1.0 mm to about 2.0 mm being most preferred. Among the considerations determining the height of the projections is the concern that the web will tear upon removal from the screen if the projections are too tall. The thickness of the photosensitive resin applied to the foraminous member can be controlled by conventional means such as by use of nip rolls, doctor blades and the like.

30 Masks useful with practice of the invention can be any suitable material provided with opaque and transparent regions so as to shade certain areas of the photosensitive resin and expose others to activating radiation. Preferred masks are produced from flexible film materials such as polyester, polyethylene or cellulosic films with gravure printed polyester films being particularly preferred. The opaque
35 regions can be applied to the mask by means such as the Ozalid process, photographic, gravure, flexographic or rotary screen printing as are known in the art.

The liquid photosensitive resin is exposed to activating light through the mask thereby inducing curing of the resin in register with the transparent regions of the mask. Any suitable source of radiation such as are well known in the art may be
40 used to cure the photosensitive resin. The intensity and duration of the exposure to radiation are also well within the ordinary skill in the art. Curing of the resin is

5 evidenced by solidification of the resin in the exposed areas. After completion of such curing, the uncured resin is removed from the foraminous element by wash methods. According to one method, a precure step is carried out wherein 50 to 75% of the polymer is reacted followed by removal of the mask and barrier. Next, the liquid resin is vacuumed and a wash step is carried out to remove the remaining
10 liquid resin. Finally, a post cure step is carried out to complete polymerization of the initial solidified resin.

The patterned design defined by the gross foramina on the foraminous member corresponds to the fiber containing areas on the nonwoven fabric and is determined by the design of opaque areas on the mask. Conversely, the apertures of the
15 nonwoven fabric correspond to the raised areas of cured resin on the foraminous member. Because of the great flexibility of the photo-curing methods utilized by the invention, apertures of virtually any size, shape, height, alignment and pattern can be created in nonwoven fabrics according to the end uses of those fabrics. Raised areas having different heights and/or wall slopes can be formed and the porosity of the
20 underlying foraminous member can be varied. For example, where a nonwoven material is to be used as a topsheet in an absorbent sanitary product such as a diaper, the apertured web can be provided with larger and more numerous apertures at some locations and fewer and smaller at others according to the particular requirements of that product. For example, there is a need for larger and more numerous apertures
25 in topsheets used in diapers for newborn babies in order to more rapidly absorb runny bowel movements. The requirements of different products or even of various portions of single products can thus be accommodated by the method of the present invention. Nevertheless, apertures should not be created which detract from the structural integrity of the nonwoven web.

30 The foraminous member produced according to the methods described above may then be used in the production of apertured webs by means of a hydroentanglement process comprising the steps of providing a layer of fibers on the foraminous member and applying fluid streams to the layer of fibers such that the fibers are randomly entangled in regions interconnected by fibers extending between
35 adjacent entangled regions in a pattern determined by the pattern of the gross foramina of the foraminous member to form an apertured web.

In practicing the methods of the invention, a layer of fibers such as a nonwoven batt or other initial fibrous layer is formed on the foraminous member and is subjected to a hydroentanglement process such as are well known in the art. In this
40 regard, the disclosures of Griswold, U.S. Patent No. 3,025,585 and Evans, U.S. Patent No. 3,485,706 are incorporated herein by reference. The initial layer may

5 consist of any web, mat, or batt of loose fibers, disposed in random relationship with one another or in any degree of alignment, such as might be produced by carding and the like. The fibers can be any natural, cellulosic, and/or wholly synthetic material. The initial layer may be made by any desired technique, such as by carding, random laydown, air or slurry deposition and the like. It may consist of blends of fibers of
10 different types and/or sizes. In addition, the initial layer may be an assembly of loose fiber webs, such as for example cross-lapped carded webs.

In order to adequately interentangle the fibers, the fluid streams impinging upon the fibrous layer can be formed at high pressure and present a high energy flux. The design of hydroentanglement jets and the selection of operating parameters and
15 conditions for their use is well within the ordinary skill of those in the art.

In operating the process, water or another suitable liquid or fluid is forced under high pressure through small diameter orifices so as to emerge continuously or intermittently in the form of fine, essentially columnar, high-energy flux streams. The web or other fibrous layer is placed on the foraminous member and the assembly is
20 moved, layer side up, into the path of the high-energy-flux streams. Either the web, or the streams, or both are moved to traverse the web. The high-energy flux streams impinge upon and physically cause the individual fibers to move away from the projections defining the gross foramina and into the depressions corresponding to the gross foramina on the foraminous member. As the impingement continues the fibers
25 of the web are simultaneously realigned, entangled, and locked into place in a pattern corresponding to the pattern of the gross foramina. The resulting structure comprises fibers arranged in an ordered geometric pattern of intersecting bundles locked together at their intersections solely by fiber interaction.

The apertured webs of the present invention may be dried while still on the
30 foraminous members but are preferably dried after removal from it. The apertured webs may be subjected to dyeing, printing, heat treatment, or to other types of conventional fabric processing including treatment with resins, binders, sizes, finishes, and the like, surface-coated and/or pressed, embossed, or laminated with other materials.

35 The invention will be better appreciated by consideration of the examples of specific embodiments thereof presented herein. These examples are illustrative of the invention but are not to be considered to be limitative thereof. Example 1 describes forming a foraminous member according to the invention. Example 2 describes use of the foraminous member produced by the method of example 1 to produce an
40 apertured web according to the invention.

5

EXAMPLE 1

According to this example, a foraminous member comprising gross foramina and fine foramina wherein the gross foramina is produced according to the methods of Johnson et al., U.S. Patent No. 4,514,345, Smurkoski et al., U.S. Patent No. 5,098,522 and Trokhan, U.S. Patent No. 4,528,239 the disclosures of which are hereby incorporated by reference. Specifically a photosensitive resin is applied to the foraminous element (10) of Fig. 1 comprising a woven matrix of filaments (12) defining fine foramina and was covered with a photo mask having transparent portions defining rounded vertex diamond-shaped projections. Activating radiation is transmitted through the mask to cure the photosensitive resin on the foraminous element (10) such that the cured resin forms elevated portions (14) on said fine foramina defining gross foramina. The uncured photosensitive resin is then removed from the foraminous element (10) to produce a foraminous member (8) comprising gross foramina defined by the elevated portions (14) and fine foramina wherein the gross foramina define a patterned design superimposed on the fine foramina.

20

EXAMPLE 2

In this example, a foraminous member (8) comprising gross foramina and fine foramina which is produced according to the method of example 1 is used to produce an apertured web. The foraminous member (8) is formed on a foraminous element which is a woven matrix (10) comprising 50 filaments per inch in the machine direction and 50 filaments per inch in the cross machine direction woven in a square weave design. The filaments (12) in each direction are 0.006 inches in diameter and made of polyester. The thickness of the foraminous element (10) is about 0.012 inches. The gross foramina are created by the intermittent positioning of the elevated photopolymer protuberances (14) on the foraminous element (10). The elevated portions (14) are in the shape of rounded vertex diamonds occurring at a frequency of 37 discrete elevated portions per square inch. The elevated portions (14) occur at a machine direction pitch of about 0.22 inches and a cross machine direction pitch of about 0.12 inches. Each protuberance (14) extends about 0.025 inches from the web-side surface of the foraminous element (10). Each elevated portion (14) has a dimension of about 0.1725 inches in the machine direction and about 0.1214 inches in the cross machine direction. The radius of curvature at each vertex of protuberance is about 0.025 inches. The elevated portions cover about 50% of the total area of the foraminous member (8).

40

According to the method depicted in Fig. 2 an unbonded fibrous web (20) is provided to and supported by a forming belt (22) comprising the foraminous member

5 (8) produced according to the method of Example 1. The fibrous web is generally composed of polyester staple fibers characterized by the following parameters: denier, from 1.0 to 3.0 dpf, preferably 2.0 dpf; cut length, from 0.5 to 1.0 inch, preferably about 0.75 inch; basis weight from 15 g/square yard to 100 g/square yard, preferably about 50 g/square yard. The forming belt (22) is supported and driven by
10 rolls (23) and (24).

High pressure water is supplied to the process from a piping line (26) which is supplied from pumps and a reservoir (not shown). The water is directed into several supply lines which are regulated by valves (27a - 27d), and pressure controllers (28a - 28d). The water is then supplied to a series of manifolds, (29a - 29d), each of
15 which contain rows of high pressure jets. Given the control scheme presented each manifold can maintain its own pressure according to the desired characteristics of the finished web.

Each manifold has a cooperating vacuum box (30a - 30d) which is located below its manifold and in close proximity to the forming belt. Each of these vacuum
20 boxes has a slot opening positioned against the underside of the forming belt through which air is drawn by pumps and piping to de-water the fibrous web. Each water supply line, valve controller, manifold and vacuum box constitutes a forming zone. Typical process conditions for the forming zones range from 100 to 3,000 psi, preferably about 1000 psi for water pressure, and 5 to 30 inches of water, preferably
25 about 20 inches of water for the vacuum level. As the water passes through the fibrous web and forming belt into the vacuum boxes the fibers are pushed away from the protrusions (solid knuckles) to the open areas of the forming belt thus forming apertures or open areas in the fibrous web. This action also serves to entangle the fibers which imparts a degree of structural integrity to the web. The resulting web is
30 essentially a mirror or reverse image of the forming belt. The web may then be used as a topsheet in the manufacture of absorbent articles such as diapers, sanitary napkins and the like. Fig. 3 is a photomacrograph depicting an apertured web produced according to the invention wherein the fibers making up the web and the apertures defined by those fibers are clearly visible. The scale marks at the bottom of
35 the photograph are in 0.5 mm increments.

Numerous modifications and variations in the practice of the invention are expected to occur to those skilled in the art upon consideration of the foregoing description of the presently preferred embodiments thereof. For example, as an
40 alternative process to that described in Example 2, the forming section may be consolidated into a circular design where the forming belt is essentially a cylindrical screen. High pressure manifolds are positioned in a radial array around the rotating

- 5 screen which houses a vacuum chamber. In this process scheme, multiple forming stages are common to achieve a particular fabric design. Consequently, the only limitations which should be placed upon the scope of the present invention are those which appear in the appended claims.

WHAT IS CLAIMED IS:

1. A method of forming an apertured web comprising the steps of:
 - (a) forming a foraminous member comprising gross foramina and fine foramina wherein the gross foramina define a patterned design superimposed on said fine foramina by means of applying a photosensitive resin onto a foraminous element comprising fine foramina, curing said photosensitive resin by photoactivation in a pattern selected such that said cured resin forms elevated portions on said fine foramina defining said gross foramina, and removing all uncured photosensitive resin from said foraminous member;
 - (b) providing a layer of fibers on said foraminous member; and
 - (c) applying fluid streams to said layer of fibers such that the fibers are randomly entangled in regions interconnected by fibers extending between adjacent entangled regions in a pattern determined by the pattern of the gross foramina of the foraminous member to form an apertured web.
2. The method of Claim 1 characterized in that said apertured web comprises an irregular pattern.
3. The method of Claim 1 characterized in that said elevated portions range in height from about 1.0 mm to about 2.0 mm.
4. The method of Claim 1 characterized in that said fibers have a cut length between about 0.5 and about 1.0 inches.
5. The method of Claim 1 characterized in that said fibers are applied at a basis weight between about 15 and about 100 grams per square yard.
6. An improved apertured web produced according to the method of Claim 1.
7. The apertured web of Claim 6 in which the pattern of apertures is non-regular.
8. The apertured web of Claim 6 which comprises polyester fibers.

9. The apertured web of Claim 6 characterized in that the fibers have a cut length between about 0.5 and about 1.0 inches.
10. The apertured web of Claim 6 characterized in that the fibers were applied at a basis weight between about 15 and about 100 grams per square yard.

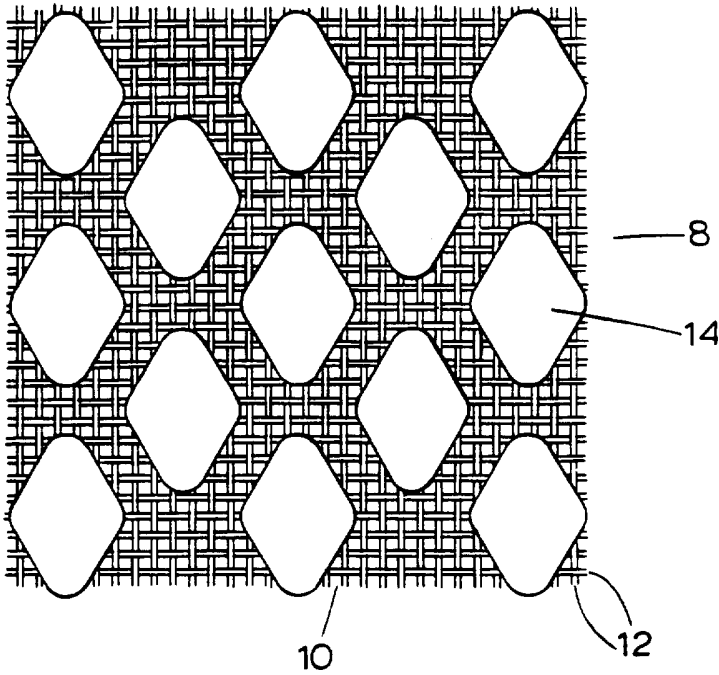


FIG. 1

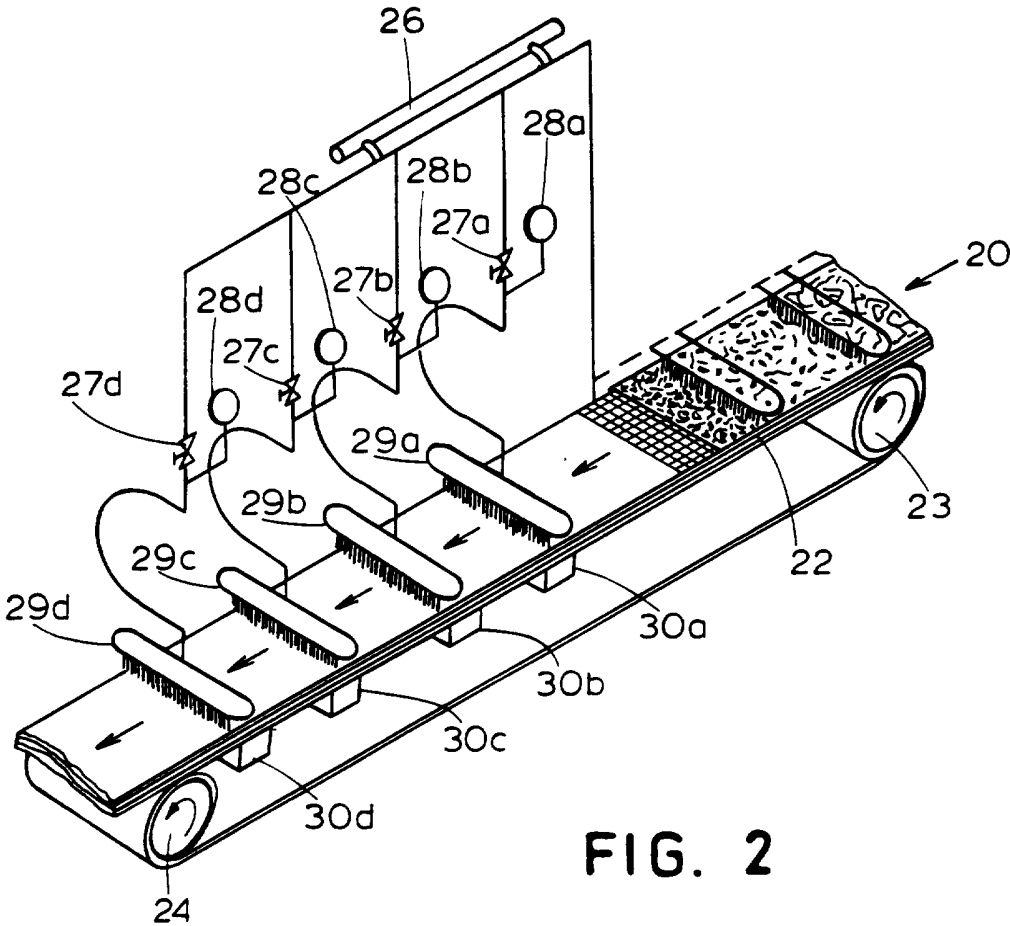


FIG. 2

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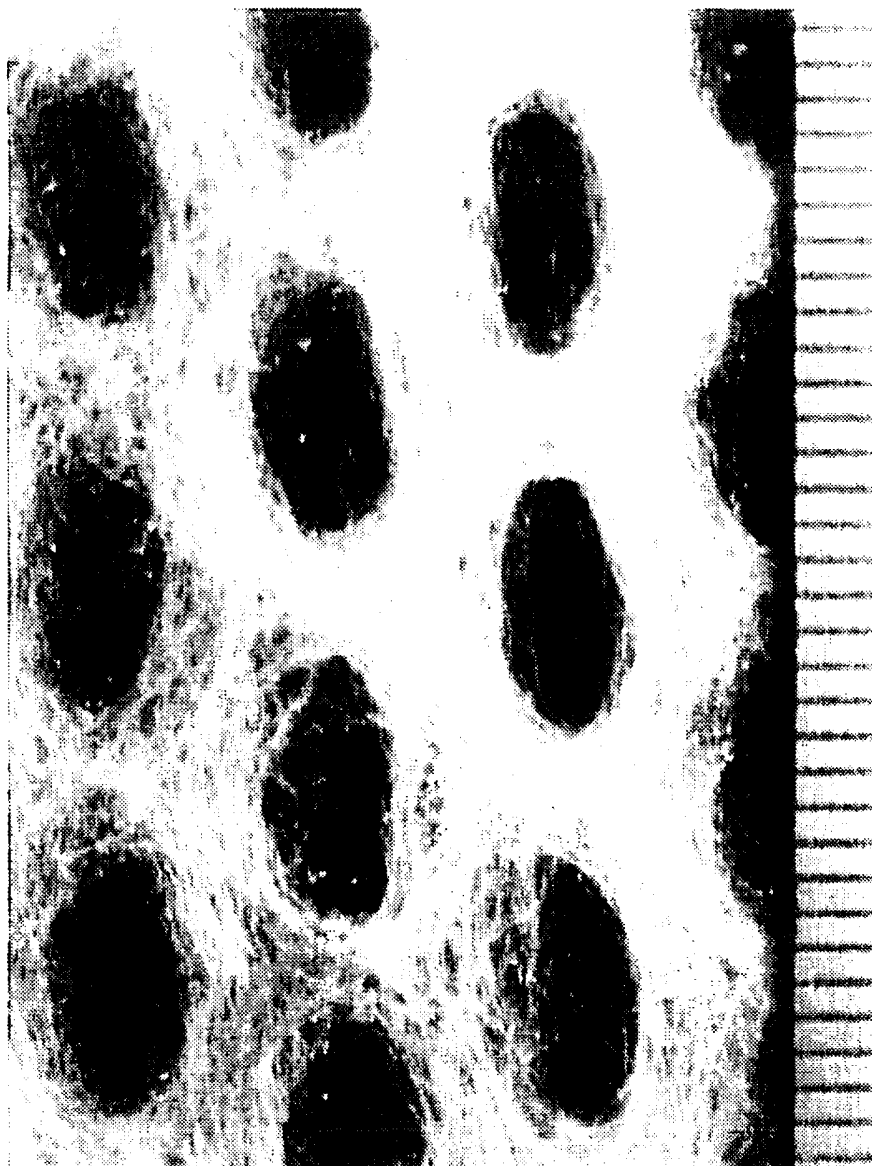


FIG. 3