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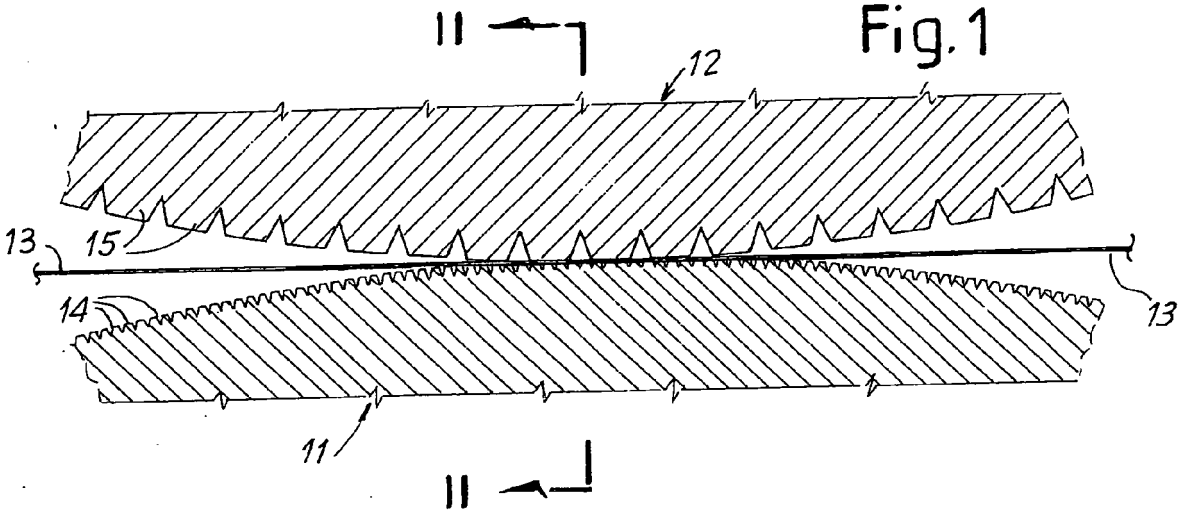
(54) Method and apparatus for producing webs perforated in a through manner and resulting product

(57) A method for producing webs perforated in a through manner, which comprises the passage of a web (13) between two counter-rotating rollers (11, 12) pressing against each other, of which a first roller (11) presents on its surface protuberances (14), which create the perforation, and a second roller (12) presents a contrast surface for said protuberances (14). The contrast surface of the second roller (12) presents contact areas (15A) for the protuberances (14) which are separated from each other by depressions (16), in which the material of the web expands.

Fig.1



EP 2 353 809 A1

Description

DESCRIPTION

Technical Field

[0001] The present invention relates to the field of the production of films, sheets or webs in textile material, in non-woven fabric or other material, to be used mainly in domestic products for house cleaning or in hygiene and sanitary products. In particular, the present invention relates to a method for perforating a film, sheet or web, preferably in non-woven fabric, to be used mainly in domestic products for house cleaning or in hygiene and sanitary products.

State of the Art

[0002] As it is well known, non-woven fabrics are widely used in many industrial sectors. A sector, in which they are particularly widely used, is for example the sector of the production of domestic products for house cleaning or of hygiene and sanitary products.

[0003] In this last case, but also in many other uses, there is often the need to perforate the web of non-woven fabric, in order to create a product, which allows the passage of liquids (for example physiological liquids).

[0004] A typical application is that of the diapers or the sanitary napkins for feminine hygiene. In general, diapers and sanitary napkins are substantially constituted by four elements that, starting from that into contact with the skin, are called: topsheet, sublayer, core and backsheet.

[0005] The topsheet, for example, has the function of being crossed quickly by the liquids, and it must act as a barrier between the inner part of the diaper, which have captured the liquids, and the body, from which the liquid has been released. This function is the more effective, the more the material is thick and permeable. There is therefore the need to perforate the surface of the topsheet perpendicularly, thus obtaining cross channels for crossing the section. An important aspect of this type of products is obviously the softness, as they are into direct contact with the skin.

[0006] The methods currently used for perforating webs of non-woven fabric can be summarized in the following types.

[0007] A first type is defined "needles perforation", and refers to a production method wherein a web of non-woven fabric is made cross the contact line of two counter-rotating rollers, the first of which is provided with needles arranged perpendicularly to the cylindrical surface, and the second is provided with complementary surface holes, suitable to receive the needles of the first one.

[0008] A second type is called "vacuum perforation" and refers to a production method, wherein a layer of very thin and hot film / web is arranged on a rotating roller having the surface micro perforated and depressurized on the inner part. Due to the difference of pressure between the inside and the outside of the roller, the web is subjected to a micro perforation.

[0009] A third type, even if not much applied, relates to a "perforation through abrasion", and is described in US 3,408,776. The production method described in this patent document provides for the passage of a web of non-woven fabric between two rollers, a first roller provided with projections perpendicular to its surface, each with a head of diameter substantially equal to the diameter of the holes to be realized, and a second roller provided with an abrading surface, which must be less rigid and less hard than the projections. The abrading roller rotates with a very higher speed than the speed of the roller with projections, that support the web and act as a contrast surface for the abrading roller. Practically, the abrading roller "tears", for each projection, a piece of fabric substantially equal to the dimension of the head of the projection itself; this piece remains attached with one end to the periphery of the hole created on the web and is stabilized on the web through the heat caused by the abrasion (the not heated abrading roller).

[0010] This method brings to poorly satisfactory results, for example in terms of softness of the final product (it is in fact clearly apparent that the torn piece creates an element thermally stiffened on the edge of the hole, and this reduces the softness of the fabric).

[0011] A fourth type relates to a "mechanical perforation" of the web, and in particular it relates to a method described in the European patent document EP 0 598 970 and consists of two counter-rotating cylinders, one of which is smooth and the other is provided with protuberances, maintained into contact one with the other and having different peripheral speed (the smooth roller is slower than the roller with protuberances). In these conditions, in the contact line of the two cylinders, the protuberances make an impression on the web; thanks to the contemporaneous slipping between the protuberances and the smooth cylinder, due to the different speeds, when the impressions are produced also the perforation of the web occurs at these impressions.

Object and summary of the invention

[0012] The object of the present invention is to provide a method to produce films, sheets or webs of textile material, non-woven fabric or the like, which are perforated in a through manner and which are particularly soft.

[0013] With reference to the object described above, a further object of the present invention is to provide a method for producing perforated films, sheets or webs, which is more economical relative to known methods.

[0014] These and other objects, which will be more apparent hereinafter, are achieved through a method for producing webs perforated in a through manner, which comprises the passage of a web between two counter-rotating rollers pressing against each other, of which a first roller presents on its surface protuberances creating the perforation, and a second roller presents a contrast

surface for these protuberances; the two rollers rotate with different speeds relative to each other, and a relative slipping consequently occurs between the contact surfaces of the two rollers. In particular, the surface of the second roller presents contact areas for the protuberances, which are separated from each other by means of depressions.

[0015] It is advisable, to obtain a better perforation in terms of quality, that the first roller rotate with a speed greater than that of the second roller.

[0016] The contact areas are formed for example by the end surfaces of the heads of projections coming out from the second roller, and the depressions present between these contact areas are defined by the spaces between these projections.

[0017] The protuberances drag on the contact areas, thus creating perforations on the web passing between the two rollers, which present dimensions substantially equal to that of the protuberances. The space between the contact areas of the second roller (that, as stated, can be considered depressions between areas or spaces between projections) allows the material forming the web to expand, i.e. to swell, thus allowing obtaining a surprising softness of the web.

[0018] It is clearly apparent that on the product there are first regions in which through holes are present (these regions substantially correspond to the contrast areas on the second roller) and second regions delimiting the first regions, where holes are not present and that are practically softer and thicker than the first ones, in view of the above description.

[0019] In particular, when at least one of the two rollers is heated, this softness is due also to the fact that in the second non perforated regions surrounding the perforated regions, the material of the web has not been into contact with both the surfaces, or it has been into contact with them less relative to the classical process, and therefore there is no stiffness by virtue of the process temperature.

[0020] It should be noted that the linear pressure between the two rollers are reduced relative to the corresponding pressure which the first roller (i.e. that provided with protuberance) would need if it worked coupled with a smooth roller. Consequently, an undoubted advantage is obtained in terms of powers necessary to the motion of the rollers, as well as reduced problems for balancing the bending of the rollers, that must be carried out in the traditional case. The web is therefore subjected to a lower compression relative to the traditional process, with an advantage in terms of characteristics of softness of the web.

[0021] The cross pitches (i.e. parallel to the axis of the rollers) of the protuberances of the first roller and of the contact areas of the second rollers are substantially different from each other; in this way the contact between areas and protuberances is assured. The same occurs for the longitudinal pitch (i.e. along the cylindrical development) of the protuberances and of the contact areas. In this way the rollers are not "meshed" with each other, making the contact occur only between the contact areas (i.e. the end surface of the projections defining these areas) of the second roller with the end surfaces of the protuberances (i.e. without contact between the flanks of the projections and protuberances), actually allowing slipping between protuberances and areas belonging to the cylindrical surfaces of the respective rollers.

[0022] By combining the geometry of the protuberances of the first roller and of the contact areas of the second roller, as well as depending upon the relative speed of the contact surfaces, different perforated shapes are possible, contained in limited regions surrounded by unperforated regions with greater thickness and softness relative to the original material.

[0023] At most, single through holes can be obtained, surrounded by regions unperforated due to the lack of contact with surfaces of the protuberances. This occurs, for instance, when the longitudinal and cross pitch of the protuberances of the first roller is equal respectively to the longitudinal and cross dimension of a respective contact area (i.e. the dimension of the head of a respective projection) of the second roller.

[0024] It is clearly apparent that the contact areas of the second roller, delimited by the depressions which allow the expansion of the material, are of greater surface dimensions relative to the surface dimensions of the heads of the protuberances of the first roller, with which they come into contact.

[0025] To obtain an optimum perforation, the maximum width and / or the maximum length of each contact area shall be preferably at least double than an equivalent dimension of each protuberance.

[0026] Advantageously, these contact areas of the second roller are preferably completely surrounded by depressions, thus practically constituting contact "islands" separated from each other. These areas are preferably distributed in an homogeneous manner on the second roller, as well as the protuberances on the first roller.

[0027] Adequately, the contact areas can have constant pitch on the surface of the second roller both in longitudinal direction and in cross direction; the same can occur for the protuberances of the first roller.

[0028] Preferably, the ratio between the (longitudinal and / or cross) pitch between two contact areas of the second roller and the longitudinal and / or cross dimension of one of said areas is substantially comprised between 1.1 and 4, thus allowing to obtain a final web particularly homogeneous in terms of thickness and softness.

[0029] Preferably, the ratio between the (longitudinal and / or cross) pitch between two contact areas of the second roller and the pitch between two protuberances of the first roller is substantially comprised between 1.5 and 10, thus allowing to obtain a final web with an optimum permeability relative to an optimum homogeneity in terms of thickness and softness.

[0030] The speed of the first roller with the protuberances can preferably vary from 20 m/min' to 200 m/min'; the second roller with the contact areas can preferably have a speed, and therefore a slipping, variable from 20% to 90% of that of the first roller with the protuberances.

[0031] The contact linear pressures between the two rollers can be preferably comprised between 40 N / mm to 200 N / mm

[0032] Preferably, the two rollers are heated, the interval of the temperatures of the two rollers is comprised between 60° and 170°, adjustable independently (i.e. each roller can be set at a desired temperature inside this interval).

[0033] The types of webs which can be used can be for example in polypropylene fibers, bicomponents polypropylene-polyethylene, polyethylene-polyester, natural fibers such as cotton and viscose and polyethylene films.

[0034] The present invention also relates to an apparatus for producing perforated webs, sheets or films, which uses two rollers as described above.

[0035] Furthermore, the present invention also relates to a web, sheet or film produced through the method described above and suitable to allow the passage of liquids, which presents in particular areas on which through holes are present, delimited by regions of greater thickness relative to the thickness of said areas.

Brief description of the drawings

[0036] Further characteristics and advantages of the present invention will be more apparent from the description of some preferred, although not exclusive, embodiments, illustrated by way of non limiting example in the attached tables of drawings, wherein:

figure 1 is a schematic view in cross section (i.e. orthogonal to the axes) of a portion of a pair of parallel rollers into contact with each other to perform a method according to the present invention;

figure 2 is an enlarged view of a portion of the contact area of the two rollers shown in figure 1, cut away according to the line II-II of figure 1, i.e. a lying plane for the axes of the rollers.

figure 3 is a schematic view of the plan development of the superposition of a part of the protuberances of the first roller relative to the contact areas of the second roller (these latter shown with a broken line);

figure 4 is a view of a portion of the contact region of the two rollers shown in figure 1 and 2, cut away according to the line II-II of figure 1, wherein the web has been omitted;

figure 5 is a view analogous to that of figure 4 but with a lower ratio between pitch of the areas of the second roller and pitch of the protuberances of the first roller (i.e. the areas are of smaller dimensions);

figure 6 is a view analogous to that of figure 3 but related to the configuration of figure 5;

figure 7 is an axonometric view of a schematic portion of a web perforated according to the method of the present invention, wherein the thicknesses are greater than in the reality to highlight specific aspects thereof.

Detailed description of some embodiments of the invention

[0037] With reference to the figures cited above, the method according to the present invention provides for the use of a pair of rollers 11 and 12, (called respectively first roller and second roller), counter-rotating and pressing against each other, which define in the contact region an entrance for a web 13 of non-woven fabric, such as for example a cohesive web of polypropylene fibers or bicomponents polypropylene-polyethylene or polypropylene-polyester or natural fibers such as cotton or viscose.

[0038] The first roller 11 is heated. The working temperature depends, among the other things, upon the type of fiber, the process speed and other characteristics. In the described example this temperature is preferably comprised between 70° and 170° (for example 120°). Analogously, also the second roller 12 is heated at a temperature comprised between 70° and 170°.

[0039] The first roller 11 presents protuberances 14 on the surface, which are distributed in an homogeneous manner on the cylindrical development of the roller, and which project orthogonally relative to this cylindrical development.

[0040] In this example, these protuberances 14 are distributed according to equal circumferential series with constant pitch lying on planes perpendicular to the axis of the roller; adjacent series are mutually displaced by half pitch, as it is shown in figures 3 and 6.

[0041] In this example, the cross section (i.e. related to a plane on which the axis of the roller lies) of a protuberance 14 has a shape similar to a trapezoidal shape, and more precisely it is similar to an equilateral trapezium, with the greater base facing the axis. In particular, the protuberances 14, on which the web 13 to be perforated will come into contact, present a shape similar to a truncated cone ending with an end face 14A, which is a cylindrical surface lying on the cylindrical surface of the respective roller. In figures 4 and 6 the end faces 14A are delimited by small continuous circumferences.

[0042] The second roller 12 presents projections 15 developing orthogonally from its cylindrical core. These projections 15 present a head 15A, with cylindrical surface lying on the cylindrical surface of the second roller and suitable to come into contact with the end face 14A of the protuberances 14.

[0043] In this case again, the projections 15 are distributed according to equal circumferential series with constant pitch lying on planes perpendicular to the axis of the second roller 12; adjacent series are displaced from each other by half pitch.

[0044] Both the cross pitch and the longitudinal pitch of the protuberances 14 of the first roller 11 are substantially different from the relative pitches of the projections 15 of the second roller 12; in this way the contact is ensured between the end surfaces 15A of the heads of the projections 15 and ends 14A of the protuberances 15.

[0045] In this example, both the projections 15 and the protuberances 14 have the shape of a truncated cone facing the opposite roller.

[0046] The end surfaces 15A of the heads of the projections 15 practically lie on a surface with cylindrical development and constitute contact areas for the ends of the protuberances 14.

[0047] The spaces 16 between the projections 15 practically constitute depressions surrounding the contact areas (that are also indicated with the reference number 15A) of the second roller 12 with the projections 14 of the first roller 11. The second roller can therefore be seen as a rotor, from which projections develop, or as a rotor with greater diameter, with cylindrical surface subdivided in contact areas 15A separated through depressions 16. The contact areas are completely surrounded by these depressions and practically constitute "islands" separated from each other.

[0048] As regards dimensions, the diameter of each contact area 15A is at least double the diameter of each end surface 14A of the protuberances 14.

[0049] The number of the contact areas 15A per cm^2 is preferably comprised between 3 and 30, whilst the number of protuberances per cm^2 is comprised between 20 and 200.

[0050] The ratio between the pitches of the contact areas 15A and of the protuberances 14 is preferably comprised between 1.5 and 10.

[0051] An example of second roller can provide for instance for ellipsoidal contact areas, whose cross pitch is equal to nearly 5.11 mm, the cross dimension of the ellipsoidal area is equal to nearly 4.00 mm, and consequently the ratio thereof is equal to about 1.27. Analogously, the longitudinal pitch is equal to about 8.05 mm, the longitudinal dimension of the area is equal to nearly 3.6 mm, and the ratio thereof is equal to nearly 2.23. In this example again the number of areas per cm^2 is equal to nearly 4.9 and the surface of the areas per cm^2 is equal to nearly 0.489.

[0052] In a corresponding manner, an example of first roller (i.e. that provided with protuberances) provides for a cross pitch between protuberances equal to nearly 1.2 mm, a cross dimension of the protuberances equal to about 0.76 mm, and the consequent ratio equal to nearly 1.56. Analogously, the longitudinal pitch between protuberances is equal to about 2.08 mm, the longitudinal dimension of the protuberances is equal to nearly 0.75 mm, and consequently the ratio thereof is equal to nearly 2.77. In this example again, the number of protuberances per cm^2 is equal to nearly 80 and the surface of the areas per cm^2 is equal to nearly 0.359.

[0053] The ratio between the cross pitch between the contact areas of the second roller and the cross pitch between the protuberances of the first roller can be equal to about 5.11/1.2 = 4.25. The ratio between the longitudinal pitch between the contact areas of the second roller and the longitudinal pitch between the protuberances of the first roller is equal to about 8.05/2.08 = 3.87.

[0054] The hardness of the materials composing the two cylinders into contact (for example nitriding hardened and tempered steel 42CrMo4 with hardness comprised between 50 - 60 HRC) is substantially equivalent, as well as their rigidity value. The contact surfaces of the two rollers are smooth, preferably ground.

[0055] An important aspect of the present invention is the fact that the first roller 11 rotates with a greater speed relative to the second roller 12, so that the contact surfaces of the two rollers are in slipping. Preferably, in this example, the speeds of the two rollers are respectively 70 m/min for the first cylinder and 50 m/min for the second cylinder, and the relative slipping is equal to 30%.

[0056] The linear pressure between the two rollers is preferably comprised between 40N per mm and 200N per mm.

[0057] From a practical point of view, the web is made pass through the contact region between the two rollers 11 and 12, which rotate with different speed (the first roller 11 rotates faster than the second roller 12). In the contact region between the rollers, the contact areas 15 act as a contrast surface for the protuberances 14. Whilst the protuberances 14 move towards the areas 15, the web is perforated by the protuberances at the contact with the areas 15, the protuberances make a slipping, which completes the perforation operation, allowing creating discontinuity on the web. The material of the web tends to go up the spaces defined by the depressions between the areas 15, increasing in thickness. These regions are spaced by the holes just made, and therefore present a temperature lower than the contour regions of the holes. Once the web has been cooled, these "swollen" regions present a greater softness than the contours of the holes. It is clear that the more the holes are contained inside well delimited regions (i.e. between these regions provided with a plurality of holes no other holes must be present) the greater the softness.

[0058] Obviously, the configurations of the two rollers can be the most different, according to the needs. Figure 5 and figure 6 show diagrams of a pair of rollers, wherein the number of protuberances 14 is lower than in the case of figures 2 and 3 (with equal dimension of the contact areas 15).

[0059] Also the shape of the protuberances and of the contact areas can be different than that indicated, for example they can have polygonal shape or ellipsoidal shapes or also elongated shapes, and they can also be constituted by "band" or "strip" surface portions.

[0060] Also the pitch between contact areas and between protuberances can be different from that indicated, for example it can be different between longitudinal direction and cross direction, or it can also be not constant

in cross direction.

[0061] Figure 7 shows an example of a portion of web 13 perforated according to the method and the apparatus described above. This web 13 presents a plurality of regions 17 with dimensions and shape substantially corresponding to the contact areas 15 of the roller 12, in which are present a plurality of through holes 18 with dimensions and shape substantially corresponding to that of the end surfaces 14A of the protuberances 14 of the first roller 11.

[0062] The perforated regions 17 are surrounded and spaced from each other by unperforated regions 19. These unperforated regions 19 present a greater thickness relative to the thickness of the perforated regions 17. In figures 4 and 7, the thicknesses have been exaggerated to highlight the difference thereof. This difference in thickness is less visible practically, for instance it is comprised between 1 to 4 times the thickness of the regions 17.

[0063] The types of webs which can be perforated by means of the described method can be extremely various, and can comprise continuous films, non-woven fabrics, sheets in different material, both synthetic and natural, both woven, non-woven, sized, etcetera.

[0064] The fibers which can be used can be both synthetic and natural. The webs can be consolidated or not, carded or not, etcetera. Examples can relate to webs of the type thermobonded, spunbonded, airthrough, spunlaces, polyethylene films and combinations thereof.

[0065] It is understood that what illustrated purely represents possible nonlimiting embodiments of the invention, which may vary in forms and arrangements without departing from the scope of the concept on which the invention is based. Any reference numbers in the appended claims are provided for the sole purpose of facilitating the reading thereof in the light of the description hereinbefore and the accompanying drawings and do not in any way limit the scope of protection of the present invention.

Claims

1. A method for producing webs perforated in a through manner, comprising the passage of a web (13) between two counter-rotating rollers (11, 12) pressing against each other, of which the first roller (11) presents on its surface protuberances (14) which create the perforation, and a second roller (12) presents a contrast surface for said protuberances (14), said rollers (11, 12) rotating according to different speeds with consequent relative slipping, **characterized in that** the contrast surface of said second roller (12) presents contact areas (15A) for said protuberances (14), which result separated from each other by depressions (16), in which the material of the web expands; said contact areas (15A) being of greater surface dimensions than the contact face (14A) of said protuberances (14).

2. A method as claimed in claim 1, **characterized in that** said second roller (12) rotates with a speed lower than the speed of said first roller (11).

3. A method as claimed in claim 2, **characterized in that** the percentage slipping of the two rollers (11, 12) is comprised between 10% and 90% of the speed of the first roller (11) with the protuberances (14).

4. A method as claimed in claim 3, **characterized in that** the speed of said first roller (11) is comprised between 20 m/min' and 200 m/min', preferably equal to 70 m/min', whilst the speed of said second roller (12) is comprised between 10% and 90% of the speed of the first roller (11), preferably equal to 30%.

5. A method as claimed in one or more of the previous claims, **characterized in that** said contact areas (15A) are completely surrounded by said depressions (16) to form contact islands for said protuberances (14).

6. A method as claimed in one or more of the previous claims, **characterized in that** said protuberances (14) and said contact areas (15A) present substantially constant longitudinal pitch; the longitudinal pitch of said protuberances (14) being different from the longitudinal pitch of said contact areas (15A).

7. A method as claimed in one or more of the previous claims, **characterized in that** the ratio between the longitudinal and / or cross pitch between two contact areas (15A) of the second roller (12) and the pitch between two protuberances (14) of the first roller (11) is substantially comprised between 1.5 and 10.

8. A method as claimed in one or more of the previous claims, **characterized in that** said protuberances (14) and / or said contact areas (15A) are distributed in an homogeneous manner on the cylindrical development of the respective rollers, in respective circumferential series displaced in cross direction relative to adjacent series.

9. A method as claimed in one or more of the previous claims, **characterized in that** the maximum width and / or the maximum length of each contact area (15A) shall be at least double an equivalent dimension of the face (14A) of slipping of each protuberance (14).

10. A method as claimed in one or more of the previous claims, **characterized in that** said contact areas (15A) and the end faces (14A) of said protuberances lie on respective substantially cylindrical surfaces.

11. A method as claimed in one or more of the previous claims, **characterized in that** the hardness of the materials composing the parts of the two rollers (11, 12) into contact is substantially equivalent, as well as the rigidity value thereof.

12. A method as claimed in one or more of the previous claims, **characterized in that** both the contact surfaces of the two rollers (11, 12) are smooth, preferably ground.

13. A method as claimed in one or more of the previous claims, **characterized in that** the number of contact areas (15A) per cm^2 is preferably comprised between 3 and 30, whilst the number of protuberances per cm^2 is comprised between 20 and 200.

14. An apparatus for through perforation of a web, film or sheet, functioning according to the method as claimed in one or more of the previous claims, comprising a pair of counter-rotating rollers (11, 12) pressing against each other, of which a first roller (11) presents on its surface protuberances (14) which create the perforation, and a second roller (12) presents a contrast surface for said protuberances (14), said rollers (11, 12) rotating according to different speeds with consequent relative slipping, **characterized in that** the surface of said second roller (12) presents contact areas (15A) for said protuberances (14), which result separated from each other by depressions (16), in which the material of the web (13) expands; said contact areas (15A) being of greater surface dimensions than the contact face (14A) of said protuberances (14).

15. A web in textile material or non-woven fabric, produced with a method as claimed in one or more of the previous claims, **characterized by** comprising a plurality of first regions (17) in which a plurality of through holes (18) are present, said first regions (17) being surrounded and spaced from each other by second unperforated regions (19), which present a greater thickness relative to the thickness of said first regions (17).

Fig.1

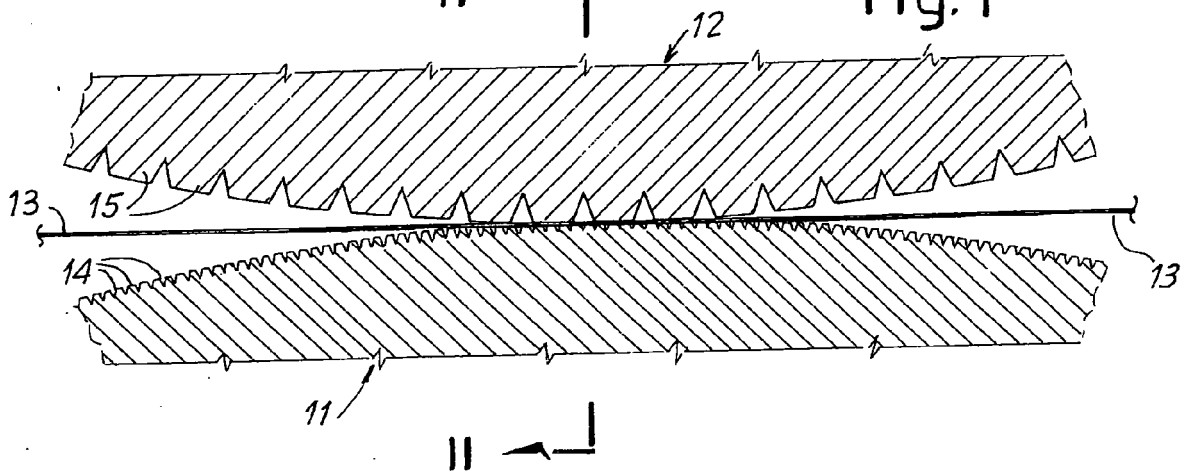
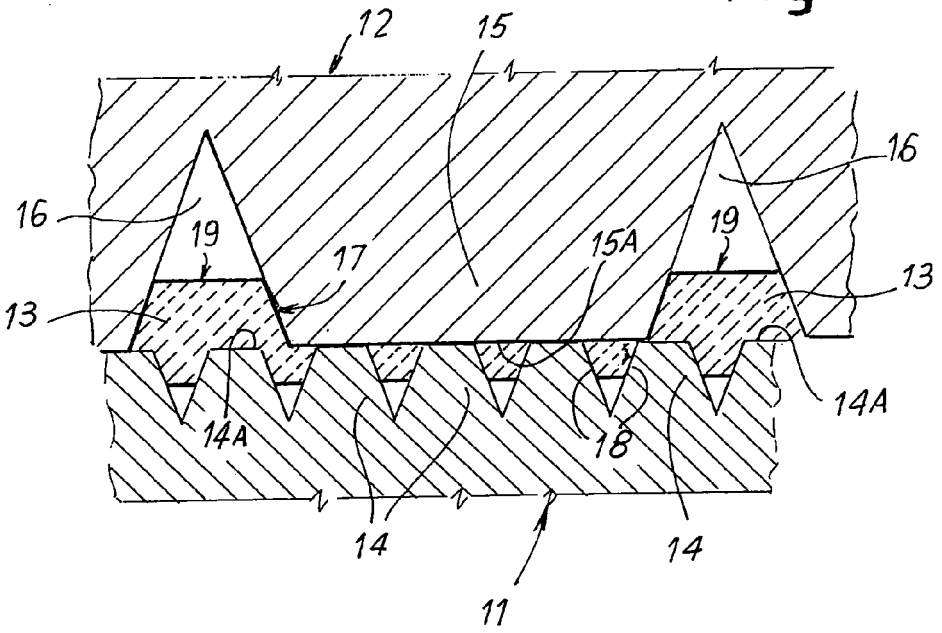

II
12
13
15
14
13
11
II

Fig.2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11

Fig. 3

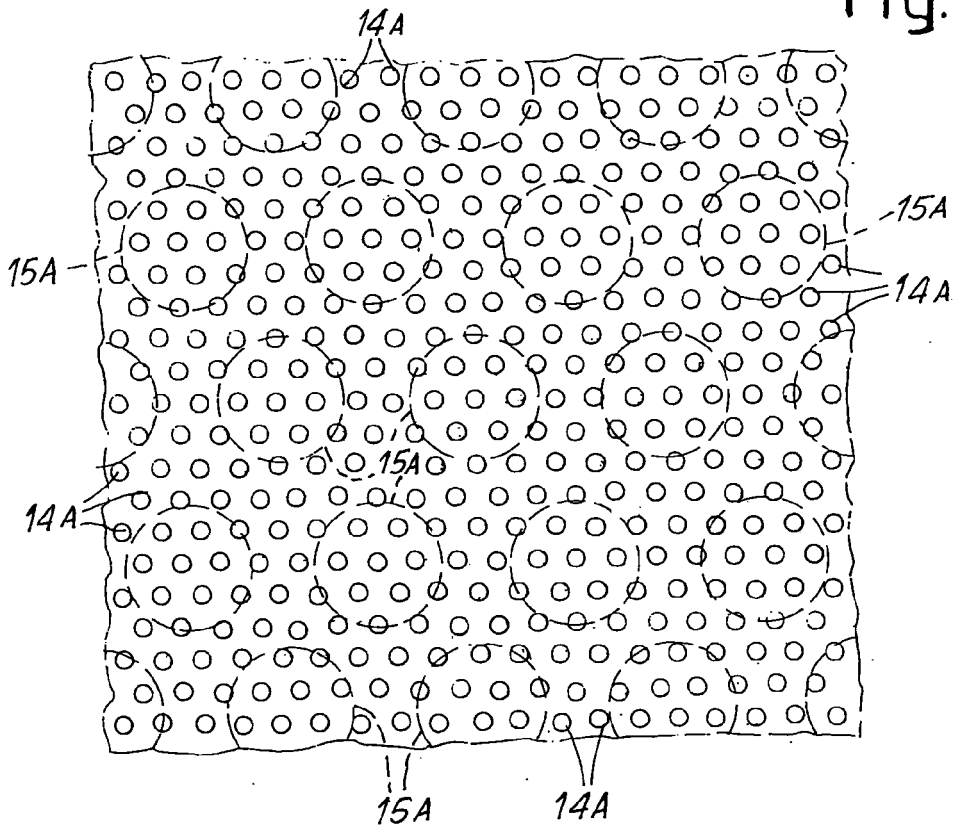
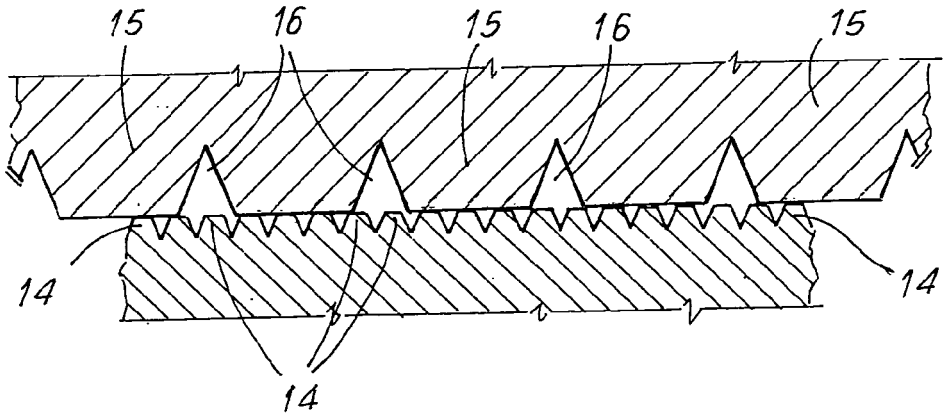


Fig. 4



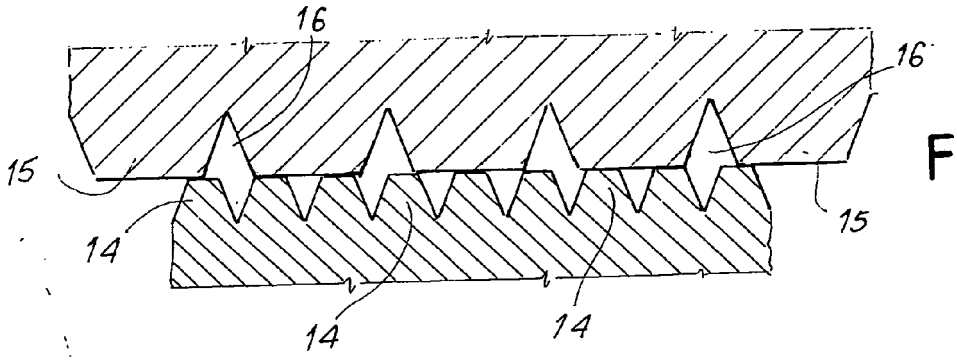


Fig.5

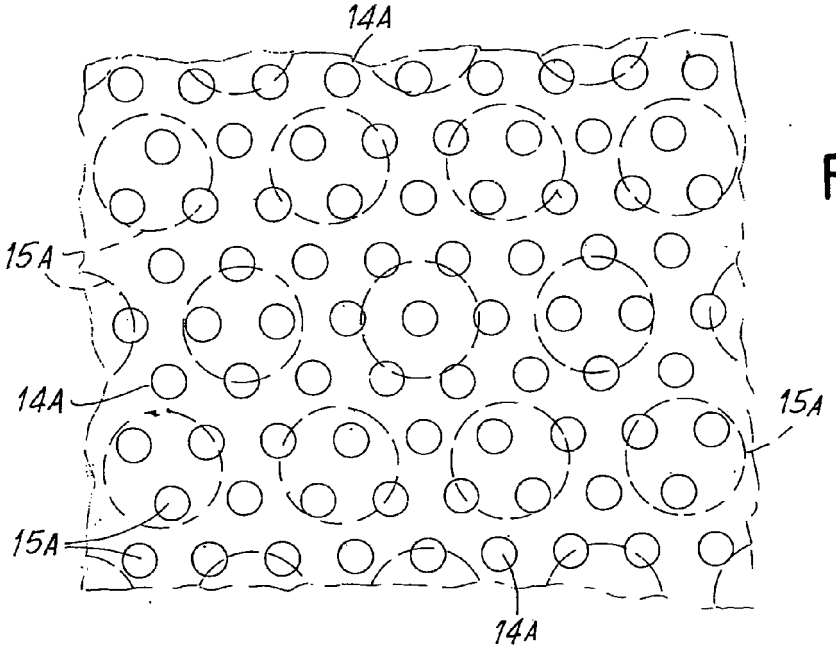


Fig.6

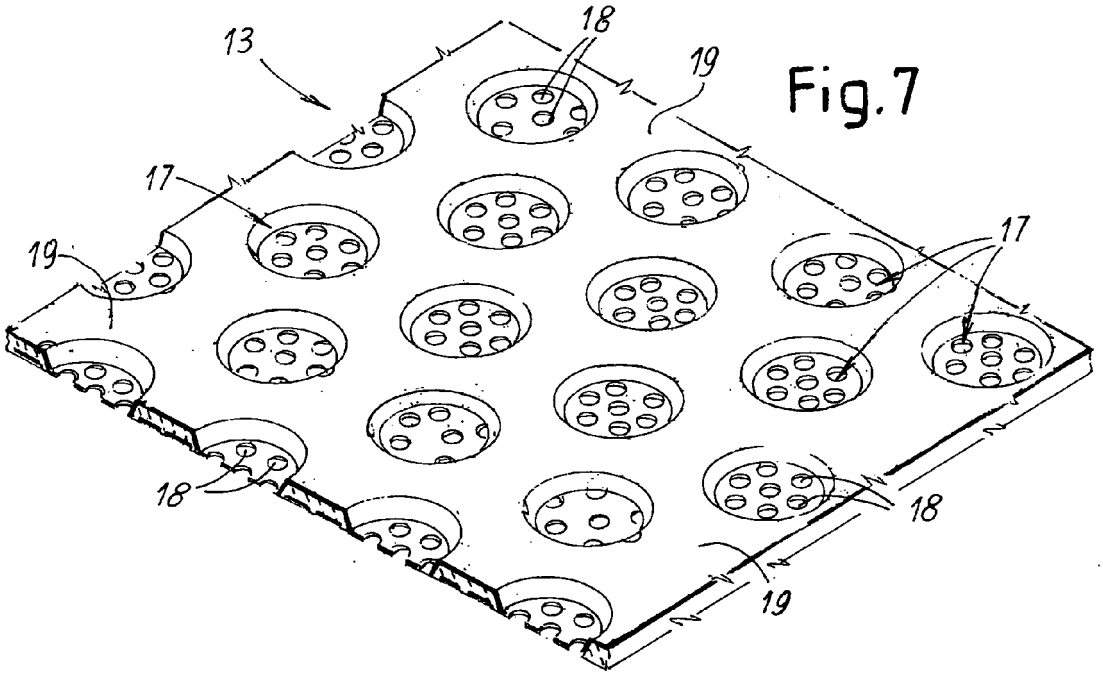


Fig.7

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EUROPEAN SEARCH REPORT

Application Number
EP 10 42 5025

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B26F
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	19 July 2010	Canelas, Rui

CATEGORY OF CITED DOCUMENTS

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