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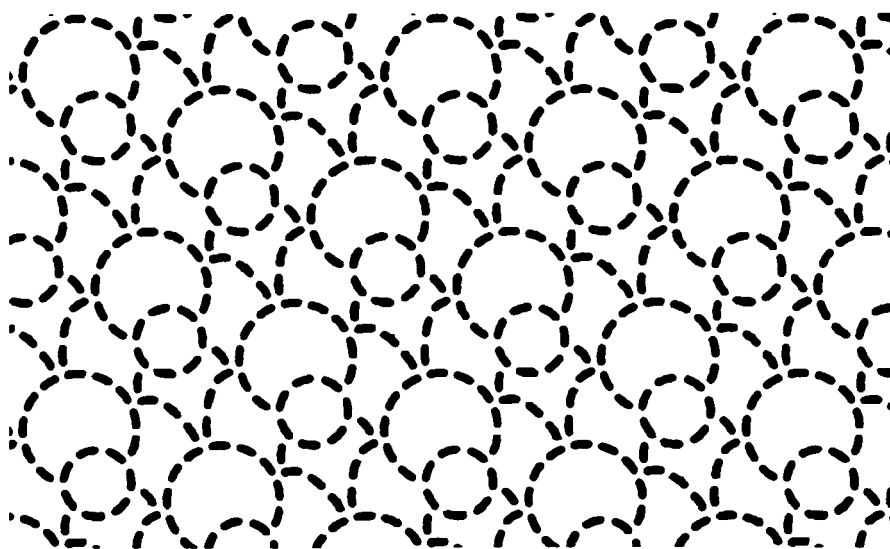
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41275 Basiskele/Kocaeli (TR)(54) **SOFT NONWOVEN FABRIC**

(57) There is provided a nonwoven fabric with improved softness and pilling resistance by using known technologies. The present invention relates to a nonwoven fabric comprising embossed portion and non-embossed portion. Nonwoven fabric is formed by polypropylene based polymer mixture. Fibers are multi-layer bonded and said nonwoven fabric being embossed with a pattern of adjacent closed geometric structures of circularly shaped forms wherein, the adjacent closed geometric structures overlapping with each other.

pylene based polymer mixture. Fibers are multi-layer bonded and said nonwoven fabric being embossed with a pattern of adjacent closed geometric structures of circularly shaped forms wherein, the adjacent closed geometric structures overlapping with each other.

**FIG. 4****EP 3 187 635 A1**

Description**Technical Field**

[0001] The present invention relates to a nonwoven fabric (2) of improved softness which is provided with an embossed portion (14) and a non-embossed portion (16). The embossed portion (14) comprising an embossed pattern of geometric structures (4) formed as unit patterns of circularly shaped geometric structures, each formed by unit shaped emboss structures are having round edges and uniform dimensions. Said geometric structures of circularly shaped forms are intersecting with each other at the non-embossed intersection points (20) and unit shaped emboss structures have uniform dimensions.

Background Art

[0002] Nonwoven fabrics are one of the oldest and simplest textile fabrics. Nonwoven fabrics can be produced by a variety of known processes other than weaving or knitting.

[0003] Nonwoven products produced by known techniques are used in various applications such as; disposable and medical applications, hygiene products, diapers, incontinence pads, feminine hygiene articles or nappies.

[0004] The nonwoven fabric properties depend on following particulars to a great extent,

- The choice of fibers,
- Technology which determines how the fibers are to be arranged,
- The bonding process and/or the bonding agents,
- Emboss structures of pattern that applied finally on the web structure,
- Emboss roll conditions that applied on web surface.

[0005] The emboss patterns mainly effect the properties of the produced nonwoven fabric such as, softness, strength, elongation or pilling properties. Various emboss patterns are applied on nonwoven webs to improve these kinds of properties.

[0006] Fabric properties of nonwovens range from crisp to that soft touch to harsh, impossible to tear to extremely weak.

[0007] In current technology it is possible to produce soft touch nonwoven fabrics by using different methods such as, bico technology can be followed by using polyethylene coating on polypropylene web or by using large weight of webs. But this method is expensive and time consuming process. Many of the other processes are not recyclable because of mixing two or more different kinds of polymers such as polypropylene and polyethylene. These kinds of fabrics are obtained at higher weight; to not to lose mechanical performance while getting softer surfaces, that makes them expensive.

[0008] Among these processes, there are piling observed on the surfaces of nonwoven fabrics, because of the used polyethylene for coating the polypropylene part to obtain softer surfaces, which is an unwanted result of producing nonwoven products.

[0009] In the prior art, there are many trials to obtain softer surfaces or to improve mechanical and physical performance of nonwoven fabrics.

[0010] EP2479331 discloses a method of using high crystalline polypropylene mixed with low crystalline polypropylene as raw material with reduced fiber denier to obtain enhanced softness of spun bond nonwoven fabrics. But using reduced denier can cause problems. For example; increased hydrophobicity of the web can be a result of reduced denier and this may cause problem with regard to used areas of nonwoven fabrics such as top sheet. This application does not express the effect of embossing structure on softness of nonwoven fabric which is a cost saving application to obtain soft surfaces.

[0011] US4333979 is related to light weight nonwoven webs, that have embossed patterns composed of fused bond areas covering a specific range of web surface with specified frequency of bond areas and web thickness. The pattern that used in this invention is shown in FIG. 5. This approach does not provide a solution to pilling of nonwoven surface. Additionally, this approach doesn't have the desired strength and robustness of the fabric which leads to deformations; sometimes of irreversible nature.

[0012] EP2554731 discloses a nonwoven fabric having embossed and non-embossed portions that defines the structure of emboss line patterns. It limits the distance of emboss lines and non-embossed portion. The shape of the emboss pattern improved in this invention is related with angle shaped structures as shown in FIG. 6. It expresses the softness effect of rhombus shaped emboss pattern but relates to the problems of lower strength of the nonwoven and lack of shape preservation.

[0013] There still exists a need for obtaining softer surfaces without losing the strength of nonwoven fabrics and improving pilling resistance of nonwoven fabrics under cost considerations of production.

[0014] The present invention overcomes above mentioned problems. In the present invention mechanically and phys-

ically improved nonwoven fabrics are produced. Nonwoven fabrics that have softer surfaces and improved resistance to pilling are obtained without losing the strength of the fabric. Additionally, less weight of fiber is used that is formed by using polymer which makes the present application cost effective.

Summary of invention

[0015] The present invention provides a nonwoven fabric (2) formed from continuous thermoplastic filaments comprising polymer based master batch. Furthermore an embossed pattern of adjacent closed geometric structures of circularly shaped forms (4) is providing softness and bulk while retaining strength and improving pilling resistance. The materials of the invention can be used for disposable products such as diapers, sanitary napkins or any kinds of hygiene products.

[0016] The present invention relates to a nonwoven fabric comprising an embossed portion and a non-embossed portion. There is provided a nonwoven fabric with improved softness and pilling resistance by using known technologies.

Total process includes;

[0017]

- Extruding polymer and additives as master batch,
- Spinning of fibers,
- Web formation of fibers and
- Thermo bonding of fibers.

[0018] The selection of raw material that used in formation of nonwoven affects the performance of web structures. Many kinds of polymers have been known to be used as fiber forming materials in this technical field.

[0019] It has also been known that, some physical and mechanical properties of nonwoven fabrics can be improved by embossing the web by deformation of the web structure.

[0020] Applying the best method with suitable raw material is the critical goal of obtaining soft and strong webs without pilling. Furthermore, cost effectiveness of manufacturing process must be considered because targeting the best nonwoven product having enhanced softness and strength may cause high production costs.

[0021] Nonwoven fabrics, typified by spun bond or melt blown nonwoven fabrics are usually partially thermo bonded via an embossing roll in order to prevent the falling-off of fibers which form the nonwoven fabric and by this way to improve the strength of the fabric.

[0022] In the present invention spun bonded or melt blown webs are bonded by thermal bonding with application of hot calender. Emboss roll is used as hot calender which has specific design pattern to obtain embossed patterns on nonwoven web. By the way, strong nonwoven fabric is obtained.

[0023] In the present invention an improved embossing design is applied on nonwoven fabric (2). Said embossing design pattern is concerning geometric structures of circularly shaped forms (4).

[0024] The nonwoven fabric (2) having emboss structures of being partially thermo bonded non-continuous lines gives excellent softness to a nonwoven fabric comparing to having an emboss pattern formed nonwoven by a continuous emboss line.

[0025] Emboss pattern that is formed by non-continuous emboss lines as dotted emboss lines (8) are round shaped and superior in softness to a nonwoven fabric having an emboss pattern formed as angled such as triangle, square, rhombic or rectangular.

[0026] In the present invention, there are non-embossed portions (16) between the dotted embossed lines (8) which comprise embossed portion (14). This structure avoids pilling and improves softness of the surface.

[0027] In known techniques polyethylene coating can be applied on polypropylene webs to obtain improved softness but it causes pilling and lack of strength. So high weight fibers are used to achieve targeted strength. Nonwoven fabrics which use polypropylene as fiber former prevents pilling of fibers comparing to polyethylene coated fibers.

[0028] In addition, using thermo bonded polypropylene fiber having specified bonding areas gives an excellent strength to nonwoven fabric that is equivalent or higher as conventional nonwoven fabrics. Besides the weight of the fiber used is reduced as an important economical factor.

Brief description of drawings

[0029]

FIG. 1. View of nonwoven fabric structure having an embossed and a non-embossed portion in an embodiment of

the present invention

FIG. 2. View of enlarged nonwoven fabric structure focusing on a unit portion of an embossed portion shown in **FIG. 1**

FIG. 3. Alternative embodiments of embossed nonwoven fabric that is used in comparative example 2

FIG. 4. Alternative embodiments of embossed nonwoven fabric that is used in comparative example 3

FIG. 5. Emboss structure of nonwoven fabric given in prior art US4333979 document

FIG. 6. Emboss structure of nonwoven fabric given in prior art EP2554731 document

[0030] Wherein;

2. Nonwoven fabric

4. Geometric structure of circularly shaped form (embossed pattern)

6. Diameter of circularly shaped form

8. Dotted emboss line

10. Length of emboss line

12. Width of emboss line

14. Embossed portion

16. Non embossed portion

18. Oblong shaped emboss structure

20. Intersection point

Detailed description of the present invention

[0031] The present invention relates to a nonwoven fabric (2) comprising an embossed portion (14) and a non-embossed portion (16).

[0032] The present invention provides improvements in continuous fibers bonded thermoplastic webs, concerning specific embossed patterns.

[0033] The term of nonwoven fabric states that in the present invention, fibers are held together by a process of bonding to form a nonwoven fabric.

[0034] The term of fiber is referring to the structure that is used to form nonwoven fabric in the present invention.

[0035] The term of fabric is referring to web of fibers that are finished by embossing with bonding techniques such as hot calendaring, in the present invention.

[0036] The term of engraving depth is referring to the depth of the pin, which goes inside the web by embossing to form the embossed portion, in the present invention.

[0037] The nonwoven fabric properties depend on different criteria such as; type of fiber that is used as raw material, the technology used to arrange the fibers, bonding processes that allow holding fibers together, emboss structure of pattern that applied on nonwoven web structure by the known techniques.

[0038] Choosing the right fiber to process the fabric is one of the most important parts of nonwoven manufacturing. Cost effectiveness, easy to use and process according to special properties of the fiber, and further processing are taken into consideration.

[0039] Non-limiting examples of polymer materials suitable for forming nonwoven fiber such as; rayon, nylon, wool or cotton can be used as natural fabrics and polyesters or acrylics as synthetic fibers. Especially synthetic fibers such as polypropylene, polyethylene, polyester, or polyurethane are used for cost consideration, ease of processing, and for new and more exacting applications.

[0040] Nonwoven webs can be produced by different methods of production such as; wet bonded, dry bonded, filament formation spun bonded, or melt blown techniques. Using one method or combination of different methods are also possible in production of multi-layer nonwoven webs such as; SSS, SMS, SMMS or SSMS. (S: Spun bond, M: Melt blown)

[0041] Nonwoven fibers that are produced by different known methods, can be bonded by using different techniques of bonding process and/or bonding agents for getting fibers together to avoid falling off the fibers. Non-limiting examples can be applied on bonding of web some of which are; mechanical bonding, chemical bonding or thermal bonding.

[0042] In the present invention different bonding techniques can be used but the most preferred bonding technique is thermal bonding as applying heat and pressure by using hot calender such as; using decorative emboss roll for area bonding, point bonding or embossing.

[0043] Especially continuous filament webs are bonded by thermal bonding using hot calendaring emboss roll. There are important criterias that affect the strength and softness of nonwoven web structures. These are bonding area, height of bonding points, number of bonding points that formed by pins, shape of bonding points which are related with calender pattern, temperature and pressure of rollers that are related with emboss roll.

[0044] Embossing nonwoven web structure is one of the critical applications to enhance the mechanical performance of nonwoven fabric.

[0045] Embossing process is the final step in nonwoven fabric production process since it enables to produce a product which is soft, aesthetically decorated and high in bulk. Depending on the embossed bonding area, and emboss structure, physical and mechanical properties of the nonwoven fabrics are changed.

[0046] The spun bond process is widely used to produce nonwoven fabrics. Typical spun bond process components are a polymer feed, an extruder, a quenching system, a drawing and deposition system, a web formation, a bonding and a winding system. In general spun bonded production requires the steps;

- 1-Formation of continues filament synthetic fibers,
- 2- Formation of continues filament webs,
- 3- Mechanical, chemical or thermal bonding of webs,
- 4- Finishing and cutting of the webs.

[0047] In the present invention, a melt solution of a fiber forming polymer or a mixture of polymers is extruded through a system providing spinnerets under a high velocity current of air. Said formed fibers are deposited on to a conveyor belt to form a web. The belt then carries the web to a bonding stage where consolidation of web occurs to form nonwoven fabric.

[0048] Spun bonded fabrics tend to have low bulk and high strength that allows their use in many industrial applications. The nonwoven fabrics of the present invention have strong webs, low elongation and filament diameter in the range of 1-3 deniers and more specifically 1,5-2 denier. Small denier is preferred because, homogen distribution of filaments are required to form web structures which is preferred to be used as top sheet or other water and air pervious layers of hygiene articles.

[0049] The melt blown process is one of the widely used processes to produce nonwoven fabrics in which the production steps are quite similar to spun bonded webs. In this process extruded polymers pass through the holes in a spinneret into a high velocity current of air.

[0050] The difference of melt blown method from spunbond method is an increased force of air current used which breaks the filaments rather than just drawing them to produce fibers of varying lengths. Melt blown fibers have smaller diameters. The fiber size is influenced by, process air volume, throughput, temperature, number of holes of spinneret and type of polymer resin. By applying higher process air temperature then melting temperature of the used polymer endless filaments can be obtained by melt blown process.

[0051] Melt blown fabrics have, filament diameter in the range of 1-3 denier, more specifically 1-1,5 denier. Melt blown filament denier is smaller than others which allow producing hydrophobic such as liquid and air impervious web structure. Nonwoven fabrics produced by this technique are preferably used as back sheet or as cuffs of diapers or hygiene articles.

[0052] Thermal bonding, in which the fibers bond together when heated under pressure, may require a bonding agent.

[0053] In the present invention melt blown method comprises the steps;

- Heating up of the laid down fibers formed as web structure,
- Welding of the webs into very small film spots at the engraving pins, while using the high temperature and pressure of the rolls,
- Fast cooling down of the web with cooling rolls to avoid neck in,
- Obtaining strong and uniformly embossed fabric.

[0054] Bicomponent multilayer fibers can be used to produce a bonded fabric with one of the components being thermoplastic to facilitate heat bonding and the other component having the property that will enhance the quality of final fabric area density in the process is controlled by the speed of conveyor belt.

[0055] If the webs are bonded over the entire area or over high bonding area, the created product is relatively stiff and dense which is not desired to be used in hygiene articles. There is a need to have softer products which are strong enough.

[0056] If the webs are bonded at discrete points, that makes the product softer, more flexible and strong.

[0057] The nonwoven products produced by using spun bond or melt blown processes are used in various applications. Nonwoven products are widely used in medical, hygiene and technical fields such as; medical applications, masks, hygienic products, diapers, incontinence pads, feminine hygiene articles or nappies, bedding, filtration or clothing.

[0058] The non-limiting embodiments are given below to understand the invention explicitly;

[0059] In one embodiment, a fiber which forms the nonwoven fabric (2) is selected from natural or synthetic fibers; specifically cotton as natural fiber and thermoplastic polymers as synthetic fibers are preferred as raw material, more specifically polypropylene based polymer mixture having 25 to 27 g/10 min melt flow index (MFI) at 230 °C, is selected for the production of nonwoven fabric in the present invention.

[0060] In an embodiment the polymer can be used singly or in combination of one or more species. It can include an antistatic agent, flame retardant, synthetic oil, a coloring inhibitor, a lubricant, a dye, a softening agent, a plasticizer or a pigment.

[0061] In another embodiment, any known technology is applied to form nonwoven fibers, such as wet bonded, dry bonded, spun bonded or melt blown techniques. In the present invention, more specifically spun bond or melt blown technology is applied to obtain desired fibers.

[0062] In a further embodiment, the present invention is specifically including a multi-layer nonwoven fabric, consisting of at least three layers which are stacked together with known techniques, wherein each of two outer nonwoven fiber layers of multi-layer nonwoven fabric are formed of a spun bond nonwoven fibers and one middle layer can be formed of a melt blown nonwoven fiber or spun bonded fiber. In the present invention one of the preferred multilayer nonwoven is SSS formed nonwoven fabric.

[0063] In one embodiment, spun bond nonwoven fibers having the diameter in the range of 1-3 denier are obtained by adjusting the line speed in the range of 700 to 750 m/min. When the line speed is more than 750 m/min low weighted webs are obtained that can be useless in preferred usage are, and when the speed is less than 700 m/min high weighted webs are obtained which is not cost effective. The line speed is adjusted to 720 m/min more specifically, that allows obtaining lighter web structures having improved properties.

[0064] In a further embodiment, nonwoven fibers formed by known methods can be bonded with known methods of thermal bonding, mechanical or chemical bonding. In the present invention, fibers are more specifically thermal bonded by adjusting the temperature and pressure during embossing.

[0065] The temperature of emboss roll is set in the range of 130-175 °C and more preferably it is adjusted to 140 °C and the pressure applied by emboss roll is set in the range of 50-110 N/mm and more preferably it is adjusted to 90 N/mm.

[0066] In the case wherein the nonwoven fabric is formed by aforementioned emboss roll conditions, when the embossing temperature is higher than 175 °C, formed fibers are fused together and it is impossible to separate them. When the applied embossing pressure is higher than 110 N/mm formed web structures are deformed in emboss points as such that they cannot be used efficiently.

[0067] In another embodiment, the engraving depth of the pins of emboss roll can be in the range of 0,3 to 0,6 mm. When more than the depth of specified range is applied on the web structure, the web can be deformed and have unwanted holes on it.

[0068] In a further embodiment a nonwoven fabric have embossed (14) and non-embossed portions (16) that form bonding and nonbonding areas. In the present invention more specifically, the bonding area is in the range of 12-18%. Higher bonding area than 18 % cause stiffness and low bonding area than 12 % decreases the strength of the nonwoven layer. The specific range enhances the softness of the surface without losing the fabrics strength and by improving the pilling resistance of the fabric. The most preferred bonding area in the present invention is 14 %.

[0069] In one embodiment a nonwoven fabric (2) having an embossed portion of geometric structure of circularly shaped forms (4) is obtained wherein the forms can have round, oblong or polygonal shapes. In the present invention more specifically round shaped embossed portion which has the diameter in the range of 12-16 mm is preferred because of enhancing the softness and pilling resistance of nonwoven fabric with excellent effect in strength.

[0070] In a further embodiment, a nonwoven fabric having embossed structures which can be in the range of 10-50 figures/cm², preferably 15-30 figures/cm² and more preferably 24 figures/cm².

[0071] In another embodiment geometric structure of circularly shaped formed embossed pattern (4) is formed by dotted embossed lines (8) having round shape edges. In the present invention the dotted emboss lines (8) have more specifically oblong shape within the range of 0,5-2 mm length and in the range of 0,1-1 mm width dimensions, which enhance softness of nonwoven fabric and provide an excellent feel to the touch.

[0072] In one embodiment, nonwoven fabric in the present invention have embossed pattern of circularly shaped forms (4) intersecting with each other at least four intersection points (20) wherein the intersection points (20) are not embossed.

[0073] As shown in FIG. 1 the nonwoven fabric (2) have a circularly shaped embossed pattern (4) wherein the diameter of circularly shaped form (6) is 15 mm.

[0074] As shown in FIG. 2 the nonwoven fabric (2) have embossed (14) and non-embossed portions (16), wherein the embossed portions are formed by dotted emboss lines (8) by oblong shaped emboss structures (18); having 1,2 mm length of emboss line (10) and 0, 55 mm width of emboss line (12).

[0075] As shown in FIG. 2 the nonwoven fabric is having intersection points (20) of embossed patterns, wherein the intersection points (20) are not embossed.

Examples:

Example 1: Process for preparing nonwoven fabric referring to the pattern shown as FIG. 1

[0076] Nonwoven fabric having embossed pattern of circularly shaped form (4) as shown in **FIG. 1** is prepared by the following steps;

- a) Granulate polypropylene having 0,90 g/cm³ density is used as raw material in master batch,

- b) Glycerol in amount of 1,5 % is added in the polypropylene based polymer master batch,
 c) Prepared polymer mixture in step a and b, is melted and extruded in the line of extruder,
 d) Melt polymer is sent to spinnerets to form fibers that are having 1,5 denier diameter,
 e) Spun fibers are sent to the conveyor belt to lay down with the help of vacuum air and spun bond web is obtained at elevated temperatures,
 f) By following SSS process multi-layer nonwoven web that is having 11,4 g/m² fabric weight is formed,
 g) Formed webs at step f are bonded with hot calendering emboss roll that is set at 140 °C temperature and 90 N/mm pressure,
 h) The emboss roll applied final web structure is obtained in step g has closed geometric structures of circularly shaped forms of embossed structures.

[0077] The product prepared as Example 1 has specific properties as shown at Table 1.

Example 2: Process for preparing nonwoven fabric referring to pattern as shown at FIG. 3

[0078] Nonwoven fabric having embossed pattern structure as shown in FIG 3, is prepared by repeating the same procedure of Example 1. The obtained nonwoven web is formed by SSS process that is having 11,2 g/m² fabric weight.

[0079] The product has specific properties as shown at Table 1.

Example 3: Process for preparing nonwoven fabric referring to the pattern shown as FIG. 4

[0080] Nonwoven fabric having embossed pattern structure as shown in FIG 4, is prepared by repeating the same procedure of Example 1. The obtained nonwoven web is formed by SSS process that is having 11,8 g/m² fabric weight.

[0081] The product has specific properties as shown at Table 1.

Test Methods:

Evaluation of Softness

[0082] For evaluation of the softness of nonwoven fabric two methods are applied as explained below;

1. Tissue Softness Analyzer (TSA) used as softness measurement equipment.

[0083] TSA is generally used for the measurements of paper softness. A new method is applied to observe the softness of nonwoven fabric by using Emtec Tissue Softness Analyzer.

[0084] According to TSA measurement, 3 results are observed which are;

- surface softness (TS7),
- bulk softness (TS750) and,
- overall softness (HF) of fabric layer.

[0085] Nonwoven softness analysis is performed by using TSA as following;

- 1- The nonwoven sample is attached on the clamping ring of TSA equipment and fastened with screws,
- 2- Measuring head with rotor and engine is put on the sample,
- 3- Measuring head with ceramic rotor rotates under touching on the surface of the sample and for 45 seconds,
- 4- The measuring cell measures the force applied on the surface,
- 5- Obtained softness results are calculated as overall softness and given as a report.

[0086] Whereby, 200 mN force is applied on the surface of the nonwoven fabric at 45 seconds and, 3 results are observed as; surface softness (TS7), bulk softness (TS750) and overall softness (HF). HF result is taken as overall softness which is calculated by the software, by using the results of TS7 and TS750.

[0087] 5 single measurements of the same sample are performed successively and the average of the measurements is taken as the final result.

2. Improved softness felt by hand feel observation.

[0088] It is a feel to the touch measurement depending on hand feel as a subjective measurement. According to this measurement the surface softness is graded on the following criteria;

- 1 point: limited amount of softness feeling
- 2 points: feeling of improved softness
- 3 points: recognizable feeling of softness
- 4 points: very good softness feeling

Results of Evaluation of Softness

[0089] According to obtained results of TSA and hand feel observations shown at table 3; it can be seen that the softness values of example 1 product is greater than example 2 and 3 products.

[0090] Comparing the results of example 1 with the results of example 2 and 3, it can be seen that the best softness result is observed in Example 1 in which FIG. 1 is used as embossed pattern.

[0091] When the results of example 1 are compared with example 2 having emboss pattern of FIG. 3 and example 3 having emboss pattern of FIG. 4, which are produced by using the same method of example 1, it can be seen that the overall softness of example 1 (102, 1) is higher than the results of example 2 (101, 7) and example 3 (101, 2). It shows that, the fabric of example 1 having embossed structure of FIG. 1 is softer than the fabric of example 2 and 3 as comparing examples which are having FIG. 3 and 4.

[0092] The softness results of hand feel observations are also supporting TSA softness test results.

[0093] As comparing the result of example 1 with the other examples of 2 and 3 it can be seen that, example 1 has very good softness which is pointed as 4, but example 2 and 3 have recognizable feeling of softness which is pointed as 3.

Evaluation of Pilling Resistance

[0094] Martindale pilling test equipment is used to measure the pilling resistance of nonwoven samples. The equipment is calibrated under ISO12947 standard. The equipment has two parts of standard felts that are upper and lower felts. Measurement conditions are followed by using ISO139 standards. According to standards the place that is used to measure the pilling resistance of the samples is set at $20(\pm 2)^{\circ}\text{C}$ and $\%65(\pm 2)$ humidity. The test is followed under TS EN ISO 12945 standards.

[0095] For the measurement of the pilling resistance of nonwoven the following procedure is applied;

- 1- Nonwoven sample is prepared with $140 (\pm 5)$ mm diameter,
- 2- The sample is attached on the upper felt, that has 90 mm diameter,
- 3- The lower felt is covered with a part of nonwoven sample,
- 4- The lower felt that has 140 mm diameter is closed on the sample,
- 5- Felts are rubbed 1000 times against each other,
- 6- 3 single measurements are applied for each sample and average of them is taken as the result,
- 7- The test sample results and the samples which are not tested under pilling equipment are compared with each other.

[0096] To evaluate the test results of the pilling resistance of nonwoven fabric visual observation is applied.

[0097] According to this measurement the surface pilling is graded on the following criteria;

- 1 point: there is no pilling
- 2 points: small amount of pilling started to form
- 3 points: recognizable pilling started to form
- 4 points: fibers are considerably turned off
- 5 points: fibers are totally turned off

Results of Evaluation of Pilling Resistance

[0098] According to pilling resistance test results of different fabrics as shown at table 3; it can be seen that the best results are observed from example 1 product. Example 1 has superior pilling resistance properties when compared with other examples.

[0099] By application of pilling process on the surface of example 1 product, no pilling is observed. When it is compared with example 2 product, which has the emboss pattern of FIG. 3 it is seen that the fibers are totally turned off.

[0100] Example 1 product is compared with example 3 product and it is observed that, the pilling resistance of example 1 is better than example 3 again. Example 3 product has limited pilling resistance than example 1.

[0101] The results show that, the best resistance of pilling is observed with the product of example 1 having FIG. 1 as emboss pattern.

Evaluation of Strength

[0102] Tensile measurement test is applied by using Zwick strength equipment to evaluate the strength of nonwoven samples.

[0103] Tensile measurements at maximum force (N/5 cm) are measured with test stripe having 50mm x 250 mm dimensions, 100 mm clamp distance and 100 mm/min testing speed. The results are shown as average values of four single measurements.

[0104] The test is followed under ASTM D882-10 standard as;

1- Nonwoven test sample is prepared having 50 mm of machine direction (MD) and 250 mm of cross machine direction (CD),

4- The upper and lower parts of the sample is attached to the draw part of the machine and,

5- Tensile strength (F_{max}) of the sample is measured.

Results and Evaluation of Strength

[0105] According to tensile strength test results of both in the machine direction (MD) and in the cross machine direction (CD) shown at Table 3, it is seen that, MD and CD tensile strength of example 1 don't have significant changes comparing to example 2 and example 3 products.

[0106] When the results of Example 1 are compared with other examples, it can be said that a small increase of strength which is not very effective on mechanical properties of nonwoven fabric that used in industrial applications. Example 1 has nearly equivalent values to other examples. MD tensile strength of example 1 is 26 N/5cm and other example's results are nearly same as example 1.

[0107] The evaluation of CD tensile strength is same as MD tensile strength values. Example 1 has nearly equivalent values to other examples. CD tensile strength of example 1 is 12 N/5cm and other example's results are nearly same as Example 1.

[0108] Comparing the MD and CD tensile strength test results of example 1 product with example 2 and 3 products, it is seen that there isn't any significant change in terms of tensile strength.

[0109] As a result when improving softness and pilling resistance of the nonwoven, strength of the fabric is preserved.

[0110] As a result of the present invention, the polypropylene spun bonded nonwoven fabric, having light weight is exhibiting excellent feeling to the touch and high softness. Additionally it is observed that the fabric shows the best resistance to pilling. The nonwoven fabric as shown in FIG. 1 is particularly employed as a material for hygiene products such as diapers, femcare products or nappies as a part of top sheet, back sheet, panels, cuff, waist parts or ears of baby diapers, adult diapers, incontinence diapers, pant like diapers or feminine hygiene article ears.

[0111] When all of the conditions are taken into consideration, it can be seen that, example 1 gives the best results of nonwoven fabric. According to the test results, example 1 has superior properties and it is chosen as the product.

[0112] Following tables are showing the specific properties of nonwoven fabrics have different embossed patterns, production conditions of nonwoven fabrics and the test results of different embossed patterns shown in examples.

Table 1

Specific properties of nonwoven fabrics have different embossed patterns			
EXAMPLES	1	2	3
Embossed pattern	FIG. 1	FIG. 3	FIG. 4
MFI (g/10 min.)	- 25	- 25	- 25
Fabric weight (g/m ²) (gsm)	11,4	11,2	11,8
Embossed pattern bonding area (%)	14,1	14,5	14,1
Granulate polypropylene PPA0330516, product of clarient is used			

Table 2

Production Conditions of nonwoven fabrics			
EXAMPLES	1	2	3
Embossed pattern	FIG. 1	FIG. 3	FIG. 4
Emboss roll pressure (N/mm)	90	90	90
Emboss roll temperature (°C)	140	140	140
Line speed (m/mm)	720	720	720

Table 3

Test results of different embossed patterns shown in examples			
EXAMPLES	1	2	3
Embossed pattern	FIG. 1	FIG. 3	FIG. 4
Softness (TS7)	4,6	4,8	4,5
Softness (TS750)	2,0	2,1	1,6
Softness (HF)	102,1	101,7	101,2
Softness of hand feel observation	4	3	3
Pilling (visual observation)	1	5	2
MD tensile strength (N/5 cm)	26,0	25,7	25,1
CD tensile strength (N/5 cm)	12	11,7	12

Claims

1. A soft and pilling resistant multilayer nonwoven fabric of polymeric fibers embossed with a pattern of closed geometric structures of circularly shaped forms with an embossing area of between 12-18 % of total nonwoven web area wherein,
 - The closed geometric structures are overlapping each other and has at least four intersection points (20) with adjacent closed geometric structures and,
 - Each closed geometric structure of circularly shaped form has the dimensions in the range of 12-16 mm and lacks embossments in their center.
2. A nonwoven web according to claim 1, wherein said web is composed of polymeric fibers of 1-3 deniers and of 10-15 g/m² density.
3. A nonwoven web according to claim 2, wherein said polymeric fibers comprise polyethylene, polypropylene or mixtures thereof.
4. A nonwoven web according to claim 3, wherein said polymeric fibers further comprising up to 10 % amount of glycerol.
5. A nonwoven web according to claim 1, wherein said multilayer nonwoven web comprise of at least three layers of spun bond or melt blown nonwoven layers wherein outer layers are spun bond layers.
6. A nonwoven web according to claim 1, wherein said closed geometric structures of circularly shaped forms can be oval, round or polygonal shaped.
7. A nonwoven web according to claim 6, wherein said closed geometric structures of circularly shaped forms are preferably round with a diameter of 12-16 mm, and more preferably with a diameter of 15 mm.

8. A nonwoven web according to claim 1, wherein said closed geometric structures of circularly shaped forms (4) are formed by series of engraved unitary embossments of dotted lines (8).
9. A nonwoven web according to claim 8, wherein said embossments of dotted lines (8) are round, oval, oblong, elliptical or polygonal shaped.
10. A nonwoven web according to claim 9, wherein said dotted structures are of 0.5-2 mm of length and 0.2-1 mm of width and 0.3-0.6 of depth.
11. A nonwoven web according to claim 10, wherein the geometric structures of the embossments are preferably oblong shaped with the preferred dimensions of 0,5 mm width and of 1,2 mm length.
12. A nonwoven web according to claim 11, wherein the preferred embossed area is % 12-16, and more preferably %14 of total nonwoven area.
13. A nonwoven fabric according to preceding claims wherein, the fabric have polypropylene based fibers formed as SSS web structure, and the webs are thermally bonded with an emboss roll having circularly shaped embossments having 15 mm diameter and forming the embossing area of %14.
14. A process for preparing a nonwoven web according to preceding claims comprising the steps;

A: providing a %1,5 glycerol containing polypropylene based polymer mixture,
B: extruding the mixture to a melt and spinning through 1,5 denier spinnerets,
C: cooling and stretching the filaments,
D: formation of webs with spun bond technique,
E: thermal bonding of at least 3 spun bond web layer formed in step D by applying emboss roll temperatures set in the range of 130-175 °C, preferably 140 °C and at pressures set in the range of 50-110 N/mm, preferably 90 N/mm.
15. Use of nonwoven webs of preceding claims in preparation of disposable absorbent article parts comprising of diapers, femcare products or nappies; as a part of top sheet, back sheet, panels, cuff, waist parts or ears of baby diapers, adult diapers, incontinence diapers, pant like diapers or feminine hygiene article ears.

Amended claims in accordance with Rule 137(2) EPC.

1. A soft and pilling resistant multilayer nonwoven fabric of polymeric fibers embossed with a pattern of closed geometric structures of round and/or oval shaped forms with an embossing area of between 12-18 % of total nonwoven web area wherein,

- The closed geometric structures are overlapping each other and has at least four intersection points (20) with adjacent closed geometric structures and,
- Each closed geometric structures of round and/or oval shaped form has the dimensions in the range of 12-16 mm and lacks embossments in their center.
2. A nonwoven web according to claim 1, wherein said web is composed of polymeric fibers of 1-3 deniers and of 10-15 g/m² density.
3. A nonwoven web according to claim 2, wherein said polymeric fibers comprise polyethylene, polypropylene or mixtures thereof.
4. A nonwoven web according to claim 3, wherein said polymeric fibers further comprising up to 10 % amount of glycerol.
5. A nonwoven web according to claim 1, wherein said multilayer nonwoven web comprise of at least three layers of spun bond or melt blown nonwoven layers wherein outer layers are spun bond layers.
6. A nonwoven web according to claim 1, wherein said closed geometric structures of oval and/or round shaped

forms are preferably round with a diameter of 12-16 mm, and more preferably with a diameter of 15 mm.

7. A nonwoven web according to claim 1, wherein said closed geometric structures of oval and/or round shaped forms (4) are formed by series of engraved unitary embossments of dotted lines (8).

8. A nonwoven web according to claim 8, wherein said embossments of dotted lines (8) are round, oval, oblong, elliptical or polygonal shaped.

9. A nonwoven web according to claim 9, wherein said dotted structures are of 0.5-2 mm of length and 0.2-1 mm of width and 0.3-0.6 of depth.

10. A nonwoven web according to claim 10, wherein the geometric structures of the embossments are preferably oblong shaped with the preferred dimensions of 0,5 mm width and of 1,2 mm length.

11. A nonwoven web according to claim 11, wherein the preferred embossed area is % 12-16, and more preferably %14 of total nonwoven area.

12. A nonwoven fabric according to preceding claims wherein, the fabric have polypropylene based fibers formed as SSS web structure, and the webs are thermally bonded with an emboss roll having oval and/or round shaped embossments having 15 mm diameter and forming the embossing area of %14.

13. A process for preparing a nonwoven web according to preceding claims comprising the steps;

A: providing a %1,5 glycerol containing polypropylene based polymer mixture,

B: extruding the mixture to a melt and spinning through 1,5 denier spinnerets,

C: cooling and stretching the filaments,

D: formation of webs with spun bond technique,

E: thermal bonding of at least 3 spun bond web layer formed in step D by applying emboss roll temperatures set in the range of 130-175 °C, preferably 140 °C and at pressures set in the range of 50-110 N/mm, preferably 90 N/mm.

15. Use of nonwoven webs of preceding claims in preparation of disposable absorbent article parts comprising of diapers, femcare products or nappies; as a part of top sheet, back sheet, panels, cuff, waist parts or ears of baby diapers, adult diapers, incontinence diapers, pant like diapers or feminine hygiene article ears.

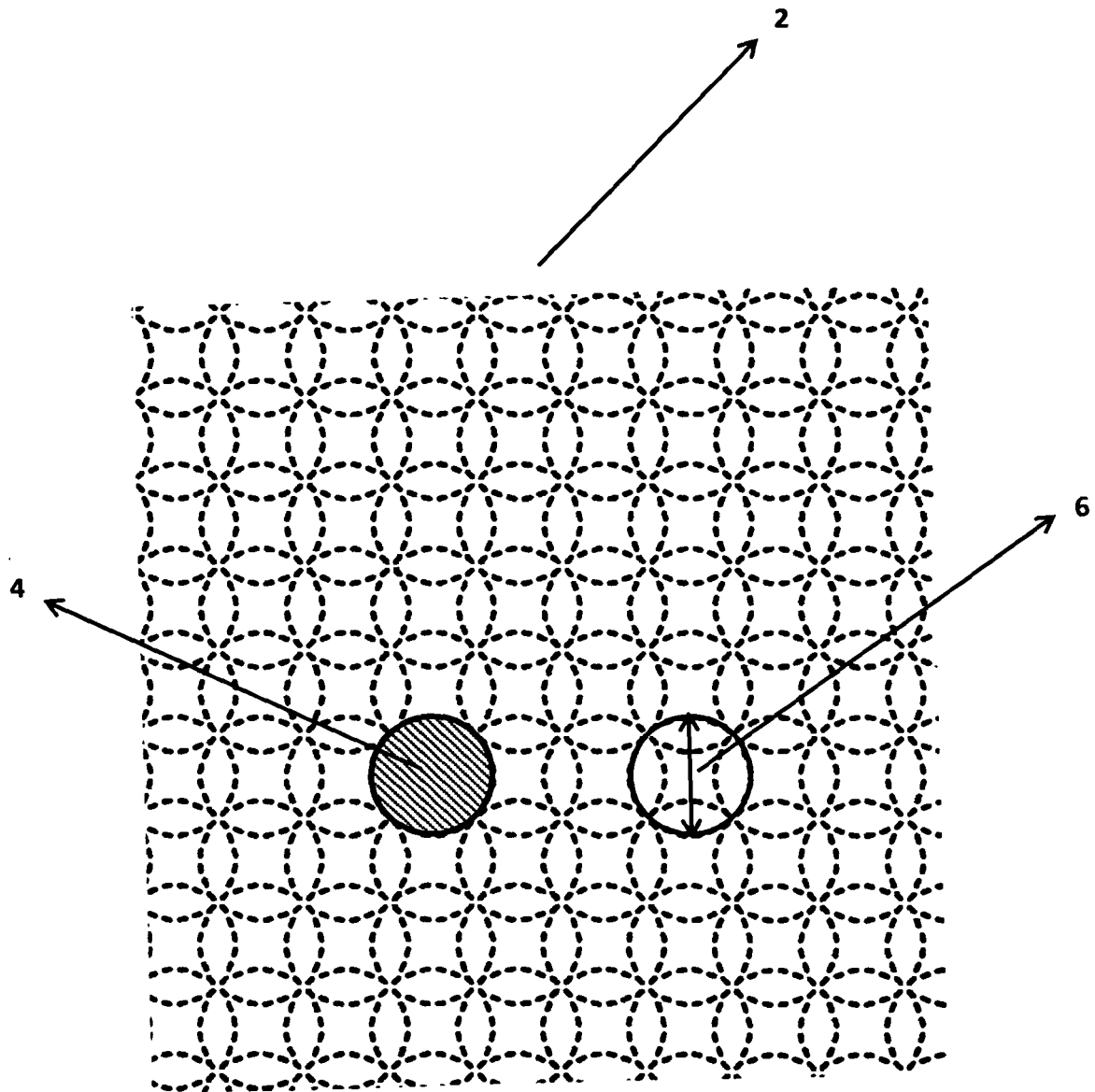


FIG. 1

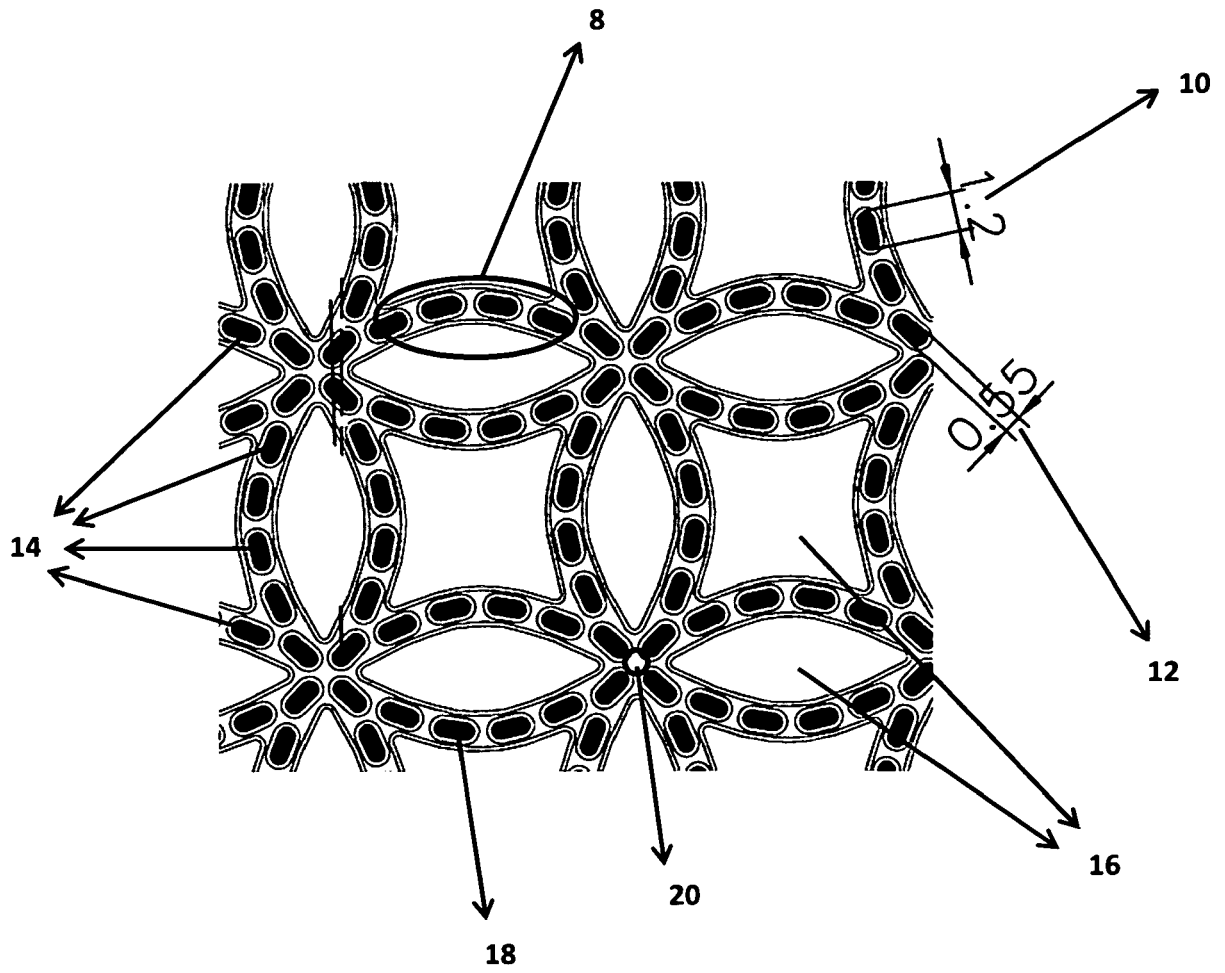


FIG. 2

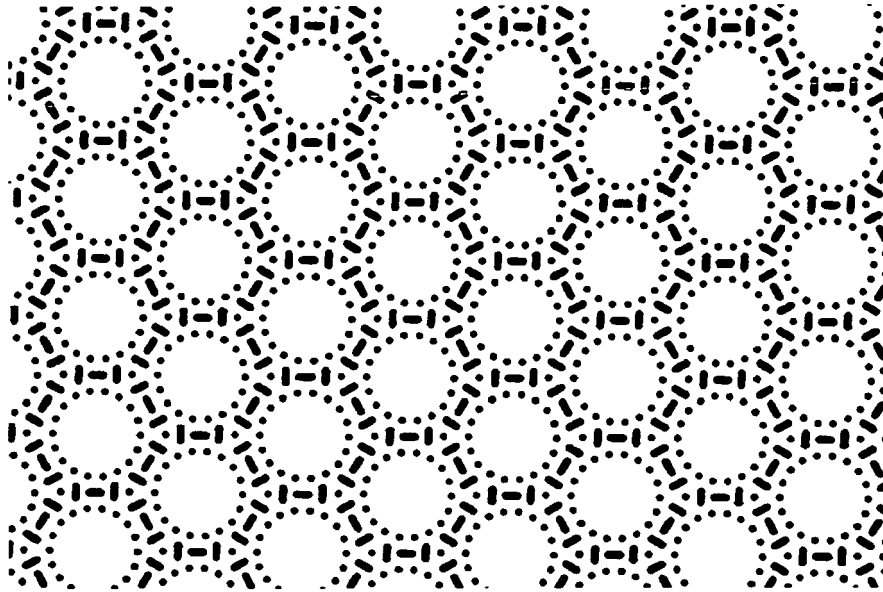


FIG. 3

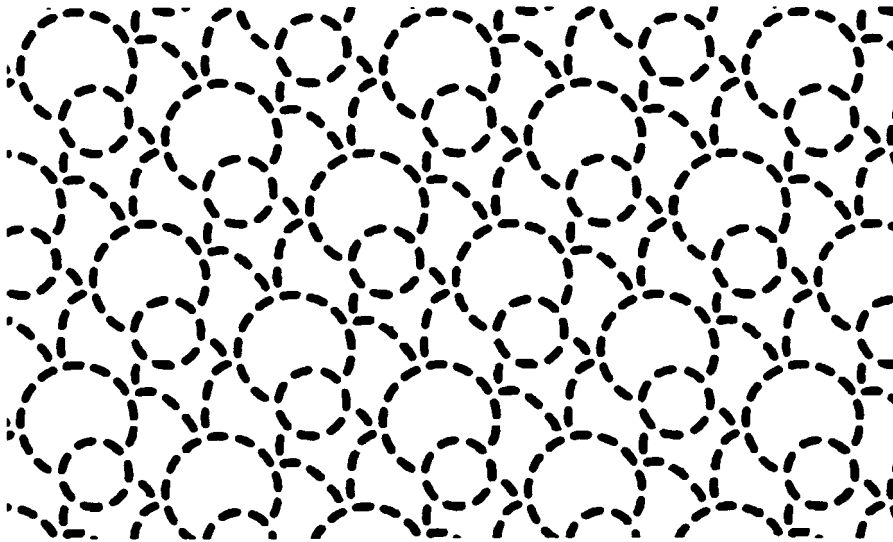


FIG. 4

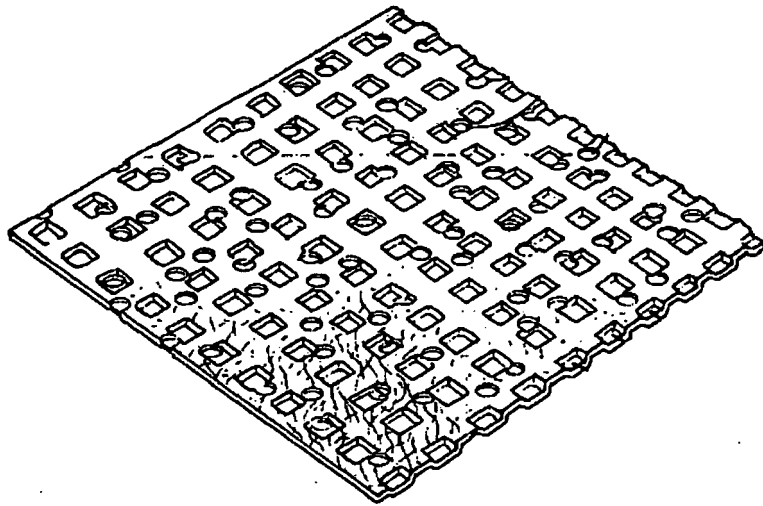


FIG. 5

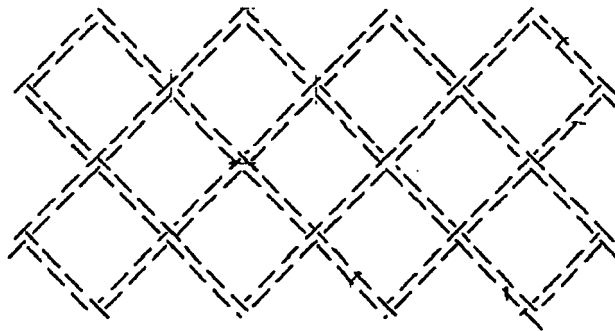


FIG. 6



EUROPEAN SEARCH REPORT

Application Number
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Place of search Munich		Date of completion of the search 16 June 2016	Examiner Elsässer, Ralf
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