Sept. 4, 1973 W. HELING 3,756,907

PRODUCTION OF PERFORATED NON-WOVEN FIBROUS WEBS

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FIG. 1.

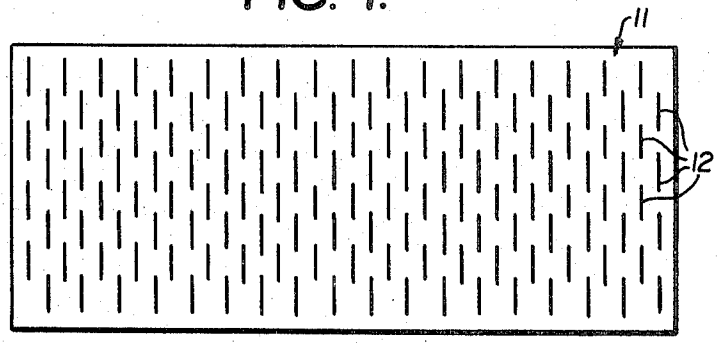
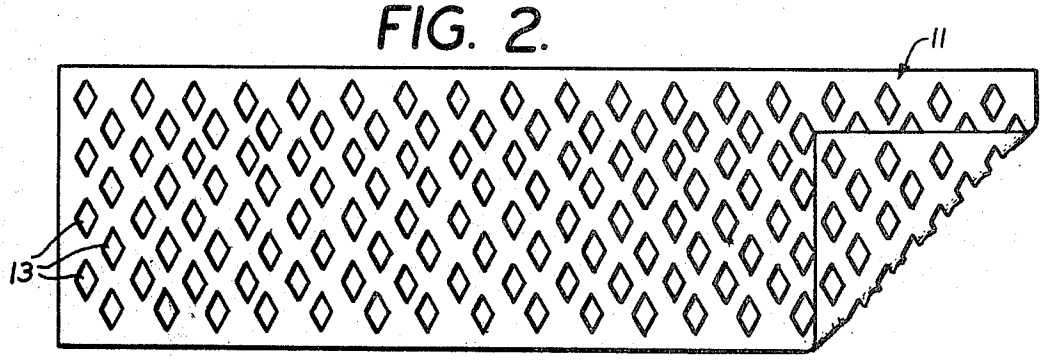


FIG. 2.



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PRODUCTION OF PERFORATED NON-WOVEN FIBROUS WEBS

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U.S. Cl. 162—114 7 Claims

ABSTRACT OF THE DISCLOSURE

Perforated non-woven fabrics are produced by forming a fibrous web containing a binder, forming elongated slits in said web, partially setting the binder, stretching said web transversely of said slits whereby said slits form holes, and completing setting of said binder with said web in stretched condition whereby said web is bonded and retains said holes even upon release of the stretching force.

The present invention relates to the production of perforated non-woven fabrics, i.e. non-woven fabrics provided with holes.

Non-woven fabrics are being used today for many purposes. For their manufacture, a mat is first prepared and then sprayed or impregnated with a binding agent. Then the mat thus impregnated is subjected to a heat treatment wherein the binding agent, latex for example, is set or vulcanized. The sheet material thus prepared has good resiliency and can be used as a stiffening insert, i.e. interfacing, or for many other purposes, e.g., as throw-away cloths.

In other applications it is desirable to produce a pattern of holes in the final product. This, however, requires a considerable investment in equipment. First the mat must be laid on a sieve and then be covered with a perforated plate, somewhat in the manner of U.S. Pat. 2,861,251. Then strong jets of water are shot from above through the holes in the plate. The water driven with great force through the holes pushes aside the fibers therebelow and then exits through the sieve. The mat thus perforated is still not very stable and must then be impregnated, at an additional great investment in equipment, so that it will be strengthened.

It has now been found that non-woven fabrics containing holes in any desired pattern can be prepared very simply by first suspending the fibers in a very great excess of water (about 1 part fibers to 1000 parts water), as is done in the manufacture of paper.

The water also contains a binding agent, e.g., latex. It is desirable to coagulate the latex, because then the precipitated binding agent deposits itself preferentially on the surface of the fibers simultaneously suspended in the water. Then the fiber suspension containing the binding agent is poured onto a screen, e.g., a screen as described in "Voith Forschung und Konstruktion," No. 16, May 1967, Article No. 12, reprint 1782, thereby forming a coherent web of fibers.

The coagulation of the binding agent can be brought about by the addition of acid or salts or by the electrical reversal of the charge of the binding agent dispersion, using known methods. The use of heat-sensitized latices is also possible. Here the binding agent coagulates as soon as a certain temperature is reached, which can be very low, e.g., 35° C.

Basically, the prior coagulation of the binding agent onto the fibers can be omitted. In this case, of course, considerably more binding agent must be added, because when the mixture is poured onto the screen a large part of the binding agent is lost with the water. If, however, it is

first coagulated, nearly all of the binding agent deposits on the fibers, so that, when the mixture is poured onto the screen, almost nothing but pure water flows through the screen.

After a wet continuous mat of fibers containing binding agent has formed, the mat is first drained as well as possible. Then the mat, still wet, is placed on a suitable support and provided with a plurality of small slits. The slits may have, for example, a length of 2 to 8 mm. At a distance of the same order of magnitude, the second slit is made, until a whole row of slits is produced. At a distance of a few millimeters from the first row of slits a second row of slits is created, preferably in such a manner that an offsetting of the slits results, i.e. the slits are staggered. The slits can be produced with fine spring blades or with rollers having razor-blade-like segments. Apparatus suitable for the slitting of plastic sheet materials can be used for the instant slitting operation.

The invention will be further described with reference to the accompanying drawings wherein:

FIG. 1 is a schematic plan view of a fiber web which has been slit; and

FIG. 2 is a schematic plan view of the web after it has been partially set, stretched transversely of the slits and setting of the binder has been completed.

Referring now more particularly to the drawing, a non-woven fleece or mat **11** containing binder is laid down in paper making fashion as described hereinabove and the wet fleece is slit to provide staggered rows of slits **12**.

Either before or after the slitting operation, the mat is given a preliminary drying on a cylinder or drum dryer to such an extent that it contains only 80 to 100% moisture (with reference to the fiber weight). Then, in the final drying process at about 130–160° C., it is stretched by about 30 to 50% transversely of the slits and at the same time dried. This widens the slits to holes **13** of generally diamond-shaped configuration as can be seen in FIG. 2. Since at the same time a vulcanization or setting of the binding agent takes place the holes are stabilized. The end product in certain embodiments resembles expanded metal structures in that the bonded web turns up sideways between openings **13** to give a three-dimensional effect.

The invention will be further described in the following illustrative example wherein all parts are by weight unless otherwise stated.

EXAMPLE

2.5 kg. of 3 denier rayon fibers 10 cm. long and 2.5 kg. of 6 denier nylon fibers 20 cm. long are dispersed in 10 liters of water. To this dispersion there are added 2 kg. of Butofan KR 2345 which is a coagulatable butadiene-acrylonitrile latex sold by Farbenfabriken Bayer. Then there are added 0.08 kg. of Pol-imin SN 20 which is a coagulant causing the Butofan to coagulate. The coagulated latex is thereby deposited on the surface of the fibers. With continuous stirring the thus prepared fiber slurry is poured onto a "Hydroformer Steigsieb," sold by the German firm Voit cif Heidenheim, i.e. the suspension is poured onto a moving sieve having a width of 1.5 m. at such a speed that the resulting non-woven on the screen has a weight of 50 g./m.^{2}. By suction the still wet fleece is freed from as much water as possible, i.e. down to 200% of water based upon the fiber weight. Then the still wet fleece is forwarded onto a backing consisting of foamed rubber. Here the sheet structure is slit with a slittling machine as described in Czech Patent 114,838, the slits having a length of 4 mm. The distance between slits in the same line is 3 mm.; the lateral distance between adjacent lines of slits is 2 mm.

Subsequently the thus slit fleece is dried on a drum dryer, the metal surface of which is heated to 120° C.

Thereby the water content goes down to 80% of the fiber weight. Then the fleece is forwarded to a tenter frame wherein the width of the fleece band is expanded from 1.5 to 2.4 m. whereupon the slits are converted into diamond like openings. Originally the length of a slit is 4 mm. but after the expansion the length is only 3 mm. but, on the other hand, the original width which is practically zero is brought to 2 mm. The temperature of the air in the tenter frame is 140° C., the binder thereupon setting so that even upon removal from the frame the fabric maintains its shape and three-dimensional appearance.

The fibers suitable for practicing the invention include synthetic fibers such as nylon, polyester, acrylics, olefins, cellulosics such as acetate, rayon, and the like, as well as natural fibers such as cotton, wool, and the like, and blends thereof. Their deniers and lengths may be varied widely. The fibers may be laid down into the initial fleece by the wet lay process described hereinabove or by the known dry lay processes, involving air deposit or cross-laying of carded laps. The binder may be included in the liquid in the event of wet laying or it may be subsequently applied by spraying, coating or the like; in the case of dry laying by air deposit the binder may be deposited simultaneously with the fibers or it may be post-applied as by sprinkling, liquid impregnation, spraying or foam impregnation. If the binder is applied as a dry solid, the initial partial setting may be achieved by a light heating to render tacky the outside of the binder particles. The type and proportion of binder to fiber may also vary widely as is known in the non-woven art depending upon the intended end use and desired hand.

As noted, the partial setting may be effected either before or after slitting. If the water content is very high it may be desirable to provide a resilient backing to facilitate slitting before partial setting. The slitting itself can be effected by localized melting in the case of fusible fibers although it is preferably effected by cutting.

The extent of transverse stretching depends upon the proportion of holes desired in the final structure and the disposition and arrangement of the slits. Drying or completion of setting of the binder is of course effected with the fabric in stretched condition so as to retain the expanded, perforated or open configuration.

In contrast with existing perforated non-wovens wherein the action of water jets to displace fibers and form holes causes bunching up of fibers about the holes, the new fabric is characterized by a substantially uniform distribution of fibers throughout the fabric, even around the holes. The three-dimensional effect gives a unique hand and appearance not heretofore realized with fiber products.

It will be appreciated that the instant specification and examples are set forth by way of illustration and not limitation, and that various modifications and changes may be made without departing from the spirit and scope of the present invention.

What is claimed is:

1. Process of producing perforated non-woven fabrics which comprises forming a non-woven fibrous web containing a binder, forming elongated slits in said web, partially setting the binder, stretching said web transversely of said slits whereby said slits form holes, and completing setting of said binder with said web in stretched condition whereby said web is bonded and retains said holes even upon release of the stretching force.

2. Process according to claim 1, wherein said slits are provided in a plurality of staggered rows.

3. Process according to claim 1, wherein said web is wet and is dried to a water content of approximately 80 to 100% based on the weight of fiber, thereby to effect partial setting of said binder, completion of setting being effected by completion of drying.

4. Process according to claim 1, wherein said slits range in length from about 2 to 8 mm. and are arranged in rows where they are spaced from adjacent slits by about 2 to 8 mm.

5. Process according to claim 1, wherein the web is formed by suspending fibers in water containing a binder, and pouring the suspension onto a screen to leave a wet binder-containing web.

6. Process according to claim 5, wherein the binder is in the suspension in coagulated condition.

7. Process according to claim 6, wherein the wet binder-containing web is dried to a water content of approximately 80 to 100% based on the weight of fiber, thereby to effect partial setting of said binder, completion of setting being effected by completion of drying, said slits ranging in length from about 2 to 8 mm. and being arranged in staggered rows in which they are spaced from adjacent slits by about 2 to 8 mm.

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19—161 P; 156—229, 252; 162—197