April 11, 1961 R. G. TURNER 2,978,786

PROCESS FOR MAKING NON-WOVEN FABRIC

Filed June 13, 1958

FIG. 1

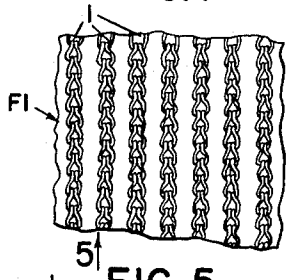



FIG. 2

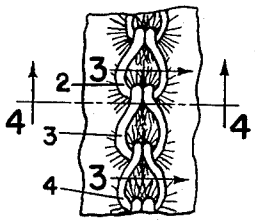



FIG. 3

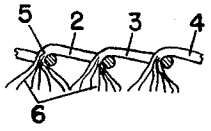



FIG. 4


FIG. 5


FIG. 6

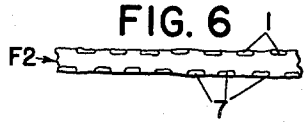



FIG. 8

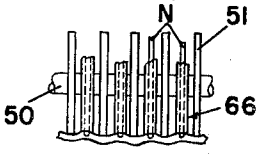



FIG. 9

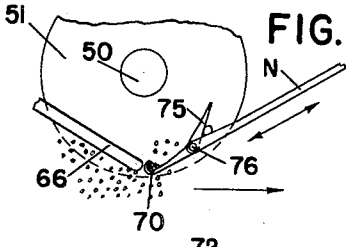



FIG. 7

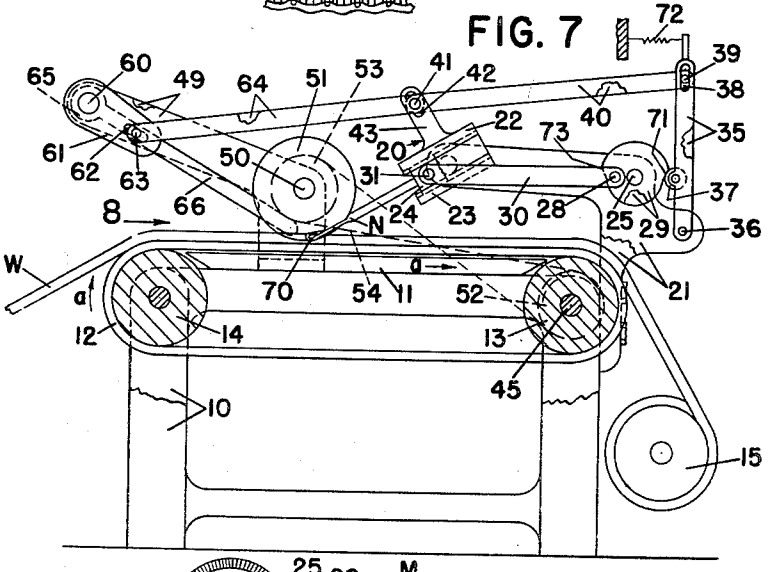



FIG. 10

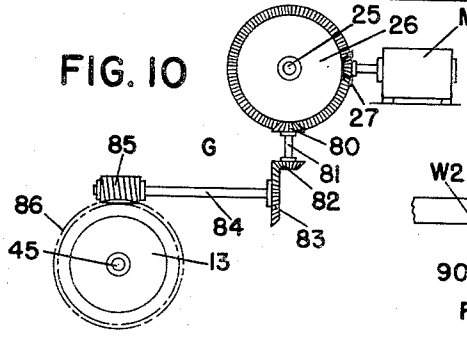
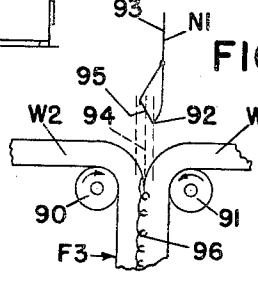



FIG. 11

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# PROCESS FOR MAKING NON-WOVEN FABRIC

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3 Claims. (Cl. 28—72.2)

This invention relates to improvements in nonwoven fabrics and to the method and apparatus for their manufacture.

Many forms of so-called nonwoven fabrics which are made directly from a web of loosely assembled fibers include binders of one form or another which tend to strengthen the fabric but also prevent it from having desirable flexibility and draping qualities. It is an important object of the present invention to reenforce a web of fibers by interconnecting groups of fibers in a manner to provide areas of increased strength which make an adhesive binder unnecessary. This result as shown herein involves the step of forming the fiber groups into loops and interlooping them in a manner similar to the knitting process but differing from the latter in that the groups of fibers are not in the form of completed threads or yarns but are rooted in the web and are frictionally engaged with other fibers of the web.

It is a further object of the invention to provide a nonwoven fabric of the general type mentioned wherein interconnecting loops formed from groups of fibers are disposed on one side of the web to give it a knitted appearance while the opposite side of the web has its fibers unlooped and possesses a fleece-like texture.

It is another object of the invention to provide a method for forming the loops including the use of a knitting needle which is projected partway into the web to engage a small number of fibers and then be withdrawn to hold these fibers in the hooked end of the needle to form a loop through which the needle can draw the next group of fibers which it collects from the web. In this method the fibers which are formed in loops may extend through to the other side of the fabric or may be frictionally entangled or engaged with other fibers of the web so that while the loops are fairly well pronounced on one side of the fabric the fibers of which they are formed extend in diverse directions into the web without producing a pattern on the opposite side.

It is another object of the invention to provide means whereby the size of the group of fibers being caught by the hook of the needle can be varied. In this feature of the invention the needle is inserted partway into the web along one path and is then depressed to be withdrawn along a different path, the amount of depression of a needle depending upon the number of fibers which are desired to form the loop.

It is a further object of the invention to provide for holding the web down at the sides of a needle so that when the latter is withdrawn it will not be able to lift the entire web.

It is a still further object of the invention to provide for holding down the fibers which are just beyond and aligned with the hook of the needle to prevent undesired lifting of unhooked fibers by neighboring hooked fibers as the needle is withdrawn. In this feature of the invention the pressing down force is exerted more or less in a line with the needle as distinguished from the first hold-down forces which are exerted at the sides of the needle.



It is another object of the invention to provide a machine by which the fabric can be made. The machine includes a bar to carry a series of needles together with means to move the bar so that the needles will be inserted into and withdrawn from the web. The machine also includes a feed for the web whereby the latter is moved progressively through the machine to and away from the operating zone at which the needles operate while forming the aforesaid loops. The machine also is so made that it can vary the amount by which the needle is depressed to vary the size of the group of fibers which are to be withdrawn from the web and means are also provided for varying the amount of downward force exerted on the parts of the web in alignment with the needles.

It is another object of the invention to provide a fabric and the method of making it wherein two webs are moved into face to face contact and are joined by interconnected loops which form wales that are buried within the fabric so that both sides of the latter will have a fleece-like structure.

In order that the invention may be clearly understood reference is made to the accompanying drawings which illustrate by way of example the three embodiments of the invention and in which:

Fig. 1 is a plan view of a fabric made according to the preferred form of the invention showing several wales of interknitted loops of fibers,

Fig. 2 is an enlargement of a part of Fig. 1 showing in greater detail the looping of the groups of fibers and the manner in which the fibers of the group are distributed into the web,

Figs. 3 and 4 are vertical sections on line 3—3 and 4—4 respectively, Fig. 2,

Fig. 5 is an end view looking in the direction of arrow 5, Fig. 1,

Fig. 6 is a view similar to Fig. 5 but showing a modified form of the invention wherein the wales of interconnected loops are formed on both sides of the fabric,

Fig. 7 is a diagrammatic view of a machine for making fabric according to the invention,

Fig. 8 is a detail side view looking in the direction of arrow 8, Fig. 7,

Fig. 9 is a diagram showing a needle which has just been inserted into a web and the means for holding down the adjacent fibers,

Fig. 10 is a diagram showing drive connections between the cam shaft and web advancing roll shown in Fig. 7, and

Fig. 11 is a diagram showing a modified form wherein two webs are joined by interconnecting loops arranged along the contacting faces of the webs.

The raw material from which the fabric is made comprises a web built up of a large number of loosely assembled fibers which may be made in any manner as for instance in a carding machine. The fabric F1 shown in Fig. 1 is made from such a web but has a series of parallel wales 1 of interconnected loops running lengthwise of the web. These wales may be as close or as far apart as the pattern of the particular fabric requires. As shown in Fig. 5 the wales are all on the top side of the fabric, the fibers below the wales being substantially in their original form and having a fleece-like texture, many of these fibers, however, being drawn into the loops which form the wales.

Referring more particularly to Fig. 2, three loops 2, 3 and 4 are shown as representing a small fragment of the structure shown in Fig. 1. The loop 2 has drawn up through it loop 3, and in turn the latter has drawn up through it loop 4. These loops are formed in successive operations of a knitting needle as will be described. Fig. 3 shows each loop being made of a group 5 of fibers which are collected more or less in stranded

form, the fibers at each side of each of the loops 2, 3 and 4 spreading out at 6 and being rooted down into the web. Fig. 4 shows the upper part of loop 3 over the widened part of loop 2.

Fig. 6 shows a modification which is somewhat similar to the fabric shown in Fig. 1 except that there is a series of wales 7 on the underside thereof as well as on the top, the wales on the underside being preferably staggered transversely with respect to the wales on the top side. The fabric F2 shown in Fig. 6 can be made by running the web through a machine as will be described to form first a series of wales on one side of the web after which the web is inverted and, if desired, passed through the machine a second time in reversed order to form a series of wales on the opposite side.

In the usual knitted fabric the breaking of a thread will result in a so-called run in which a number of loops become disconnected. In the present invention the breaking of a loop will not result in a similar run due to the fact that the groups of fibers are anchored or rooted into the web. When making the fabric shown in Fig. 6 by running the fabric through the machine in reversed order the loops of the wales on one side will be pointed or directed in a direction opposite the direction of the loops in the wales on the opposite side, thereby further preventing runs which would otherwise produce a thin spot in the fabric F2.

Referring more particularly to Figs. 7, 8 and 10, the machine has a frame 10 provided with a fixed table 11 over which runs a conveyor belt 12 trained around right and left-hand pulleys 13 and 14. The web W is supplied from the left as viewed in Fig. 7 and is deposited on the belt 12 and is moved toward the right and after the knitting operation has been performed producing the fabric F1, the latter is led to any appropriate form of wind-up mechanism 15.

Mounted for oscillation on frame part 21 on each side of the machine is a needle guide 20 having parallel guide plates 22 and 23. A needle bar on block 24 extends across the machine and has each of its ends received between plates 22 and 23. It is to be understood that the guides 20 rock in unison and that by their angular position they determine the angle of motion of bar 24.

The bar 24 has secured thereto a number of aligned transversely spaced needles N which are very similar to a well-known type of knitting needle. These needles project away from the bar 24 in an inclined downward position as shown in Fig. 7 and the position of the needles is determined by the location of the bar 24 in the guides 22 and 23.

In order to cause sliding of the bar 24 along its guides 22 and 23 there is provided a shaft 25 which has secured thereto a relatively large bevel gear 26 driven by motor M by means of a smaller bevel pinion 27. A crank pin 28 on each of two cam plates 29 secured to shaft 25 is connected to one end of a link 30 the other end of which is pivotally connected at 31 to an end of bar 24. It is to be understood that there is a link 30 and a cam plate 29 at each side of the machine so that reciprocating motion may be given to the opposite ends of the bar 24 as the shaft 25 rotates.

At each side of the machine is a lever 35 pivoted at 36 to frame part 21 having rotatable thereon a roll 37 which engages the adjacent cam 29. The upper end of each lever 35 is formed with a slot 38 in which is adjustably secured a stud 39 on which is pivoted the right-hand end of a link 40 as viewed in Fig. 7. The link has its left-hand end pivoted to the stud 41 which is adjustable in a slot 42 formed in an arm 43 projecting upwardly from the adjacent guide 20. It is by means of cams 29, levers 35, links 40 and studs 41 that the needle carrier or guides 20 can be rocked angularly with respect to the machine frame.

A system of gearing G interconnects the shaft 25 and shaft 45 to which the roll 13 is secured. This system G



effects a considerable reduction in speed so that the shaft 45 will rotate at a low rate compared to the speed of shaft 25. The roll 13 will advance only a fraction of an inch for each rotation of the shaft 25 and the belt 12 will be relied upon to turn the roll 14. The web is therefore fed through the machine at a uniform rate which, however, is slow enough to permit insertion and withdrawal of the needles N into the web as the shaft 25 rotates.

Other frame parts 49 have mounted for rotation thereon a shaft 50 having secured thereto a number of spaced discs 51 which are at the sides of the needles so that the latter project into the spaces between the discs, see Fig. 8. These discs serve to limit upward motion of that part of the web adjacent to the needles or at the operating zone and are rotated so as to have a peripheral speed equal to the linear speed of the web. Rotation of the discs is effected by pulleys 52 and 53 secured to shafts 45 and 50 respectively and connected by a crossed belt 54. The discs therefore rotate in a direction to assist in feeding the web to the right as viewed in Fig. 7 as the belt 12 moves in the direction indicated by arrow *a*.

Mounted for oscillation on the frame parts 49 is still another shaft 60 to which are secured arms 61 each having a radial slot 62 in which is fixed in adjusted position a stud 63 on which is pivoted the left end of a link 64. The right-hand ends of the latter links may be pivoted on studs 41 or another stud similar to it.

Secured to the shaft 60 is a push-down structure 65 from which extend downwardly into spaces between the discs a series of placer feet 66. These feet are aligned with the needles and terminate close to the latter when the needles are fully inserted into the web. The feet are mounted for slight rising and falling motion and are intended to be in low position when the needle is being withdrawn after which the feet can be lifted to remove any frictional obstruction which they might otherwise offer to onward feed of the web. The undersides of the feet will, of course, be smooth so that the web can slide under them and while the feet have been shown as capable of having a slight motion toward and from the web they can, if desired, be left in fixed down position and not rocked.

In operation the needle bar 24 will be reciprocated along the slides 22 and 23 and as the needles move downwardly toward the web their hooks 70 will be exposed and will be partially inserted into the web as bar 24 reaches the limit of its lefthand motion, Fig. 7. The hooks are rounded as shown in Fig. 9 and any of the fibers which engage the underside of the hook will be pressed down so that they cannot be caught by the hook when the latter is withdrawn. The fibers engaging the upper part of the hook, however, may be somewhat deflected by the hook and as the latter passes the deflected fibers they will tend to move back into the path of the hook. When the needles are withdrawn the fibers in the paths of their hooks will be lifted and be collected into groups, as already described.

If the needle is not pushed down after being inserted into the web as shown in Fig. 9 but is withdrawn along the same path of its insertion then all of the fibers which are in the path of the hook as shown in Fig. 9 will be pulled up to form groups. This condition could exist by disconnecting a mechanism which rocks the needle carrier or guides 20 and fixing the latter in position. If, however, it is desired that a lesser amount of fibers than that indicated in Fig. 9 be lifted by the hooks the latter will then be rocked in a downwardly direction before being withdrawn. This downward rocking is effected by a decline 71 on each cam 29 which comes under its roll 37 when the needles have reached their lowest position so that a slight further turning of shaft 25 will allow springs 72 to rock the carrier 20 and depress the hooked ends of the needles. The bar 24 is then withdrawn so that the needles are pulled out of the web

along the path somewhat lower than the path they traveled when being inserted into the web. The hooks **70** therefore withdraw a reduced number of fiber to make a smaller group and loop. After the needles have been fully withdrawn and the shaft **25** given a half turn from the position shown in Fig. 7 an incline **73** on each cam **29** will engage its roll **37** to rock carriers **20** in a clockwise direction and thereby lift the needles for their next inserting motion.

As the hooks of the needles are withdrawn from the web they tend to lift the fibers engaged by them and in doing so may tend to lift the whole area across the web at the operating zone. The discs **51**, however, exert downward forces on the web so that only those parts of the web between discs can be lifted by the needles. Also, the feet **66** exert downward forces on those parts of the web intermediate the discs but aligned with the needles so that the lifting effect of the hooks as the needles are withdrawn is limited to a small area between the discs and to the right of feet **66**, Fig. 7.

The needles N as shown herein are of the latch type and each is provided with the usual latch **75** pivoted to the needle at **76**. The latches operate somewhat similarly to latches found in usual knitting needles in that they will be moved to the left from the position shown in Fig. 9 by the previously formed loop as the needle is withdrawn from the web and in doing so will close the hook **70** and permit the group of fibers caught by it to be drawn through the previously formed loop.

The operation thus far described will produce a fabric such as shown in Figs. 1 and 5. If it is desired to form the fabric F2 suggested in Fig. 6 the web can then be inverted and run through the machine again so that the previously formed wales will be moved along the table or plate **11** and another series of wales **7** produced on the opposite side of the web.

The previously mentioned gearing G has been omitted from Fig. 7 for the sake of clarity but is shown in Fig. 10. The bevel gear **26** meshes with a bevel pinion **80** on an upright shaft **81** the lower end of which has secured thereto another bevel pinion **82** which meshes with a bevel gear **83** on a horizontal shaft **84**. A worm **85** on shaft **84** meshes with a worm gear **86** on shaft **45**. The gearing G effects a considerable reduction in speed from shaft **25** to shaft **45**, and the diameters of the gears, pinions and rolls **13**, and the reduction effected by the worm, are chosen to produce a slow forward feed of the web while permitting a high rate of needle operation.

Any other suitable speed reducing mechanism can be used so long as it effects the general result suggested by Fig. 10.

In the fabrics thus far described the wales of interconnected loops are either on one or both sides of the finished fabric but it may be desirable in some instances to employ the principles of the invention to produce a fabric in which the reenforcing wales are buried within the fabric so that each side of the latter has a soft fleece-like texture. This modification of the invention is illustrated in Fig. 11 wherein webs W2 and W3 similar to web W are trained respectively around rotating drums **90** and **91** which are turned in opposite directions by appropriate drive means to feed the webs W2 and W3 downwardly and into face to face contact with each other as shown in Fig. 11. Knitting needles N1 which are employed in this form of the invention may be similar to those already described but preferably have their lower ends pointed as at **92**, the shanks **93** of the modified needles moving in a plane parallel to that indicated by line **94** which is tangent to the contacting faces of the webs W2 and W3 and bisects the angle between them. The point **92** may be offset to the right of line **94** so that as the needles N1 are projected downwardly a part at least of the web W3 will be deflected to the left where it will be ultimately picked up by the hook **95** of the needles on withdrawal of the latter. The left-hand end of the hook **95** preferably extends to the left of line **94** so that upon full insertion of the needle down at least to the nip between the two rolls **90** and **91**, and preferably beyond the nip, some fibers of each of the two webs W2 and W3 will be deflected to the left and then will tend to move to the right to be over the hook **95**. In this way fibers from both of the webs W2 and W3 will be collected by each needle to form a group of fibers which will result in loops as the needles N1 are reciprocated.

The lower part of Fig. 11 shows the finished product or fabric F3 wherein the wales **96** formed as described are intermediate the right side of web W3 and the left side of web W2, thus exposing soft fleece-like textured surfaces on both sides of the fabric. Mechanisms similar to those shown in Fig. 7 can be employed to reciprocate the needles N1 and drive the drums **90** and **91**.

From the foregoing it will be seen that the invention sets forth simple means by which fibers of a web are caught into small groups and are knitted together to form interconnected loops running lengthwise of the web. In fabric F1 the loops form wales on one side of the fabric but the fibers forming the loops extend down into and are dispersed through and rooted into the web in a manner quite unlike the interlocking of threads or yarns as encountered in the usual knitting operation. The fabric thus produced will have a knitted texture on one side of a fleece-like texture on the opposite side, but if desired both sides of the web can be formed with wales to form fabric F2. It will also be seen that provision is made for permitting the hooks to lift only those parts of the fibers engaged with them which are between discs **51** and are forward of the feet **66**. It will further be seen that provision is made for depressing the needles after they have been inserted into the web for the purpose of reducing the numbers of fibers which the hook will lift when the needles are withdrawn from the web. The invention also sets forth an improved method for producing a nonwoven fabric from a web of random or oriented loosely assembled fibers or textile material or elements wherein some of the latter are formed into loops which are knitted together in loops to form wales. It will be further noted that the fabric F3 is produced by loops the fibers of which are drawn from each of the two webs W2 and W3.

Having now particularly described and ascertained the nature of the invention and in what manner the same is to be performed, what is claimed is:

1. The method of forming a nonwoven fabric from two webs of loosely assembled textile fibers consisting in the following steps: feeding the two webs into face to face engagement with each other in a manner to form a nip therebetween, gathering fibers beyond the nip to be drawn from both webs into a group, some of the fibers of which are rooted into one web and other fibers of which are rooted into the other web, and forming successive groups thus formed into interconnected knitted loops.

2. The method set forth in claim 1 wherein the knitted loops are formed by a needle which is inserted between the nip into and parallel to both webs to hook onto fibers of each web and is then withdrawn to lift fibers from each web into a group from which the loop is formed.

3. The method set forth in claim 2 wherein the needle has a pointed inserting end and a hook at one side of the pointed end and the needle is inserted substantially parallel to each of said faces so that its pointed end enters one of the webs adjacent said nip to enable the hook to collect some of the fibers of that web and the hook upon withdrawal of the needle lifts fibers from the other web.

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