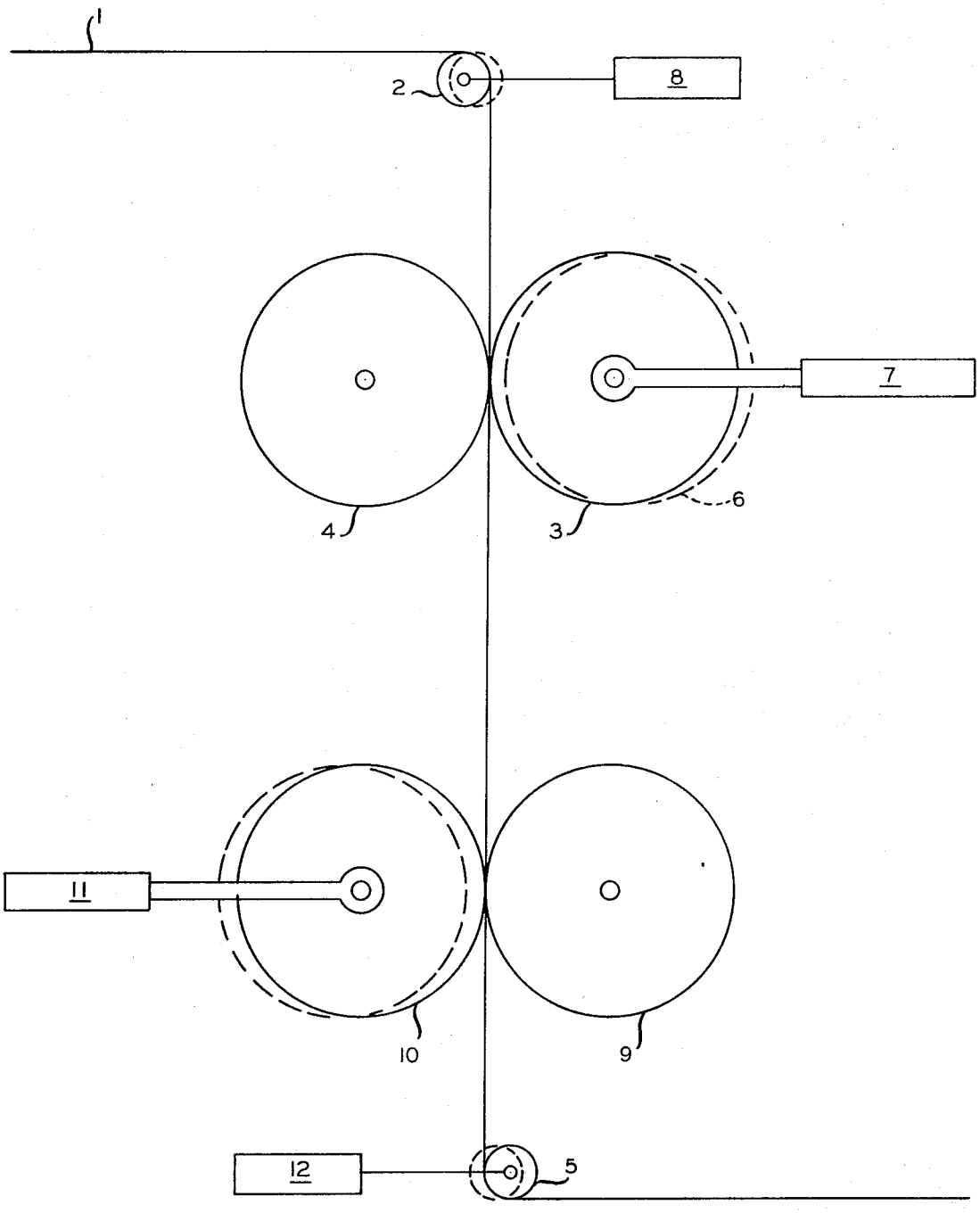
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METHOD OF BONDING NONWOVEN TEXTILE FABRICS

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METHOD OF BONDING NONWOVEN TEXTILE FABRICS

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ABSTRACT OF THE DISCLOSURE

A batt of fibers containing at least some thermoplastic fibers arranged in either ordered or random orientation is bonded into a coherent batt by passing the batt through the nip of two pairs of rollers comprising one heated roller and one cool roller, the heated rollers being on opposite sides of said batt.

BACKGROUND OF THE INVENTION

This invention relates to the formation of a nonwoven textile batt by the fusion bonding of a batt of fibers. In another aspect, this invention relates to the embossing of a nonwoven textile batt.

It is known in the art that nonwoven coherent batts can be formed by depositing a mass of fibers in either random or ordered orientation to form a batt, and bonding the fibers together to form a web. One method of bonding the fibers is to pass the batt through a heating device wherein at least a portion of the fibers in the batt fuse, interlocking the individual fibers in a coherent batt. This heating has been accomplished in a number of ways, none of which has proved entirely satisfactory for certain types of fabrics.

One prior art method, as disclosed in U.S. 2,891,279, comprises passing a fiber fleece between layers of a wire fabric through a tortuous path around a series of rollers in order to fuse said fiber fleece whereby the fiber fleece is fused on its surface at the points of contact of said wire fabric. As is obvious to one skilled in the art, the cover; that is, the percentage of uniformly fused surface area in a product of this type, is poor.

A more recent method is disclosed in copending application Ser. No. 638,230, filed May 15, 1967 now U.S. Pat. 3,452,128, wherein an unsupported fiber batt is passed vertically through one set of rollers both of which are heated. However, this method is somewhat inflexible as to operating conditions and it has been difficult to operate at commercially economical line speeds.

A major difficulty with the prior art methods lies in the fact that the heating step must be carefully controlled to ensure that the fibers are brought to the correct temperature and maintained at that temperature for the proper length of time and under carefully controlled pressure in order to produce the desired end product. Overheating of the batt will result in total fusion of the fibers, which is often undesirable, while underheating will cause insufficient fusion, resulting in a structurally weak batt.

Another method of bonding is that of print bonding whereby a liquid adhesive or binder is printed onto the web in an intermittent pattern. A third method of bonding is that of web saturation in a liquid adhesive. These two methods have a common disadvantage in that they require somewhat complicated equipment to effect the application of the liquid adhesive and also suffer an inherent disadvantage in requiring an extra added expensive material, i.e., the adhesive or bonding agent itself. Not only do these methods require extra equipment for effecting the saturation of the batt with adhesive, but they also require means for drying or curing the adhesive after it has been applied. Another important consideration is that these methods of bonding do little, if anything, to achieve the desired finish on the nonwoven fabric and hence extra steps must be carried out to provide the proper finish on the nonwoven batt. In this instance, the finishing may consist of resaturation and perhaps curing.

It is therefore an object of this invention to provide a method for bonding fibers into a coherent batt under carefully controlled conditions of temperature and pressure whereby a web of uniform quality can be obtained. Another object of this invention is to provide a method for bonding fibers into a coherent batt whereby a batt of improved hand and cover can be obtained.

Another object of this invention is to provide a method of bonding fibers into a coherent batt whereby a batt of better weight distribution and higher strength can be obtained. Another object of this invention is to provide a method of bonding fibers into a coherent batt while maintaining shrinkage loss at a minimum.

It is still another object of this invention to provide a method for bonding fibers into a coherent batt whereby the speed of heat setting is greatly increased.

It is stil another object of this invention to provide a method for bonding fibers into a coherent batt whereby a wider range of process conditions can be used such that more varied products can be obtained.

It is still another object of this invention to provide a method for producing a secondary carpet backing of improved quality.

It is still another object of this invention to provide a method for producing a primary carpet backing of nonwoven bonded fibers having superior quality and strength.

SUMMARY OF INVENTION

Therefore, according to the above and further objects of this invention, thermoplastic fibers in a batt are fused together by passing said batt through the nip between a first pair of rollers comprising one heated fusing roller and one back-up roller, and then passing said batt through a second pair of rollers spaced from said first pair of rollers wherein said second pair of rollers comprises one heated fusing roll and one back-up roll positioned such that the fusing roller of said second pair of rollers is located on the opposite side of the batt from the fusing roll in said first pair of rollers. Sufficient heat and pressure are applied to fuse at least some of said thermoplastic fibers and bond said fibers into a coherent web. The practice of this invention may be successfully achieved without supporting the batt; for example, by placing the batt of fibers between wire gauze.

DESCRIPTION OF THE DRAWING

The operation of our invention can be seen by reference to the drawing which is a schematic diagram of an apparatus suitable for carrying out one embodiment of the present invention which comprises two pairs of rollers.

Referring now to the drawing, a batt of fibers, which may or may not be interentangled, is shown at 1. This batt passes over retractable feed roller 2, and then passes vertically through the nip between rollers 3 and 4. Heated fusing roller 4 is maintained at an elevated temperature and roller 3 is a back-up roller which is either heated or cooled or neither, depending upon the desired process results. However, roller 3 is most generally maintained at a temperature lower than that of roller 4. The second set of rollers is displaced vertically downward from the first set of rollers. It is generally preferred to pass the batt in a vertical direction between the two sets of rollers. However, this is not essential. The batt can be passed hori-

zontally or at any desired angle. Roller **10** is identical in function to roller **3** and roller **9** is identical to roller **4**. The heated rollers are conveniently heated by steam or electrical coils, and they are maintained at a temperature suitable to cause fusion of at least some of the fibers within the batt. The pressure exerted on the fibers is determined by the fluid pressure in the hydraulic cylinders biasing the rolls together. Said fluid pressure has a material effect on the characteristics of the finished product. Higher fluid pressure causes greater compression and more rapid heat transfer, with resultant more rapid fusion of the fibers within the batt. A suitable pressure between rolls has been found to be about 115 pounds per square inch of actual roll contact area on fiber batt, including compressed and uncompressed portions of said batt. The bonded batt is passed over discharge roller **5** to further processing or packaging operations.

In order to prevent overheatng in case of stoppage of the batt travel, roller 3 is retractable by means of hydraulic cylinder **7** to the position indicated by dotted lines **6**. The gap between the two rollers when roller **3** is retracted is conveniently about **6** inches. The actuating device (not shown) which operates hydraulic cylinder **7** is also operatively attached to hydraulic cylinder **8**. This cylinder moves feed roller **2** horizontally about half the distance of the retraction of heated roller **3**. Thus, the two hydraulic cylinders acting at the same time will open the gap between the two rollers **3** and **4**, and simultaneously move the web forward to be centered between the two rollers, and out of contact with both of them. The actuating mechanism which operates hydraulic cylinders **7** and **8** is one which senses any stoppage of travel of the batt, and could be conveniently located on feed roller **2**, discharge roller **5**, or at any other point of the fiber feeding or web takeup means. Similarly, hydraulic cylinder **11** moves roller **10** and hydraulic cylinder **12** moves discharge roller **5**. Movement of all hydraulic cylinders occurs simultaneously.

During passage of the batt between the two pairs of rollers, the heated roller causes the fibers of the contacted batt to fuse while the back-up roller engages and supports these fibers in position while being fused on the heated roller side. The controlled temperature of both rollers in the first step provides for the necessary heat transfer at a prescribed and controlled rate to fuse, heat set and/or finish the batt on one side. During the passage of the batt through the second set of rollers, **9** and **10**, the order of arrangement of which is opposite that of the first set, the heated roller causes the fibers on the contacted side of the batt to fuse while the filled roll supports these fibers in position while being fused on the heated roll side. The controlled temperature of both rolls in the second step provides for the necessary heat transfer at a prescribed and controlled rate to fuse, heat and/or finish the batt on the opposite side.

The heated fusing rollers may be smooth steel rollers or embossing rollers. The back-up rollers may be covered with a fabric apron, for example, a nonwoven polypropylene fabric or a felt apron. The back-up rollers may also be filled or be fibrous surface rollers which have a hollow metallic mandrel to allow heating or cooling.

In general line speeds of from about 10 to about 120 feet per minute, heated fusing roller temperatures from about 300 to about 450° F., back-up roller temperatures from about 100 to about 200° F., and contact pressures from about 20 to about 150 p.s.i.g. can be employed. In general, for making nonwoven batts containing a major proportion of fusible thermoplastic fibers of from about 2 oz. per sq. yd. to about 8 oz. per sq. yd., the above operating conditions apply.

The process of over invention can be used with any batt containing fusible organic thermoplastic fibers. The batt can consist entirely of such fusible fibers, or it can be a blend of fusible fibers with other synthetic or natural fibrous materials. The batt may be formed by any conventional means. For example, the fibres can be supplied from a carding machine in the form of a unidirectionally oriented web, in which case all fibers will be oriented in the direction of the batt travel. Alternately, the fibers can be cross-lapped by layering a unidirectionally oriented web from one or more cards or garnetts back and forth on a moving conveyor. In another embodiment, the fibers can be deposited on a conveyor belt by air deposition, giving a random orientation. Batts formed by any of the above methods can be taken directly to the bonding process of my invention, or can be subjected to some preliminary treatment which could increase the coherency of the batt prior to heat bonding.

In a preferred embodiment, the batt is subjected to a conventional textile needling operation prior to the fusion bonding process. When the batt is so needled, it can be observed that there is a difference in the two surfaces of the batt. The side on which the needles enter, needle side, is smoother than the other or nap or beard side, and, in order to obtain satisfactory fusion, it is preferable to use a higher roll temperature on the smooth side than on the nap side of the batt. The temperature differential between the two heated rolls in this embodiment is in the order of about 5 to about 150° F., preferably about 10° F.

The heat fusible materials which can be used in forming batt for the process of my invention include substantially all of the synthetic organic thermoplastic materials. Polyolefins, such as polymers of ethylene, propylene, butene, and copolymers and blends thereof are particularly suitable. Also suitable are polyesters, polyamides, polyurethanes, cellulosics, acrylics, modacrylics, vinyl polymers, and other known organic thermoplastics and blends thereof which are capable of being formed into filaments. Particularly suitable for making carpet backing are blends comprising about 90 to 98 percent polypropylene and about 10 to 2 percent polyethylene terephthalate, a polyester. Most preferred at present for making carpet backing is a blend comprising about 96 percent polypropylene and about 4 percent polyethylene terephthalate.

The characteristics of the bonded batts produced by the process of our invention can vary widely. By using high temperatures and high roll contact pressure with a low line speed, we can produce completely fused paper-like webs. By using only a small proportion of fibers which are fusible at the roll temperature, and providing low roll contact pressure with higher line speed, we can produce a very low density web. Intermediate density webs are produced by variations of roll temperature, roll contact pressure, and line speed.

By use of blends and different materials, we can also vary the properties of the web produced. For example, a blend of about 10–25 percent fusible polyethylene with wool fibers forms a good insulating batting. A blend of a small proportion of fusible polyethylene with foamed and crimped filaments of high melting point polyolefin, polyurethane or other synthetic filaments forms a batting-like web of excellent insulating properties, and one which is nonallergenic and resistant to organism growth. Batts of fibers which are partly or completely fused have many textile appilcations; polypropylene web of medium density is suitable, for example, for carpet backing.

EXAMPLE

The following comparative operating conditions show the improvement of the two-step finishing technique for a needled batt compared to the one-step finishing of the prior art.

Description of two-step finishing machine

The machine used in the test runs included the following basic features:

(a) Two sets of rolls with each set made up of a steel heated roll of aproximately 24 inches in diameter by 200 inches length and a paper-filled back-up roll approxi-

mately 24 inches in diameter by 200 inches length. Said back-up roll may be filled with, for example, regular X cotton paper. Steel rolls were fixed in position and filled roll bearings were mounted in sliding blocks moved by hydraulic cylinders to nip the rolls.

(b) In-feed and discharge guide rolls were moved by hydraulic cylinders to disengage the batt from the heated roll when desired.

(c) Steel support frame to suport the rolls and drive mechanism.

(d) Approximately 10 HP variable speed drive to control roll line speed.

(e) Temperature controller for each heated steel roll to control roll surface temperature.

TABLE I

	Run 1		Run 2	
	Two-step	Single step	Two-step	Single step
A. Description of batt:				
Polypropylene fiber:				
Denier	4.5	4.5	4.5	4.5
Cut length, inches	4.0	4.0	4.0	4.0
Weight, lb./sq. yd	0.258	0.275	0.2676	0.2863
Weight, percent	93	93	96	96
Polyester warp yarn:				
Cotton count	18s	18s	30s	30s
No. of yarn ends/inch batt width	8	8	8	8
Weight, lb./sq. yd	0.020	0.020	0.0114	0.0114
Weight, percent	7	7	4	4
Total Weight, lb./sq. yd	0.278	0.295	0.279	0.2977
Width batt feed, inches	156	160	156	160
B. Operating conditions:				
Line speed, ft./min	15	15	22	22
Contact pressure, lb./sq. in.	115	22	115	22
Roll temperatures:				
Beard side, ° F., first step	320	330	335	350
Needle side, ° F., second step	310	325	325	345

An improvement in the range of operating conditions for the 4.5 oz./sq. yd. batt described in Table I is also apparent from the following comparison of operating conditions in Table II.

TABLE II

	Two-step finishing	Single step finishing
A. Operating condition range:		
1. Line speed range, ft./min.	10 to 120	10 to 40
2. Fusing roll temp. range, ° F.	310 to 405	310 to 405
3. Contact pressure, p.s.i.	40 to 125	10 to 40

	Two-Step finishing							Single step finishing, max.					
B. Operating conditions at various line speeds:													
Line speed ft/min	15	19	22	28	36	60	120	15	19	22	28	36	40
Roll Temp. beard side ° F	320	330	335	345	355	375	405	330	338	345	368	388	405
Roll Temp. needle side, ° F	310	320	325	335	345	365	395	325	333	340	363	383	400
Contact pressure p.s.i.	125							125					

Thus, there is a vast improvement in line speed in the two-step process resulting in increased output and lower operating expense.

In a presently preferred embodiment, the line speed is about 20 to about 25 ft./min., preferably about 22 ft./min., the roller temperature, beard side, is about 330 to about 340° F., preferably about 335° F., the roller temperature, needle side, is about 320° F. to about 330° F,. preferably about 325° F., the roller temperature beard side, being 5 to about 15° F., preferably about 10° F. higher than the roll temperature, needle side, and the contact pressure is about 110 to about 120 p.s.i.g. preferably about 115 p.s.i.g. The back-up roller is allowed to assume a temperature compatible with the existing temperature of the heated roller and fiber batt.

Product quality of the batt described in Table I is also improved through the use of the two-step finishing technique as shown by the following Table:

TABLE III

Parameter	Two-step	Single step
Cover [1]	75–100	50–75
Hand [2]	0	+1
Shrinkage [3]:		
Measured inches	3	6.5
Loss, percent	1.9	4.1
Weight distribution-variation: edges to center, ounces	0	0.5
Tensile strength, lb./in.:		
Warp direction	80–90	60–70
Fill direction	110–130	80–90
Size of finished roll of bonded batt:		
At 30 in. diameter:		
Linear yards	850	610
Weight, lb	1,000	760

[1] Judged visually by appearance of uniformity per unit area when viewed over a source of illumination.

$$\text{Percent uniformity} = \frac{\text{Uniformly dense area}}{\text{Total sample area}} \times 100$$

100%=perfect cover.

[2] Judged subjectively by sense of feel by the hand on a graduated scale when compared to the desired specification hand of the product on the following scale:

Soft	−2
Medium soft	−1
Specification	0
Medium hard	+1
Hard	−2

[3] Shrinkage in a 12-foot wide batt.

Thus the product made by the two-step process exhibits better cover, better hand, less shrinkage loss, better weight distribution, higher strength and also makes a better roll of finished product containing more yards of goods.

We claim:

1. A process for bonding an unfused batt of synthetic thermoplastic fibers into a coherent web under controlled conditions of temperature and pressure to produce a web of fused fibers comprising:

(a) passing an unfused batt of fusible thermoplastic fibers into the nip of a first pair of rollers comprising a heated roller and a backup roller of lower temperature, the backup roller comprised of a material sufficiently thermally conductive to transfer heat through the batt at a rate to fuse the batt on the side adjacent the heated roller, and pressing the batt between the first pair of rollers, contacting the heated roller and the batt only at the nip, to heat and fuse the batt on the side adjacent the heated roller,

(b) passing the batt from the first pair of rollers into the nip of a second pair of rollers, the second pair of rollers comprising a heated roller and a backup roller of lower temperature with the heated roller in the second pair of rollers located on the opposite

side of the batt from the heated roller in the first pair of rollers, the backup roller comprised of a material sufficiently thermally conductive to transfer heat through the batt at a rate to fuse the batt on the side adjacent the heated roller, and pressing the batt between the second pair of rollers, contacting the heated roller and the batt only at the nip, to heat and fuse the batt on the side adjacent the heated roller, and

(c) recovering from the second pair of rollers a coherent web having fibers bonded at both sides of the batt.

2. A process according to claim **1** wherein the thermally conductive material in the backup rollers is paper and the backup rollers are unheated and are allowed to assume a temperature compatible with existing temperatures of the heated fusing rollers and fiber batt.

3. The process of claim **1** wherein the batt is passed vertically downwardly through the first pair and the second pair of rollers at a rate of from about 10 to about 120 feet per minute.

4. The process of claim **1** wherein the unfused batt comprises a needled batt having a smooth side and a beard side.

5. The process of claim **4** wherein the heated fusing roller in contact with the smooth side is heated to a higher temperature than the heated fusing roller in contact with the beard side of the batt.

6. The process of claim **5** wherein the heated fusing roller in contact with the smooth side is heated to a temperature from about 5 to about 150° F. higher than the heated fusing roller in contact with the beard side of the batt.

7. The process of claim **6** wherein the batt is passed vertically downwardly through the rollers at a rate of from about 20 to about 25 feet per minute, the heated fusing roller in contact with the smooth side is heated to a temperature from about 330 to about 340° F. and the heated fusing roller in contact with the beard side of the batt is heated to about 320 to about 330° F.

8. The process of claim **7** wherein the pressure is about 110 to about 120 p.s.i.g.

References Cited

UNITED STATES PATENTS

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