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(71) Applicant: **POLYMER PROCESSING RESEARCH INSTITUTE LIMITED**
9-2 Kaga 1-chome Itabashi-ku
Tokyo(JP)

Applicant: **NIPPON PETROCHEMICALS CO., LTD.**
3-1, Uchisaiwai-cho 1-chome Chiyoda-ku
Tokyo(JP)

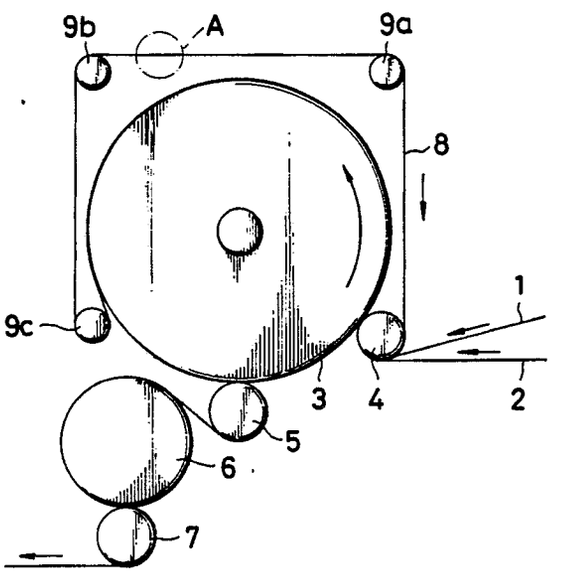
(72) Inventor: **Tani, Haruhisa**
1-31-3 Matsugaoka Kume 1774
Tokorozawa-shi Saitama-ken(JP)
Inventor: **Kurihara, Kazuhiko**
3-11-5-1002 Takashimadaira
Itabashi-ku Tokyo(JP)
Inventor: **Yazawa, Hiroshi**
2-25-15, Higashi
Kunitachi-shi Tokyo(JP)
Inventor: **Ohishi, Toshikazu**
13-30 Kanayama-cho
Kawaguchi-shi Saitama-ken(JP)

(74) Representative: **Gordon, Martin et al**
G.F. Redfern & Company Marlborough Lodge
14 Farncombe Road
Worthing West Sussex, BN11 2BT(GB)

(54) Method and apparatus for making cross-laminated non-woven fabrics.

(57) In a method and apparatus for making a cross-laminated non-woven fabric composed of warp and weft webs (1, 2), the warp and weft webs (1, 2) are firmly gripped at least at their opposite selvages by and between the outer peripheral surface of a hot cylinder (3) and a pair of endless belts (8) as they are bonded together and heat-set on the hot cylinder (3). With this arrangement, the warp and weft webs (1, 2) are prevented from shrinking widthwise during heat-set on the hot cylinder (3).

FIG. 1



EP 0 379 764 A1

METHOD AND APPARATUS FOR MAKING CROSS-LAMINATED NON-WOVEN FABRICS

The present invention relates generally to the manufacture of cross-laminated non-woven fabrics, and more particularly to a method and apparatus for heat setting a cross-laminated non-woven fabric composed of warp and weft webs as they are bonded on and around a hot cylinder.

Throughout the specification and claims, the term "warp web" is used to refer to a web formed of fibers arranged to extend substantially in the lengthwise direction of the web and hence having a larger strength in the lengthwise direction than in the transverse direction thereof, the term "weft web" is used to refer to a web formed of fibers arranged to extend substantially in the transverse direction of the web and hence having a larger strength in the transverse direction than in the lengthwise direction, and the term "cross-laminated non-woven fabric" is used to refer to a non-woven fabric composed of the warp and weft webs laminated together, with the fibers in the warp web extending crosswise the fibers in the weft web.

Cross-laminated non-woven fabrics, cross-laminated films or the like cross-laminated sheet materials have recently been developed and placed on the market. In the manufacture of such cross-laminated sheet materials, warp and weft webs are bonded together into layers. In this instance, it is necessary to heat-set the warp and weft webs as they are bonded together. To meet this requirement, a hot cylinder is utilized in general. The hot cylinder has the advantage of its small installation space and high heat efficiency. The hot cylinder has a drawback however that the warp and weft webs while being heat-set on the hot cylinder are caused to shrink widthwise. This widthwise shrinkage lowers the productivity of the cross-laminated sheet material and also adversely affects the strength, Young's modulus and other physical properties of the cross-laminated sheet material.

The foregoing widthwise shrinkage of the webs while being heat-set can be prevented by using a conventional tentering process in which the webs are held firmly at the opposite sides or selvages by pins or clips. The tentering process, however, requires an expensive apparatus which is large in size and hence occupies a large space for installation thereof. Another problem is that a hot air heating system employed in the tenter frame is low in thermal efficiency. Furthermore, the tentering process is totally unsatisfactory when used in the manufacture of a cross-laminated sheet material in which bonding of warp and weft webs is major requirement.

With the foregoing difficulties in view, the present invention seeks to provide a method of making a cross-laminated sheet material composed of warp and weft webs bonded together into layers and heat set on a hot cylinder without causing widthwise shrinkage which would otherwise lower the productivity and physical properties of the cross-laminated sheet material.

The present invention further seeks to provide an apparatus for reducing the foregoing method into practice, which apparatus is simple in construction and can be manufactured less costly, and is small in size and occupies only a small space for installation thereof.

According to a first aspect of the present invention, there is provided a method of making a cross-laminated non-woven fabric of the type in which a warp web having a larger strength in the lengthwise direction than in the transverse direction and a weft web having a larger strength in the transverse direction than in the lengthwise direction are bonded together and heat-set while they are continuously fed around a rotating hot cylinder, wherein the improvement comprises: holding the warp and weft webs in superposed relation to one another by gripping at least their opposite selvages by and between an outer peripheral surface of the rotating hot cylinder and a pair of parallel spaced endless belts held under tension against the outer peripheral surface of the rotating hot cylinder, thereby preventing the superposed warp and weft webs from shrinking widthwise as they are heat-set on the hot cylinder.

According to a second aspect of the present invention, there is provided an apparatus for making a cross-laminated non-woven fabric of the type having a rotating hot cylinder for bonding and heat-setting a warp web having a larger strength in the lengthwise direction than in the transverse direction and a weft web having a larger strength in the transverse direction than in the lengthwise direction as they are continuously fed around the rotating hot cylinder in a superposed relation to one another, wherein the improvement comprises: an endless belt held under tension against an outer peripheral surface of the rotating hot cylinder for gripping at least opposite selvages of the warp and weft webs therebetween as the warp and weft webs are fed around the hot cylinder, thereby preventing the warp and weft webs from shrinking widthwise as they are heat-set on the hot cylinder.

Many other advantages and features of the present invention will become manifest to those versed in the art upon making reference to the detailed description and the accompanying sheets of drawings in which preferred structural embodiments incorporating the principles of the present

invention are shown by way of example.

Figure 1 is a diagrammatical view showing the general construction of an apparatus according to the present invention;

Figure 2 is a schematic plan view of a rotating hot cylinder and associated endless belts of the apparatus shown in Figure 1;

Figure 3 is an enlarged side view of a portion of the endless belt which is indicated by a circle A in Figure 1;

Figure 4 is a view similar to Figure 2, but showing another embodiment of the present invention.

Figure 1 diagrammatically shows the general construction of an apparatus for making a cross-laminated non-woven fabric or the like sheet material by bonding and heat-setting a warp web 1 and a weft web 2 as they are continuously fed on and along an outer peripheral surface of a hot cylinder 3 rotatably driven by a motor (not shown). At least one of the warp and weft webs 1, 2 has a certain degree adhesiveness or is treated with an adhesive. The apparatus further includes first and second pinch or nip rolls 4, 5 held in contact with the hot cylinder 3 and having their central axes spaced from one another at an angle of about 60 degrees relative to the central axis of the hot cylinder 3 so as to guide the warp and weft webs 1, 2 along about five-sixths of the full circumference of the hot cylinder 3. Disposed downstream of the second nip roll 5 is a cooling cylinder 6 for cooling a cross-laminated sheet material composed of the warp and weft webs 1, 2 which have been bonded together and heat-set on the hot cylinder 3. The cooling cylinder 6 is provided with a third pinch or nip roll 7 for holding the cross-laminated sheet material in intimate contact with the cooling cylinder 6 as the cross-laminated sheet material is withdrawn from the cooling cylinder 6.

According to an important feature of the present invention, the warp and weft webs 1, 2 are gripped at least at opposite sides or selvages while they are fed around the hot cylinder 3 in superposed relation, so that the warp and weft webs 1, 2 are prevented from shrinking widthwise. To this end, the apparatus includes a pair of parallel spaced endless belts 8, 8 guided around the first nip roll 4 and first, second and third guide rolls 9a, 9b, 9c so as to be held under tension against the outer peripheral surface of the hot cylinder 3. In the illustrated embodiment, the third guide roll 9c is disposed upstream of the second nip roll 5 and circumferentially spaced at an angle of about 60 degrees from the second nip roll 5 so that the endless belts 8 travel about four-fifths of a longitudinal portion of the superposed warp and weft webs 1, 2 which is retained on the hot cylinder 3. The endless belts 8 may be arranged to further extend around the second nip roll 5 in which instance the endless belts 8 coextend with the respective selvages of the warp and weft webs 1, 2 retained on the hot cylinder 3.

The endless belts 8 are made of a heat-resistant material so as to withstand a temperature of the hot cylinder 3. As shown in Figure 3, each of the endless belts 8 has a release coating layer 8a on one surface thereof which is engageable with the outermost web 1. The release coating layer 8a preferably comprises a fluorine plastic film or a silicone plastic film.

Materials eligible for the warp web 1 includes a web of stretched or oriented tapes arranged in parallel juxtaposition in the lengthwise direction of the web, a reticular split fiber web spread widthwise 1.1 - 5.0 times its original width, and a non-woven fabric formed of fibers arranged to extend in the lengthwise directions. The weft web includes a laminated web which is composed of a continuous warp web of parallel-laid non-woven fabric, and a succession of discrete weft webs of parallel laid non woven fabric arrange lengthwise of and bonded with the continuous warp web, with their adjacent edges slightly overlapping one another. The laminated web may be made by a cross-laminating machine such as disclosed in U. S. Patent No. 4,052,243 proposed by the present inventors. In making the laminated web, a weft web is conveyed laterally over the warp web in the machine direction and overlaid onto the warp web in the manner of side by side arrangement without leaving any gaps between each other, after being cut by the length corresponding to the width of the warp web. Stated otherwise, one of two identical continuous warp webs of parallel laid non-woven fabric is fed transversely over the other warp web in timed relation to the movement of the other warp web. The one warp web is severed successively into individual lengths which are substantially equal to the width of the other warp webs. The thus severed individual lengths of warp web are united by bonding to the other warp web with their adjacent edges slightly overlapping one another, as stated above. The weft web may be a continuous transversely stretched web such as disclosed in U. S. Patnt No. 4,349,500, or a non-woven fabric formed of fibers arranged to extend in the widthwise or transverse directions.

In operation, the warp and weft webs 1, 2 are longitudinally fed successively around the first nip roll 4, the hot cylinder 3 and the second nip roll 5. During that time, the warp and weft webs 1, 2 are firmly gripped at their opposite selvages by and between the outer peripheral surface of the hot cylinder 3 and the respective endless belts 8, 8 with the result the warp and weft webs 1, 2 are heat-bonded together into a cross-laminated sheet

material and heat-set on the hot cylinder 3 without causing heat-shrinkage in the widthwise direction. The cross-laminated sheet material is withdrawn from the hot cylinder 3 and then fed around the cooling cylinder 6 during which time the cross-laminated sheet material is cooled to set. The thus cooled cross-laminated sheet material is finally withdrown from the apparatus through the third nip roll 7.

A modified apparatus shown in Figure 4 is substantially identical to the apparatus shown in Figures 1 and 2 with the exception that the superposed warp and weft webs 1, 2 are gripped substantially throughout the width thereof by and between the outer peripheral surface of the hot cylinder 3 and a single endless belt 10. The endless belt 10 has substantially the same width as the webs 1, 2 and includes a multiplicity of small pores or perforations 11 uniformly distributed over the entire surface thereof. The perforated endless belt 10 is permeable to vapor and hence allows smooth vaporization of the moisture content from the webs 1, 2 as the webs 1, 2 are heat-set on the hot cylinder 3.

As described above, at least the selvages of warp and weft webs are gripped by and between the outer peripheral surface of a hot cylinder and two endless belts, so that the warp and weft webs are bonded together into a cross-laminated sheet material and heat-set without causing widthwise heat-shrinkage. The thus produced cross-laminated sheet material is sightly in appearance, is uniform in structure and posesses improved physical properties such as tensile strength and Young's modulus. The apparatus of the present invention which is composed of a hot cylinder and endless belts is simple in construction and hence can be manufactured easily at a low cost. Furthermore, the apparatus is small in size and hence occupies only a small space for installation thereof.

Claims

1. A method of making a cross-laminated non-woven fabric of the type in which a warp web (1) having a larger strength in the lengthwise direction than in the transverse direction and a weft web (2) having a larger strength in the transverse direction than in the lengthwise direction are bonded together and heat-set while they are continuously fed around a rotating hot cylinder (3), characterized in that said method comprises holding the warp and weft webs in superposed relation to one another by gripping at least their opposite selvages by and between an outer peripheral surface of the rotating hot cylinder (3) and a pair of parallel spaced endless belts held under tension against the outer peripheral surface of the rotating hot cylinder (3), thereby preventing the superposed warp and weft webs (1, 2) from shrinking widthwise as they are heat-set on the hot cylinder (3).

2. A method according to claim 1, wherein the warp and weft webs (1, 2) are gripped throughout the width thereof.

3. A method according to claim 2, wherein the warp and weft webs (1, 2) are gripped by and between the outer peripheral surface of the rotating heated cylinder (3) and a single endless belt (10) having a width substantially the same as the width of the warp and weft webs (1, 2).

4. A method according to claim 3, wherein the endless belt (10) is permeable to vapor.

5. A method according to claim 4, wherein said endless belt (10) has a multiplicity of perforations (11) uniformly distributed over the entire surface thereof.

6. A method according to claim 1, said endless belt (8; 10) has a release coating layer (8a) on one surface thereof engageable with an outermost one (1) of the webs (1, 2).

7. A method according to claim 6, wherein said release coating layer (8a) comprises a fluorine plastic film.

8. A method according to claim 6, wherein said release coating layer (8a) comprises a silicone plastic film.

9. A method according to claim 1, wherein the warp web (1) comprises a reticular split fiber web spread widthwise 1.1 - 5.0 times the original width.

10. A method according to claim 1, wherein the weft web (2) comprises a laminated web which is composed of a continuous warp web of parallel-laid non-woven fabric, and a plurality of discrete weft webs of parallel-laid non-woven fabric, arranged lengthwise of and bonded with said continuous warp web with their adjacent edges slightly overlapping one another in such a manner that fibers in said warp web extend crosswise fibers in each said weft web.

11. A method according to claim 1, wherein said weft web (2) comprises that a weft web is conveyed laterally over said warp web in the machine direction and overlaid onto said warp web in the manner of side by side arrangement without leaving any gaps between each other, after being cut by the length corresponding to width of said warp web.

12. A method according to claim 1, wherein the weft web (2) comprises a transversely stretched web of parallel-laid weft fibers.

13. An apparatus for making a cross-laminated non-woven fabric of the type having a rotating hot cylinder (3) for bonding and heat-setting a warp web (1) having a larger strength in the lengthwise direction than in the transverse direction and a weft

web (2) having a larger strength in the transverse direction than in the lengthwise direction as they are continuously fed around the rotating hot cylinder (3) in a superposed relation to one another, characterized in that said apparatus comprises an endless belt (8; 10) held under tension against an outer peripheral surface of the rotating hot cylinder (3) for gripping at least opposite selvages of the warp and weft webs (1, 2) therebetween as the warp and weft webs (1, 2) are fed around the hot cylinder (3), thereby preventing the warp and weft webs (1, 2) from shrinking widthwise as they are heat-set on the hot cylinder (3).

14. An apparatus according to claim 13, wherein said endless belt comprises a pair of parallel spaced endless belt members (8, 8) engageable with the respective selvages of an outermost one (1) of the warp and weft webs (1, 2).

15. An apparatus according to claim 13, wherein said endless belt (10) has a width substantially the same as the width of the warp and weft webs (1, 2).

16. An apparatus according to claim 13, wherein the endless belt (10) is permeable to vapor.

17. An apparatus according to claim 16, wherein said endless belt (10) has a multiplicity of perforations uniformly distributed over the entire surface thereof.

18. An apparatus according to claim 13, wherein said endless belt has a release coating layer (8a) on one surface thereof engageable with an outermost one of the webs (1, 2).

19. An apparatus according to claim 18, wherein said release coating layer (8a) comprises a fluorine plastic layer.

20. An apparatus according to claim 18, wherein said release coating layer (8a) comprises a silicone plastic film.

FIG. 1

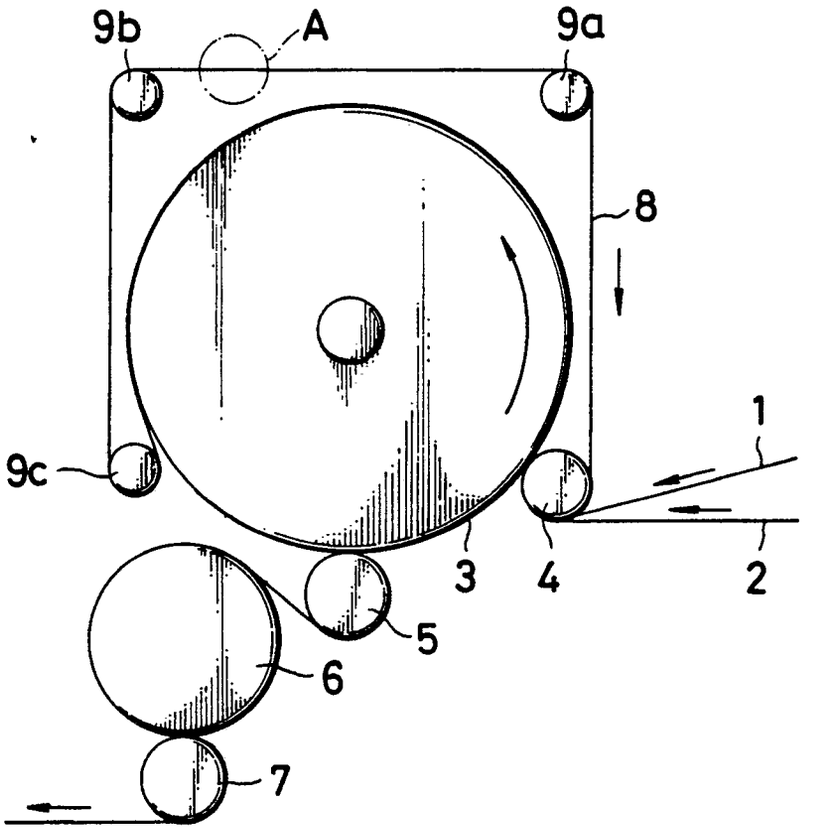


FIG. 2

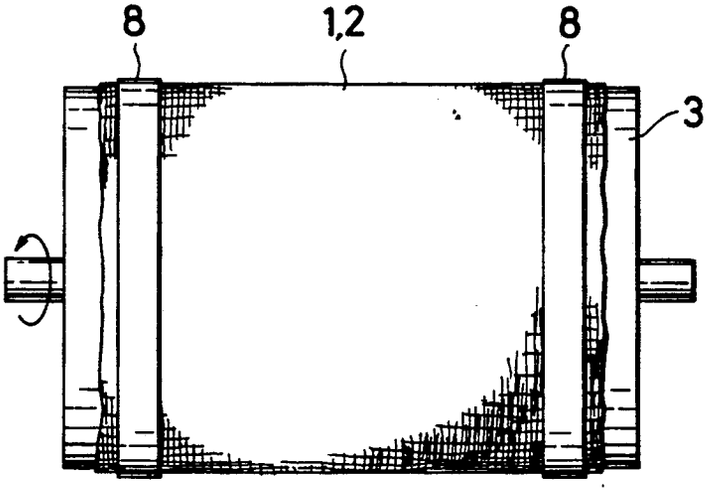


FIG.3

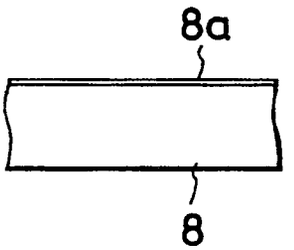
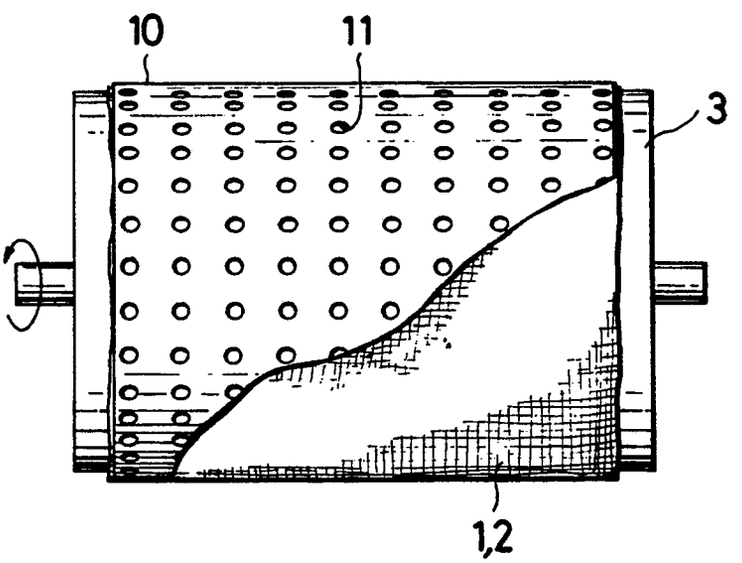


FIG.4



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EUROPEAN SEARCH REPORT

Application Number

EP 89 30 0803

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	FR-A-1 505 969 (UNION CARBIDE CO.) * Abstract, points 1,2,f,3,b,d,5,a; page 4, right-hand column - page 5, right-hand column; figures 4,6 *	1,13	D 04 H 3/04 D 04 H 1/54 D 04 H 3/16
A		14	
Y	US-A-4 609 423 (A.A. ZUFANG et al.) * Claims 1,2,4,5; column 1, line 50 - column 5, line 28; figures 3,4 *	1,13	
A		2,3,6-8,15,18-20	
D,A	US-A-4 052 243 (M. YAZAWA) * Claims 1,2,4; column 3, line 6 - column 6, line 37; column 8, line 61 - column 11, line 58; example 1; figures 1a-1c *	1,9-12	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

D 04 H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	31-08-1989	BLASBAND I.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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