United States Patent [19]

Thomas

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[54] **MULTIPLE EMBOSSED FLEXIBLE WEB**

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[73] Assignee: **Kimberly-Clark Corporation**, Neenah, Wis.

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 785,508, Dec. 20, 1968, Pat. No. 3,611,919.

[52] **U.S. Cl.**..... **161/57**, 156/179, 156/220, 156/291, 161/116, 161/129, 161/141, 161/146, 161/DIG. 3, 101/32

[51] **Int. Cl.**..... **B32b 5/12**

[58] **Field of Search**..... 161/116, 57, 58, 161/59, 125, 128, 129, 141, 146, 148, 156, 166, DIG. 3; 156/219, 220, 179; 101/23, 32, 101/22

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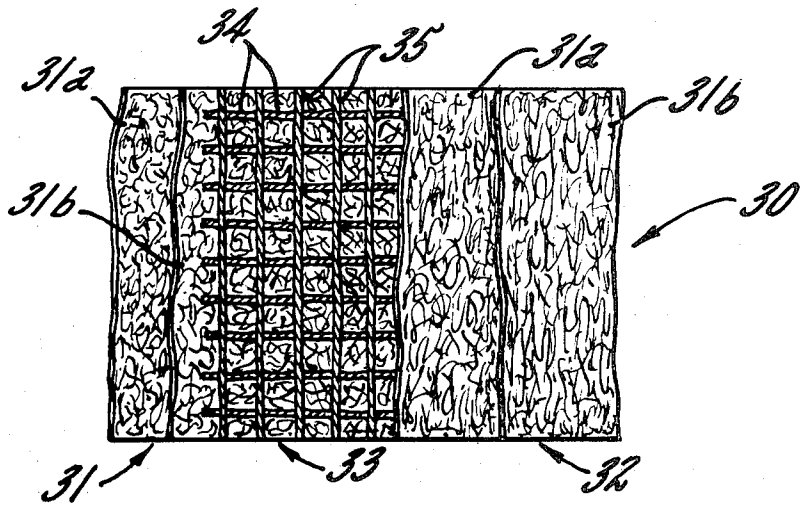
[57] **ABSTRACT**

A flexible reinforced web of creped cellulosic tissue and a nonwoven reinforcing scrim having two or more embossments repeated continuously along the length of the web and superimposed on but out of register with each other. The embossments are formed by passing the web through two or more embossing stations on the surface of a single embossing roll, and drawing the web away from the surface of the embossing roll between successive embossing stations. The flexible web may be made of creped cellulosic tissue or other substantially non-resilient material, and reinforced with resilient threads or other elements extending continuously in the longitudinal direction of the web so as to maintain a constant web length between pairs of successive embossing stations.

5 Claims, 3 Drawing Figures



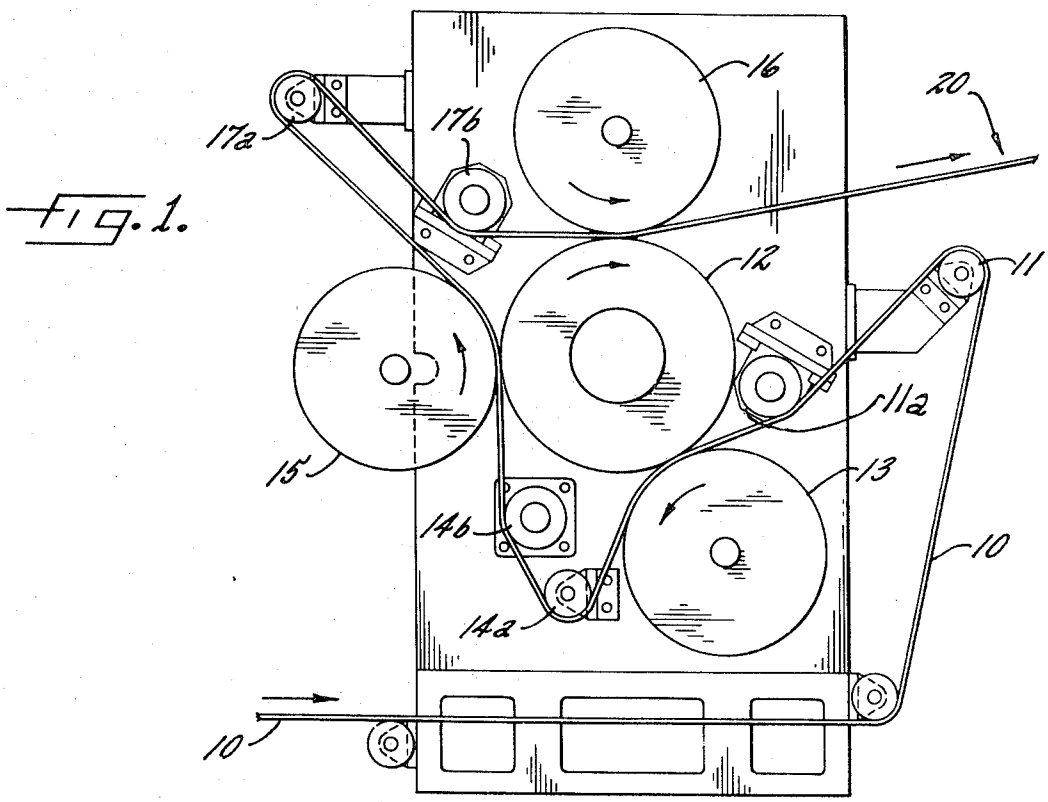


Fig. 1.

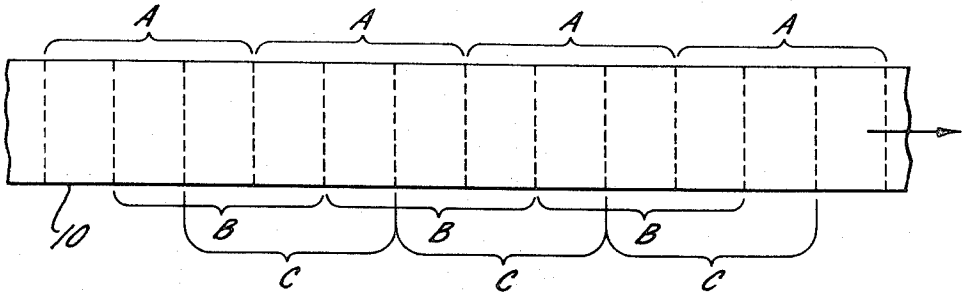


Fig. 2.

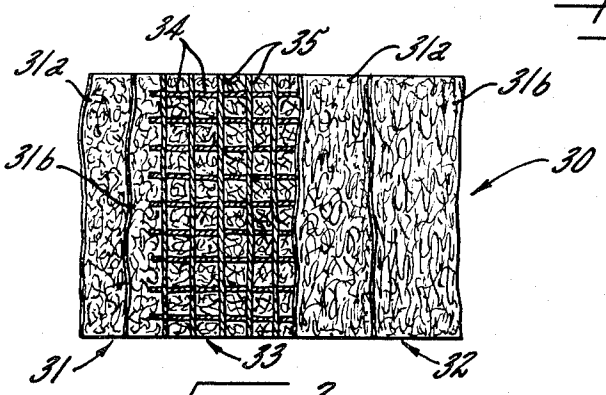


Fig. 3.

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MULTIPLE EMBOSSED FLEXIBLE WEB

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of application Ser. No. 785,508 filed Dec. 20, 1968, now U.S. Pat. No. 3,611,919.

This application is also directed to subject matter related to the following applications:

Ser. No. 725,067 filed Apr. 29, 1968 now U.S. Pat. No. 3,546,056

Ser. No. 21,269 filed Mar. 20, 1970

Ser. No. 150,152 filed June 4, 1971, now U.S. Pat. No. 3,708,383.

BACKGROUND OF THE INVENTION

The present invention relates to a nonwoven material particularly useful for wipe and toweling applications, and which is made of outer layers of creped cellulosic tissue reinforced by an open mesh scrim.

As disclosed in my U.S. Pat. No. 3,546,056, I have found that such material made of wet strengthened high stretch tissue and provided with puff zones of such tissue protruding through the windows of the scrim has improved product toughness, dry and wet bulk and the like. According to that patent, puff zones may be produced in such material by incorporating a scrim with heat shrinkable threads, and subjecting the material to heat in the course of the manufacturing process. Furthermore, increased liquid absorbency and surface texture may be obtained as stated in said patent by pin embossing the material through the puff zones, perforating the material and causing small protruberances on one surface of the sheet. Such meterials with and without puff zones have been marketed by the assignee hereof and found effective as indicated in said patent for heavy duty industrial wipes, heavy duty toweling and the like.

However, there has been a need for a household towel providing generally the same features as such material, but having a low enough cost to be sold in the household market.

It was my primary objective, which resulted in this invention, to provide a lower cost and higher bulk towel material having generally the same features as the heavy duty towel material as specified in my prior patent; that is, substantial strength, dimensional stability, high liquid absorbency, toughness, flexibility and softness. The higher bulk was sought as a contribution not only to higher liquid absorbency, but also to satisfy a marketing objective where the towel material was aimed for sale in the household market in roll form; namely, to provide a greater roll diameter for a given length of towel material, or number of sheets per roll.

Pin embossed scrim reinforced tissue material, subsequently heavily embossed in a single embossing station to enhance bulk and absorbency, was tested as a household towel material but such material was not bulky enough to completely satisfy my objectives. One of the problems was that as the embossing pressures were increased to enhance bulk, the material was overstressed and the threads were ruptured or nicked by the pin embossing, reducing the strength of the material. Description of the Invention

According to the present invention, higher bulk and absorbency is obtained with lower stretch (and lower cost) creped cellulosic tissue without pin embossing, by

repetitive heavy out of register embossing through the windows of the scrim, such repeated embossing works, stretches and molds the cellulosic tissue in the window areas causing the tissue to bulk and protrude through the windows, while strength and dimensional stability is obtained by incorporating a reinforcing scrim having resilient threads which yield in the embossing nip and spring back to their original dimensions and configuration as soon as the embossing pressure is released in each successive embossing operation.

The present invention thus relates generally to embossing flexible webs and, more particularly, to a flexible web having two or more embossments repeated continuously along the length of the web.

It is a primary object of the present invention to provide an improved flexible web having two or more out-of-register embossments which can be formed repetitively along the length of the web by using a single embossing roll. A releated object of the invention is to provide such a flexible web which is made of reinforced creped cellulosic tissue or other substantially non-resilient but stretchable material.

A further object of the invention is to provide an improved embossed flexible web of the type described above which can be efficiently produced at high production rates.

Still another object of the present invention is to provide an improved reinforced web of cellulosic tissue with relatively high bulk and texture which can be produced using relatively low emobssing pressures.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings, in which:

FIG. **1** is a partially schematic end elevation of an embossing method and apparatus for producing an embossed flexible web embodying the invention;

FIG. **2** is a schematic plan view of an embossed flexible web formed by the method and apparatus illustrated in FIG. **1**; and

FIG. **3** is a schematic plan view of a reinforced paper web for use in the embossing method and apparatus illustrated in FIG. **1.**

While the invention is susceptible of various modifications and alternative forms, certain specific embodiments thereof have been shown by way of example in the drawings which will be described in detail herein. It should be understood, however, that it is not intended to limit the invention to the particular forms disclosed, but, on the contrary, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the invention.

Turning now to the drawings, and referring first to FIG. **1**, a continuous web **10** of flexible material is drawn around an inlet roller **11** and continuously advanced under a guide roll **11***a* into engagement with a driven embossing roll **12** at a first embossing station where the web is pressed firmly against the surface of the embossing roll to form a first embossment in the web. More particularly, the web **10** is drawn through the nip formed by the metal embossing roll **12** and a first rubber roll **13** so as to form a first series of repetitive embossments along the length of the web **10.** As can be seen in FIG. **1**, the guide roll **11***a* is located to feed the web **10** into the nip of the rolls **12** and **13** along a common tangent line for the two rolls. The embossments formed at this first embossing station are illus-

trated schematically in FIG. 2 as embossments A repeated continuously along the length of the web **10.** The repetition rate of the embossments A may be varied by a number of factors, including the diameter of the embossing roll **12** and the rate of repetition, if any, of the embossing pattern on the surface of the roll **12.** For example, if the pattern of the embossing surface on the roll **12** repeats itself every 10 inches around the circumference of the roll **12,** then the length of each embossment A illustrated in FIG. **2** will also be 10 inches, i.e., the embossments A will be repeated every 10 inches continuously along the length of the web **10.**

In accordance with an important aspect of the present invention, the embossed web is continuously withdrawn from the first embossing station, drawn away from the surface of the embossing roll, and then passed through a second embossing station on the surface of the same embossing roll used to form the embossments at the first station. Thus, in the illustrative embodiment shown in FIG. **1,** the embossed web **10** is continuously withdrawn from the nip of the rolls **12** and **13** and drawn away from the surface of the embossing roll **12** over a guide roll **14***a*. From the guide roll **14***a*, the embossed web is returned to the surface of the driven embossing roll **12** over a second guide roll **14***b*, and passed through a second embossing station formed by the nip of the metal embossing roll **12** and a second rubber roll **15.** As can be seen in FIG. **1,** the second guide roll **14***b* is located to feed the web **10** into the nip of the rolls **12** and **15** on a common tangent line for the two rolls. As the web is passed through the nip of the rolls **12** and **15,** it is again pressed firmly against the surface of the roll **12** to form a second embossment in the web. These second embossments are illustrated schematically in FIG. **2** as embossments B repeated continuously along the length of the web **10,** with the repetition rate being determined by the same factors discussed above in connection with the first embossments A.

It is important that the embossments formed at the second embossing station be out of register with the embossments formed at the first embossing station, so that the maximum area of the web is embossed, and to avoid overstressing any given portion of the web material. Consequently, if the embossing pattern on the surface of the metal roll **12** repeats itself around the circumference of the roll **12,** the locations of the rubber rolls **13** and **15,** the rate of advancement of the web **10,** and the distance that the web **10** is drawn away from the surface of roll **12** by the guide rolls **14***a* and **14***b* must be selected so that the embossments formed at the successive embossing stations are out of register with each other. In one example of the illustrative embodiment, the embossing roll **12** has a diameter of 20 inches with an embossing pattern that repeats itself every 10 inches around the circumference of the roll; the embossing roll **12** is driven at a rate sufficient to provide a web speed of 500 feet per minute; the embossing stations are located at the angular positions shown in FIG. **1;** and the centers of the guide rolls **14***a* and **14***b* are located 36 and 28 inches, respectively, from the center of the driven embossing roll **12.**

It will be understood that any desired number of additional embossing stations may be provided around the circumference of the embossing roll **12,** depending upon the characteristics desired in the final embossed web. Thus, in the illustrative embodiment, a third embossing station is provided by a third rubber roll **16** bearing against the outer surface of the roll **12.** As the double-embossed web **10** emerges from the nip of the second rubber roll **15** and the embossing roll **12,** the web is drawn outwardly away from the surface of the embossing roll **12** and over a guide roll **17***a*. From the guide roll **17***a* the double-embossed web is returned under a second guide roll **17***b* to the surface of the roll **12,** and then passed through the third embossing station formed by the nip of the third rubber roll **16** and the metal embossing roll **12.** As in the case of guide rolls **11***a* and **14***b* described previously, the second guide roll **17***b* is positioned so that the web **10** is fed into the nip of the rolls **16** and **12** on a common tangent line for the two rolls.

As the web is passed through the nip of the rolls **16** and **12,** it is once again pressed firmly against the surface of the metal roll **12** to form a third embossment in the web. These third embossments are illustrated schematically in FIG. **2** as embossments C repeated continuously along the length of the web **10,** with the repetition rate being determined by the same factors discussed above in connection with embossment A. It is again important that the embossments C be out of register with the embossments A and B, and in the particular example described previously the centers of the guide rolls **17***a* and **17***b* are located 63 and 32 inches, respectively, from the center of the embossing roll **12.** The resulting triple-embossed web emerging from the nip of the rolls **16** and **12** is withdrawn from the embossing machine as at **20** for winding or further processing.

In order to maintain the rubber rollers **13, 15** and **16** at a temperature sufficiently low to prevent degradation of the rubber, the rollers are preferably water cooled. In general, it is desirable to prevent the temperature from rising above about 200° F. at any point in the rubber, which is generally in the form of a cover on the outer surface of a hollow metal drum. To facilitate cooling, the rubber cover is typically made as thin and hard as possible, consistent with good embossing performance.

In accordance with another important aspect of the present invention, the web to be embossed is made of paper or other substantially non-resilient material, and is reinforced in the longitudinal or machine direction by continuous threads or other reinforcing members made of a resilient material. It has been found that the non-resilient material is permanently stressed during the embossing operation, whereas the resilient reinforcing elements tend to spring back to their original dimensions and configuration as soon as the embossing pressure is released. Consequently, a substantially constant web length is maintained between successive embossing stations. Without the resilient reinforcing elements extending continuously in the machine direction in the web, the web continuously acquires a permanent stretch at each embossing station, so that the web length between each pair of successive embossing stations gradually increases.

In accordance with one specific aspect of the present invention, the embossed web comprises a pair of flexible layers of cellulosic tissue, and an open mesh, nonwoven web of crossed threads interposed between the layers of cellulosic tissue, with at least the warp threads of the crossed-thread web being made of a resilient material. Thus, it has been found that the embossing method and apparatus provided by this invention are

particularly suitable for embossing the type of web shown in FIG. 3. More specifically, the web 30 in FIG. 3 includes two layers 31 and 32 of non-woven cellulosic tissue or wadding with a non-woven fabric 33 of crossed threads 34 and 35 interposed and adhesively bonded between the layers 31 and 32. In the preferred embodiment, each layer 31 and 32 is formed of two plys 31*a*, 31*b* and 32*a*, 32*b*, respectively, of creped cellulosic tissue. The cellulosic tissue preferably has a drier basis weight before creping of from about 4 to about 12 pounds per 2,880 square foot ream, with a crepe ratio before stretching and pressing of from about 1.1 to about 2.5 as it is creped off the dryer of the paper machine. The creped tissue is typically stretched and pressed after creping to reduce the original high crepe ratio to about 1.1 to 1.8 in order to produce a soft sheet such as is customarily used in the manufacture of facial tissue.

In the central layer 33 of non-woven fabric, the fill threads 35, i.e., the threads which extend in the transverse direction, are all on the same side of the warp threads 34, i.e., the threads which extend in the longitudinal or machine direction, with the two sets of threads disposed in face-to-face relation to each other and adhesively bonded together where the threads of one set cross the threads of the other set. For the purposes of the present invention, it is preferred that the crossed-thread fabric have a relatively low thread count, e.g., two to three threads per inch in both directions to provide a relatively high bulk in the final embossed product. The threads in each of the two cross-laid sets normally run parallel to each other and are uniformly spaced. The adhesive is normally applied to both sets of threads in order to achieve the most effective bonding of the non-woven fabric 33 to the outside layers 31 and 32 of cellulosic tissue, although adhesive may be applied to only one of the two sets of threads if desired. It will be understood that the term "threads" is intended to include both monofilament and multifilament structures, although multifilament structures are generally preferred in non-woven fabrics of this type.

Non-woven laminates of the type illustrates in FIG. 3 are known per se in the art, as exemplified by U.S. Pat. No. 3,072,511 to K.J. Harwood. When a web of such material is to be embossed by the method and apparatus of the present invention, it is important that at least the warp threads 34 be made of a resilient material, such as 40 denier high tenacity nylon or comparable polyester or rayon, for example. Whereas the cellulosic tissue layers 31 and 32 are permanently stressed during the embossing operation, to provide the resulting embossed laminate with the desired bulk and texture, the resilient warp threads 34 are only temporarily distorted during the embossing operation, and tend to spring back to their original configuration as soon as the embossing pressure is released so that a substantial portion of the stretched tissue in the windows of the scrim protrudes out of the plane of the material. Thus, the resilient reinforcing warp threads 34 prevent any permanent elongation of the laminated web at any given embossing station, so that a substantially constant web length is maintained between successive embossing stations.

One of the significant advantages of the present invention is that the flexible web may be embossed to any desired degree by using a single embossing roll, and yet the embossing pressure required at each embossing station may be sufficiently low to provide a long operating life for the embossing equipment, particularly the rolls 13, 15 and 16 which are conventionally made of rubber, and which cooperate with the metal embossing roll to form the embossing stations. For example, if the same degree of embossing attainable with the three-station arrangement shown in FIG. 1 were to be achieved with a single embossing station, the embossing pressure required would be so great that the risk of failure of the rubber roll from heat build-up would render the operation unfeasible. Furthermore, supplemental operations such as pin embossing and the like are not necessary to improve the response of the flexible web to the main embossing operation, because the desired yieldability, bulk, and embossing response is improved in each subsequent embossing station, and it is simply a matter of providing the necessary number of such stations around the single embossing roll.

I claim as my invention:

1. A web of nonwoven material comprising the combination of at least two layers of stretchable, soft cellulosic tissue and a fabric made of open-mesh threads interposed between the layers of cellulosic tissue and bonded thereto, said fabric including a first set of substantially parallel threads spaced from each other and extending in a first direction and a second set of substantially parallel threads spaced from each other and extending in a second direction so as to cross said first set of threads, any of said first and second sets of threads that extend in the longitudinal direction of said web being made of a resilient material, the composite material formed by said tissue and said fabric having been embossed under pressure repetitively by patterned embossing means to form embossments repeated continuously along the length thereof and superimposed on each other but out of register with each other with a substantial portion of the cellulosic tissue protruding beyond said threads to increase the bulk, yieldability and surface texture of the material, the cellulosic tissue having been permanently stretched by the embossing of the composite material without overstressing the threads.

2. A web of nonwoven material as set forth in claim 1 wherein the thread count of said threads is between about two and three threads per inch.

3. An improved nonwoven towel material comprising the combination of a central layer of fabric made of open-mesh crossed stretchable threads spaced from one another, at least one set of the threads being both stretchable and resilient, and a layer of stretchable, soft cellulosic tissue adhesively bonded to each of the opposite faces of said central layer of fabric, the composite material formed by said fabric layer and said cellulosic layers having been embossed under pressure repetitively by similarly patterned embossing means to form similar embossments repeated continuously along the length of the material and superimposed on but out of register with each other, the non-resilient cellulosic tissue and any non-resilient fabric threads having been permanently stretched by the embossing pressure without overstressing any given portion of the material including the threads, and the threads which are both resilient and stretchable having been temporarily distorted and allowed to spring back to substantially their original dimensions and configuration as the embossing pressure is released, so that a substantial portion of the cellulosic tissue protrudes through the windows of the

open mesh fabric and beyond the opposite faces thereof to increase the bulk, yieldability and surface texture.

4. An improved nonwoven towel material comprising the combination of a central layer of fabric made of open-mesh crossed stretchable threads spaced from one another, at least one set of the threads being both stretchable and resilient, and a layer of stretchable, soft cellulosic tissue adhesively bonded to each of the opposite faces of said central layer of fabric, the composite material formed by said fabric layer and said cellulosic layers having been embossed under pressure repetitively at two or more stations spaced around a single rigid metal embossing roll wherein the material is pressed against said roll by a resilient roll to form similar embossments repeated continuously along the length of the material and superimposed on but out of register with each other, the non-resilient cellulosic tissue and any non-resilient fabric threads having been permanently stretched by the embossing pressure at each station without overstressing any given portion of the material including the threads, and the threads which are both resilient and stretchable having been temporarily distorted by the embossing pressure at each station and allowed to spring back to substantially their original dimensions and congiguration as the embossing pressure is released, to increase the material bulk, yieldability and surface texture.

5. An improved nonwoven towel material comprising the combination of a central layer of fabric made of open-mesh crossed stretchable threads spaced from one another, at least one set of the threads being both stretchable and resilient, and a layer of stretchable, soft cellulosic tissue adhesively bonded to each of the opposite faces of said central layer of fabric, the composite material having been pressure embossed repetitively through the windows of the scrim with a similar embossment pattern to form similar embossments repeated continuously along the length of the material and superimposed on but out of register with each other, the non-resilient cellulosic tissue and any non-resilient fabric threads having been permanently stretched by the embossing pressure without overstressing any given portion of the material including the threads, and the threads which are both resilient and stretchable having been temporarily distorted by the embossing pressure and allowed to spring back to substantially their original dimensions and configuration as the embossing pressure is released, to increase the material bulk, yieldability and surface texture.

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