FIG. 5

ANGLE OF COMPACTOR
270°, 285°, 300°, 315°, 330°, 345°

MACHINE DIRECTION

FIG. 6

ANGLE OF COMPACTOR
270°, 285°, 300°, 315°, 330°, 345°

MACHINE DIRECTION
ABSTRACT OF THE DISCLOSURE

The invention provides an improved apparatus for producing isotropic extensibility in a web. The apparatus comprises a deformable surfaced blanket and a recoilless blanket, both utilized on an angle bar compactor, and includes a pair of stationary rods extending obliquely across the direction of travel of the deformable surfaced blanket and a means for passing the recoilless blanket through the pressure nip of the compactor which means include means disposed obliquely across the direction of travel of the recoilless blanket and disposed at a greater angle relative to the recoilless blanket than the angle the pair of stationary rods makes with the deformable surfaced blanket, whereby the compactor is operative to cause isolation of the web while in the pressure nip from the speed differential between the deformable blanket and the stationary nip rod of the compactor.

The invention provides an improved method and apparatus for producing isotropic extensibility in a web and includes deformable and recoilless surfaced blankets utilized on an angle bar compaction apparatus with a unique roll arrangement, whereby the compactor is operative to cause isolation of the web while in the pressure nip from the speed differential between the deformable blanket and stationary nip rod of the compactor.

This invention relates to a method and apparatus for the production of a modified web material. More particularly, this invention provides an extendible web having improved physical properties such as toughness, tear, smoothness, stretch, and drape giving the web material greater utility without sacrificing its other useful properties.

It has also been found that such webs formed from natural or synthetic fibers bonded by polyester systems have had rather limited use as substitutes for textile fabrics because such webs are stiff and consequently resist deformation under complex stresses such as are encountered in bodily movements. Additionally, the hand of such webs is liable to be harsh, the surfaces tend to present a matted appearance and such webs do not drape well.

While it has been determined that the procedure outlined in United States Letters Patent to Fred H. Freuler, 3,122,469 of Feb. 25, 1964, provides a concept wherein an oblique stretch or extensibility is imparted to the web to disclose a more versatile web having many end uses, it has been found that the Freuler patent is not always available to overcome the problem of providing a web which is not harsh or free of surface fuzz.

According to this invention, it has now been discovered that in spite of the different character of fiber used in production of the modified web, it is possible to produce an inexpensive modified web with extensibilities far in excess of the primitive extensibility of the web and, at the same time, it is possible to improve the surface appearance and smoothness of the web and to increase materially the toughness, tear, and drape of the web.

An object of this invention is to provide an improved method and apparatus for producing a modified web, which will be soft to the touch or feel, which will have increased extensibility, toughness, smoothness and drape giving the web material greater utility without sacrificing its other useful properties.

Other objects and advantages of the present invention will be apparent from the following description and drawings illustrating an example of the practice of this invention in which drawings:

FIGURE 1 is an elevation view of an illustrative web modifying machine which forms a practical and advantageous embodiment of features of the invention;

FIGURE 2 is a longitudinal profile of the machine shown in FIGURE 1;

FIGURE 3 is a view in longitudinal vertical section of the web modifying machine shown in FIGURE 1;

FIGURE 4 is a diagrammatic view illustrating the effect of the mechanism of FIGURE 1 on a web material;

FIGURES 5-8, inclusive, are charts which show the respective stretch characteristics of webs which have been (a) shrink longitudinally, (b) shrink directly crosswise of the web, (c) shrink at substantially 45° to the lengthwise dimension of the web and (d) shrink 21° plus and minus 45° to the lengthwise dimension of the web; and

FIGURE 9 is a view in longitudinal vertical section of a web which is first set into a unit of the type shown in FIGURE 1 and then fed into a Cluett unit to shrink it in the machine direction.

As was mentioned above, in connection with Freuler 3,122,469, it has been determined that the direction of web shrinkage can be preselected by setting the angular relation of the rods to the direction of travel of the blanket and the web. It has also been found that the measure of shrinkage can be predetermined by adjustment of the spacing of the rods relative to the thickness of the blanket, to provide blanket deforming pressure at a nip formed by and between the blanket and the second rod.

By setting the rods at right angles to the direction of the web and blanket travel, the shrinkage is caused to occur in the machine direction of the web. By setting the rods at an appropriate angle in the neighborhood of 45° to the direction of web and blanket travel the shrinkages surprisingly are caused to occur substantially diagonally across the web. By setting the rods at an appropriate angle in the neighborhood of 57° to the direction of web and blanket travel, the shrinkage is caused to occur chiefly at an angle of 45° to the direction of web and blanket travel.

Two-way stretch can be provided, therefore, by combining a first unit of the Freuler mechanism with the rods set at an appropriate angle for shrinking the webs across its width, with a Cluett unit, or by combining such first unit with another unit of the new mechanism in which the rods extend squarely across the web and blanket paths.

In either case, units may be arranged to shrink the web first in a machine direction and then in a cross-machine direction, or vice versa.

It has further been determined that to reduce surface harshness and nap on the surfaces of the web and obtain extensibility in an obliquely angular direction to the machine direction, it is necessary that the speed difference between the stationary rod of the Freuler patent and the surface of the web be reduced appreciably. In this connection, since the rods forming the nip must, as a result of their angular disposition, be non-rotating, the speed difference between the web and rod at the point of the zone wherein the web is shrunk is maximum. As a consequence, the web tends to take on a harsh or fuzzy surface appearance.

It has also been found that steam lubrication is not a
feasible means for lubricating certain types of web material; for example, steam is not an effective lubricant in parenchyma because the steam tends to pass through the web and sets up a cushion behind the sheet to hinder the compaction of the web. To reduce this harshness or fuzzy appearance and/or to provide a lubricant other than steam, applicators make provisions for the incorporation of a recocill blanket which is passed through the nip formed by the two rolls and in surface to surface relationship with the deformable surface blanket. In this fashion, as the web is shrunk, it tends to slide over the recocill blanket which has a low coefficient of friction.

In this fashion, a useful web having the hereinabove mentioned characteristics is the result. The product and method contemplated by the present invention will be first explained by referring to an example of the production thereof by use of the apparatus shown in the drawings.

The apparatus shown in the drawings comprises rolls 10, 11, 12, guide rolls 14 and 16 and non-rotating rods 20 and 21 and a deformable surface blanket or belt 22 having a contractible or elastomeric surface layer, preferably of rubber, with a durometer hardness of 55° to 60°. This belt preferably be formed of elastomeric material, such as natural rubber or rubber substitutes, and is preferably a continuously running belt. It preferably has a strong relatively inextensible layer, faced with a readily extensible and contractible surface layer, of any suitable material which has a smooth elastic or stretchable and contractible surface of sufficient hardness and extensibility. The rolls 20 and 21 may be adjustable moveable toward and from each other so as to properly nip the belt between them where the belt passes from the roll 11 to the roll 10. As the belt passes from the roll 11 to the roll 21, the outer surface or layer of the belt, which is convexly curved and stretched while passing around the roll 20, becomes concavely curved and compressed when passing over the roll 21 and accordingly the outer layer shortens in length.

As is obvious from FIGURES 1 and 2, the blanket passes over rod 20 in one direction of curvature and around roll 21 in the opposite direction of curvature. To overcome the fuzzing and harshness problems mentioned hereinabove, applicant provides for an apparatus comprising rolls 24, 25, 26, 27 and 28 and rods 30, 31, and 32 with a recocill blanket 34 having a low coefficient of friction. While the recocill blanket is driven, as the result of its being in contact with the deformable surface blanket and the present invention, it is obvious that means could be provided for independently driving this recocill blanket 34. The surface of the recocill blanket has a low coefficient of friction and the blanket is of less thickness than the deformable surface blanket. More particularly, the recocill blanket is preferably made as thin as physical limitations will permit; that is, it should be durable and thin and have a lower coefficient of friction relative to the web than the deformable blanket. The rods 30 and 31 are disposed at twice the angle relative to the recocill blanket 34 than the rods 20 and 21 are disposed relative to the deformable surface blanket 22. In this fashion, the recocill blanket 34 is directed into the nip 35 in a direction normal to the direction at which the rods 20 and 21 are disposed and consequently the recocill blanket and the deformable surface blanket pass through the nip in surface to surface relationship with each other.

Preferably the deformable surface blanket has a thickness sufficient to provide a surface recoil of at least 4% when it passes through the nip. A web 40 is passed onto the recocill blanket at point 41 and is carried over rod 32 by the blanket and as the blanket passes underneath rod 30, the web passes underneath the other rod 31 so as to eliminate a speedup of the web which would result by passing it around the bottom rod 30. The web is then passed into the nip 35 and in firm contact with the convex surface of the deformable surface blanket and the web adheres frictionally to the blanket surface as it passes into the nip and between the deformable surface blanket and the recocill blanket, where shortening of the blanket surface is taking place by a reversal of its curvature. The web is formed by pressure into such frictional contact, with the contracting surface of the deformable surface blanket, that the contracting belt surface tends to shorten the adhering web and compress it in a directional parallel with the surface of the web. The pressure of rod 20 on the belt induces the belt and causes the convex belt surface at the nip to momentarily move faster than the body of the belt is traveling which serves to stretch the belt into the recocill blanket to enhance contraction of the belt surface and adherent web. An opposite pressure is exerted by rod 21 against recocill blanket 34 and this opposes the pressure being applied to the deformable surface blanket and there results a zone 45 which extends obliquely across the deformable surface blanket wherein compaction of the fibers of the web occur.

While the web is shown as being carried by the blanket 34, it is obvious that an arrangement could be developed within the scope of the present invention which would eliminate this carrier function of the blanket and teach the passing of the web directly into the nip. Lubricant which may be a silicone water solution is directed into the nip area to lower the coefficient of friction between the web and recocill blanket. At the same time, causes a softening and increased flexibility of the fibers as they are crowded together by the contraction of the deformable surface blanket.

By eliminating the substantial differences in relative speeds between the web 40 and the stationary rod 20, as was the case in the Freuler U.S. 3,122,469 patent, it is now possible to produce a web which has a smooth surface appearance and does not have the harshness of the prior type webs. With elimination of speed differential, and by properly selecting the hardness of the deformable surface blanket, and applying a pressure through rod 21 to oppose the pressure applied by rod 20 against the deformable surface blanket, the web may be kept plain and the surface fuzz which resulted in prior art concepts no longer occurs. As the web is compressively shortened, the individual fibers of the web including dust fibers which lie generally lengthwise along the direction of compaction, are compressively distorted laterally of themselves and slide along one another within the body of the web. This aspect is particularly shown in FIGURE 4 wherein the web is shown roughly as it would appear in a flat, extended condition, the wrap around the rods 20 and 21 being ignored and the line of initial nip engagement being represented by the broken line 42. When the leading edge of the web 40 coincides with the dotted cross line 44, the leading end of the web edge 46 is just entering the nip. As the web advances, it is progressively shrunken toward the web edge 46 and this draws the opposite web edge toward the edge 46 until the leading end of the opposite web edge enters the nip. The opposite web edge therefore extends along a straight course 47 parallel to the edge 46 up to the line 44, then along a course 48 which is inclined toward the edge 46 until the point 49 is reached at which point this edge enters the nip, and finally along a straight course 50 which is parallel to the edge 46. In normal operation, this pattern of progressive shrinkage is maintained so long as the feeding of the web through the unit is continued.

The curve 60 of FIGURE 5 illustrates a typical case of a web put through the unit described hereinabove with the rods 20 and 21 disposed at right angles of the machine direction. It will be observed that the machine direction stretch has been increased to the 120% but the cross-direction stretch has not been altered appreciably. The curve 61 of FIGURE 6 illustrates a typical case of a web put through the unit described hereinabove with the rods 20 and 21 disposed along the line 135°-315°, or in other words, with the rods disposed at 45° to the machine direction. The machine direction stretch of the
web has not been altered appreciably. The maximum stretch is found to occur directly across the web and to be about 17½%.

The curve 62 of FIGURE 7 illustrates a typical case of a web put through the above unit with the rods 20 and 21 disposed along the 123.3°-303.3° line or, in other words, with the rods disposed at 56.7° to the machine direction. The machine direction stretch and the cross-direction stretch have both been increased as compared with FIGURE 5, but the greatest stretch is found to be along the 45°-225° line and amounts to approximately 20%.

The curve 63 of FIGURE 8 illustrates a typical case of a web put through the unit above described, once, once with the rods 20 and 21 disposed along the 123.3°-303.3° line, and a second time with the rods disposed along the 56.7°-236.7° line. Otherwise expressed, this means that the rods were disposed at 45°-56.7° to the machine direction in the first instance and 56.7° to the machine direction in the second instance. The dotted lines represent the contributions of the respective passes to the composite curve 63. The same effect can be had by leaving the first setting of the rods unchanged while turning the web over and feeding it through a second time in the same direction as before. The curve 63 is seen to have a rounded but generally square shape with the greatest stretch extending along the two diagonals and amounting to substantially 20%.

The moisture content of the web as it enters the nip depends on the basis weight, characteristic of the fibers, and other ingredients of the web. As an example, for a 30 to 40 lb. sheet per 3000 sq. ft. you would have 65% solids in order for the web to be free from fuzz and smooth as compared to webs made in accordance with prior art methods.

It is obvious that a web made in accordance with the present invention could be simultaneously creped and/or embossed, and still be within the scope and spirit of the claims that follow.

In FIGURE 9, disclosure is made of a composite web shrinking mechanism for increasing the extensibility of the web both in the machine direction and at an angle to the machine direction. The mechanism includes a Chlett type unit 70 for shrinking the web 71 in the machine direction and a unit 72 for shrinking the web in accordance with the concepts mentioned hereinabove. The unit 70 is shown ahead of the unit 72, but the order of arrangement could just as well be reversed.

The unit 70 may desirably be a duplicate of the unit shown in FIGURE 1 of Chlett United States Patent 2,624,245 and will not be described in detail herein. A web 71 is passed through the Chlett unit and around roll 73 into a unit as described hereinabove in connection with FIGURES 1 to 3.

It is believed that the foregoing description conveys an understanding of the concepts contemplated by the apparatus shown in FIGURE 9 and no further disclosure is required.

It will be understood that various changes in the details, materials, steps and portions of components may be made by those skilled in the art within the principle and scope of the invention, as expressed in the appended claims.

We claim:

1. An angled bar compactor for increasing the extensibility of a web in a preselected obliquely angular direction, a deformable surfaced blanket, means for driving the deformable surfaced blanket in a closed path and said recoilless blanket passing through said nip, a second rod for said angled bar compactor and extending obliquely across the direction of travel of the recoilless blanket and said second rod being disposed at a greater angle relative to the recoilless blanket than the angle that the first pair of rods makes with said deformable surfaced blanket, and means for passing a web into said nip formed between said deformable surfaced blanket and said recoilless blanket.

2. Apparatus in accordance with claim 1 in which the deformable surfaced blanket is a resilient material having a thickness sufficient to provide a surface recollection of at least 4% when it passes through said nip, and said recoilless blanket being relatively thin to provide a low friction, non-recolling surface as said recoilless blanket passes through said nip.

3. An angled bar compactor for increasing the extensibility of a web in a preselected obliquely angular direction, a deformable surfaced blanket, means for driving the deformable surfaced blanket in a closed path, a first pair of rods for said angled bar compactor extending obliquely across the direction of travel of the deformable surfaced blanket and at opposite sides thereof and in such relation to the deformable surfaced blanket and to one another that the blanket is caused to have a wrap around one rod in one direction of curvature and then around the other rod in the opposite direction of curvature, said rods being non-rotary and forming a nip therebetween, a recoilless blanket, means for driving said recoilless blanket in a closed path and said recoilless blanket passing through said nip, a second pair of rods for said angled bar compactor extending obliquely across the direction of travel of the recoilless blanket and said second pair of rods being disposed at a greater angle relative the recoilless blanket than the angle said first pair of rods makes with said deformable surfaced blanket, first means for passing said web onto said recoilless blanket and second means operative to cause said recoilless blanket to pass under one of said second pair of rolls and said web to pass under the other of said second pair of rolls then into said nip between said deformable surfaced blanket and said recoilless blanket.

4. An angle bar compactor for increasing the extensibility of a web in a preselected obliquely angular direction comprising in combination: a first blanket having a deformable surface; means for driving said first blanket in a closed path, said means including a driver roller engaging said blanket; a pair of stationary rods extending obliquely across the direction of travel of said blanket at opposite sides thereof and in such relation to the deformable surfaced blanket and to one another that said first blanket is caused to have a wrap around one of said pair of rods in one direction of curvature and then around the other of said pair of rods in a direction of curvature opposite to said one direction of curvature, said rods engaging said first blanket to form a pressure nip: a second blanket moving in a closed path and being recoilless, said recoilless blanket having a coefficient of friction relative to the web such that the web will slide over the recoilless blanket when acted upon in the nip by the recoil of the deformable surfaced blanket; means for passing said second blanket through said pressure nip in surface to surface relationship with said first blanket, said blanket passing means including means disposed obliquely across the direction of travel of the recoilless blanket and disposed at a greater angle relative to the recoilless blanket than the angle said pair of stationary rods makes with said deformable surfaced blanket, whereby said angle bar compactor is operative to cause isolation of the web while in the pressure nip from the speed differential between the deformable surface blanket and one of the stationary rods.

5. An angle bar compactor for increasing the extensibility of a web in a preselected obliquely angular direction comprising in combination: a first blanket having a deformable surface; means for driving said first blan-
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A pair of stationary rods extending obliquely across the direction of travel of said first blanket at opposite sides thereof and in such relation to the deformable blanket and to one another that said first blanket is caused to have a wrap around one of said pair of rods in one direction of curvature and then around the other of said pair of rods in a direction of curvature opposite to said one direction of curvature, said rods engaging said first blanket to form a pressure nip; a second blanket moving in a closed path and being recoilless, said second blanket having a coefficient of friction relative to the web such that the web will slide over the recoilless blanket when acted upon in the nip by the recoil of the deformable surfaced blanket; means for passing said second blanket through said pressure nip in surface to surface relationship with said first blanket, said blanket passing means including a rod member disposed obliquely across the direction of travel of the recoilless blanket and disposed at a greater angle relative to the recoilless blanket than the angle said pair of stationary rods makes with said deformable surfaced blanket; web passing means including an obliquely disposed means extending obliquely across the direction of travel of said second blanket and being disposed at substantially the same angle relative to the direction of travel of said second blanket as is said rod member, and said obliquely disposed means lying outside the closed path of the recoilless blanket and engaging said second blanket between said blanket passing means and said pressure nip; whereby the web is passed in contact with the surface of said second blanket and thence carried into the pressure nip between said first and second blankets.

6. An angle bar compactor for increasing the extensibility of a web in a preselected obliquely angular direction comprising in combination: a first blanket having a deformable surface; means for driving said first blanket in a closed path, said means including a driver roller engaging said first blanket; a pair of stationary rods extending obliquely across the direction of travel of said first blanket at opposite sides thereof and in such relation to the deformable blanket and to one another that said first blanket is caused to have a wrap around one of said pair of rods in one direction of curvature and then around the other of said pair of rods in a direction of curvature opposite to said one direction of curvature, said rods engaging said first blanket to form a pressure nip; a second blanket moving in a closed path and being recoilless, said second blanket having a coefficient of friction relative to the web such that the web will slide over the recoilless blanket when acted upon in the nip by the recoil of the deformable surfaced blanket; means for passing said second blanket through said pressure nip in surface to surface relationship with said first blanket, said blanket passing means including a rod member disposed obliquely across the direction of travel of the recoilless blanket and disposed at a greater angle relative to the recoilless blanket than the angle said pair of stationary rods makes with said deformable surfaced blanket, said rod member lying outside the closed path of the recoilless blanket; web passing means including an obliquely disposed means extending obliquely across the direction of travel of said second blanket and being at substantially the same angle relative to the direction of travel of said second blanket as is said rod member, and said obliquely disposed means engaging said second blanket at a point beyond the engagement of the second blanket with said rod member and prior to the engagement of the second blanket with either of said pair of stationary rods; whereby the web is passed in contact with the surface of said second blanket and thence carried into the pressure nip between said first and second blankets.

7. An angle bar compactor for increasing the extensibility of a web in a preselected obliquely angular direction comprising in combination: a first blanket having a deformable surface; means for driving said first blanket in a closed path, said means including a driver roller engaging said first blanket; a pair of stationary rods extending obliquely across the direction of travel of said first blanket at opposite sides thereof and in such relation to the deformable surfaced blanket and to one another that said first blanket is caused to have a wrap around one of said pair of rods in one direction of curvature and then around the other of said pair of rods in a direction of curvature opposite to said one direction of curvature, said rods engaging said first blanket to form a pressure nip; a second blanket moving in a closed path and being recoilless; means for passing said second blanket through said pressure nip in surface to surface relationship with said first blanket, said blanket passing means including first means disposed obliquely across the direction of travel of the recoilless blanket and disposed at a greater angle relative to the recoilless blanket than the angle said pair of stationary rods makes with said deformable surfaced blanket; web passing means including a second obliquely disposed means extending obliquely across the direction of travel of said second blanket and being disposed at substantially the same angle relative to the direction of travel of said second blanket as is said first means, and said second means engaging said second blanket between said blanket passing means and said pressure nip; whereby the web is passed in contact with the surface of said blanket and thence carried into the pressure nip between said first and second blankets.

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