

[54] **PROCESS FOR CONDITIONING TEXTILES IN THE PRESENCE OF IMPACTING AND VIBRATING**

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[63] Continuation of Ser. No. 186,351, Oct. 4, 1971, abandoned.

[52] U.S. Cl. **26/18.5; 26/52; 38/26; 38/28**

[51] Int. Cl.² **D06C 27/00; D06C 15/10; D06C 3/02**

[58] Field of Search **26/1, 18.5, 52; 38/17, 38/24, 26, 28**

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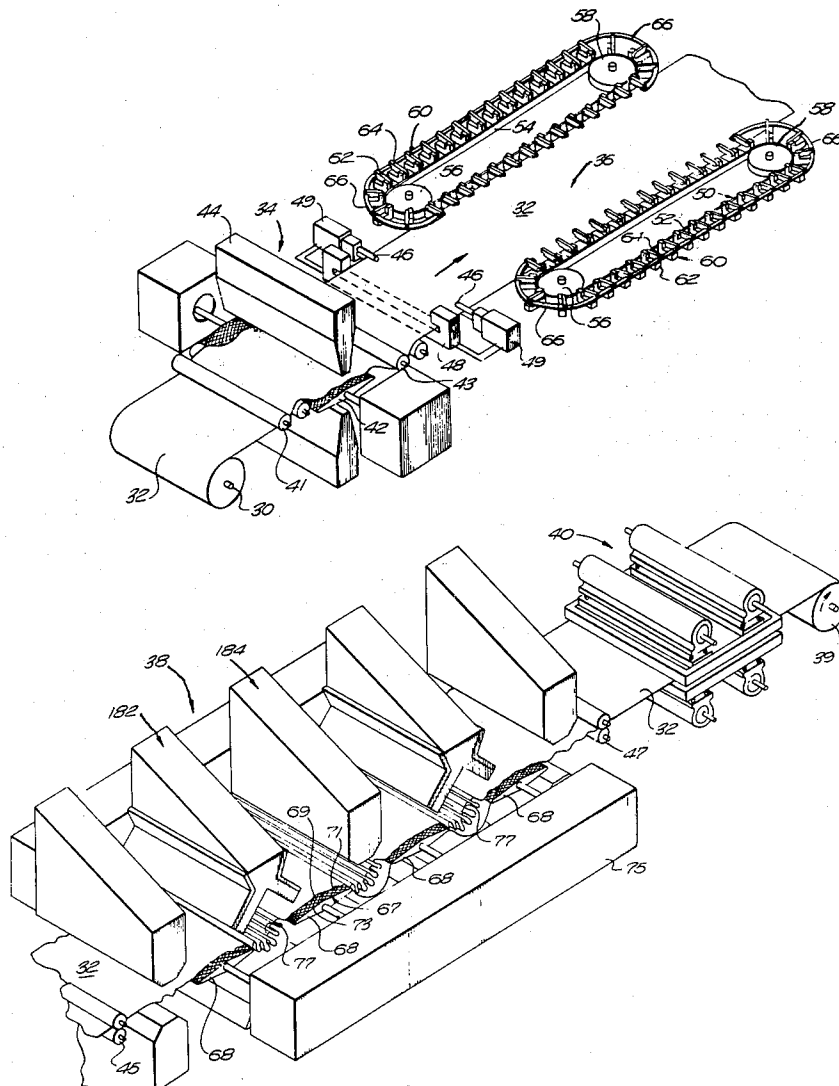
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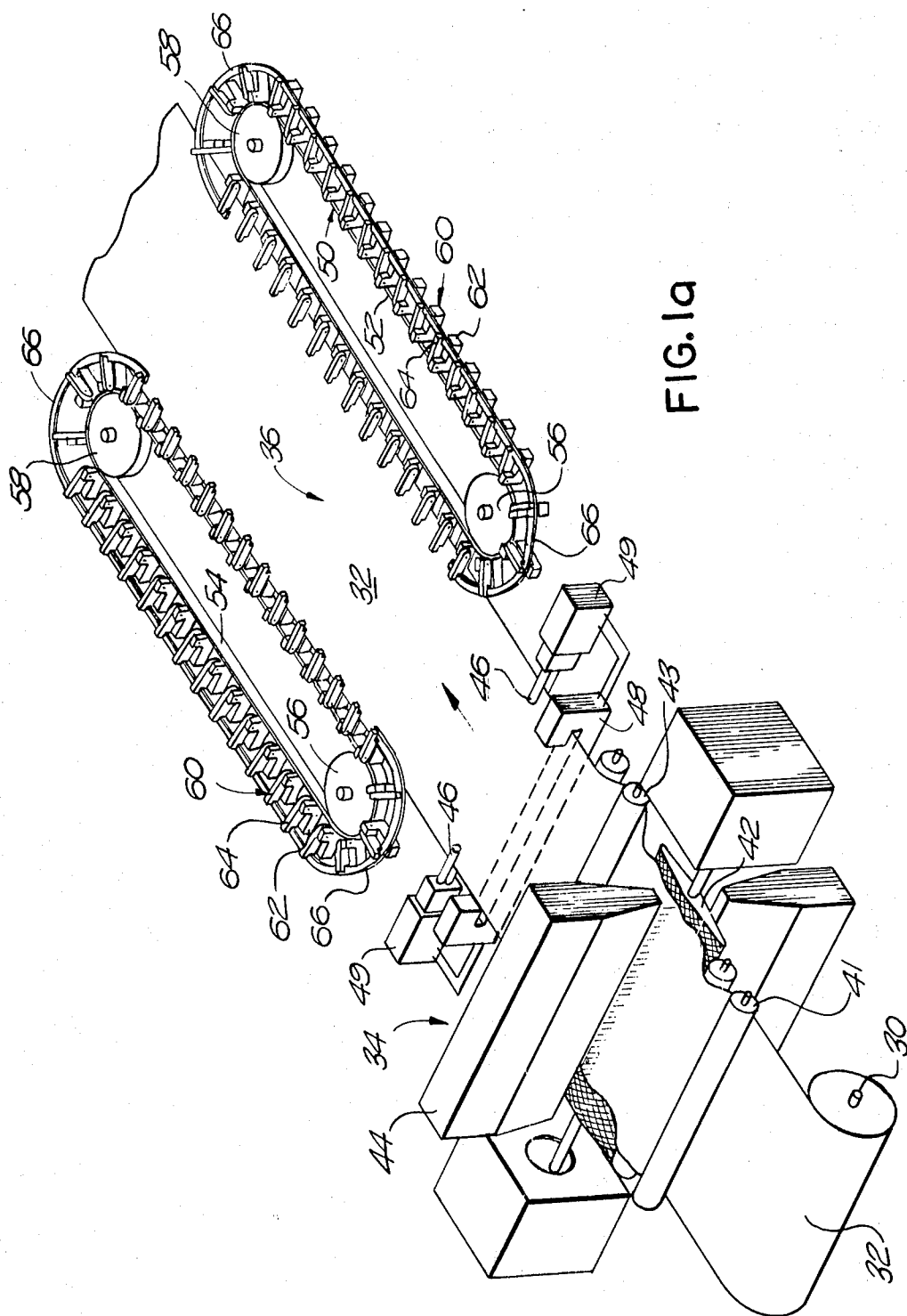
Primary Examiner—Robert R. Mackey
Attorney, Agent, or Firm—Morse, Altman, Oates & Bello

[57] ABSTRACT

A textile finishing process includes the steps of transversely stretching the wet web while permitting longitudinal contraction, directing streams of dry gas at opposite faces of the web in order to bias the web toward predetermined position and to dry the web if wet, and subjecting the web to a succession of sharp localized impacts.

9 Claims, 9 Drawing Figures





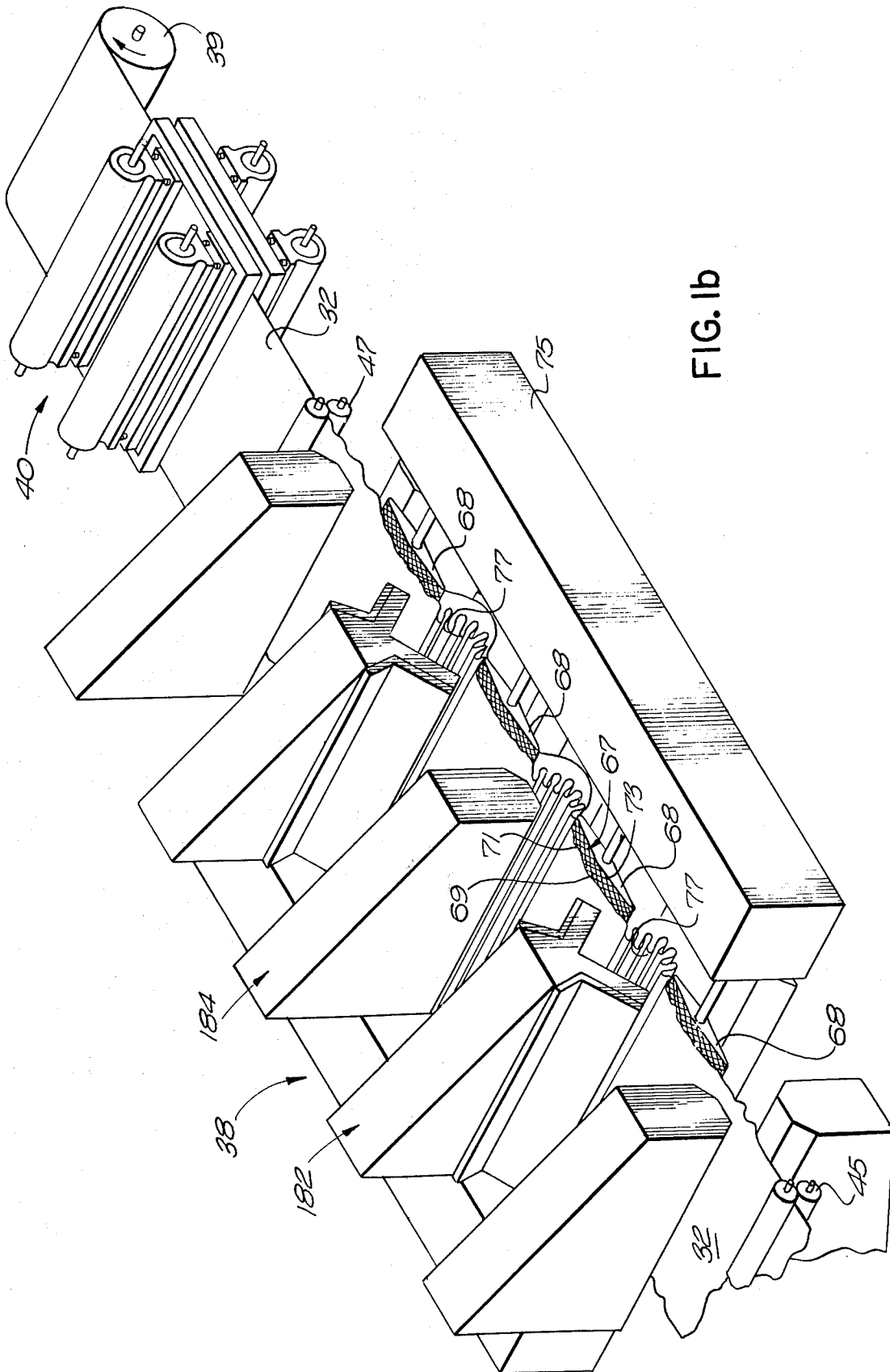


FIG. 1b

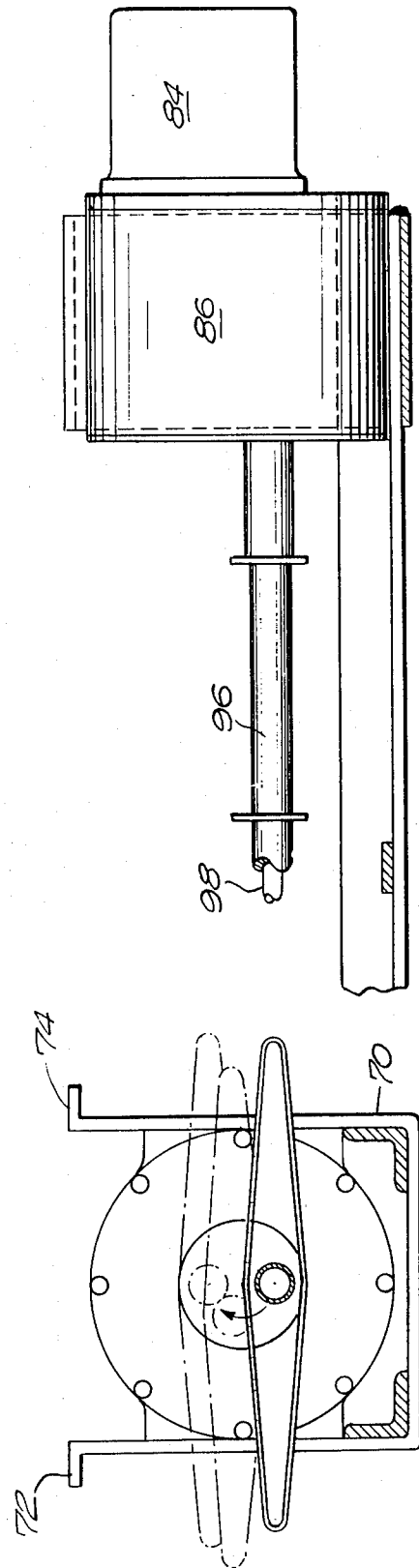
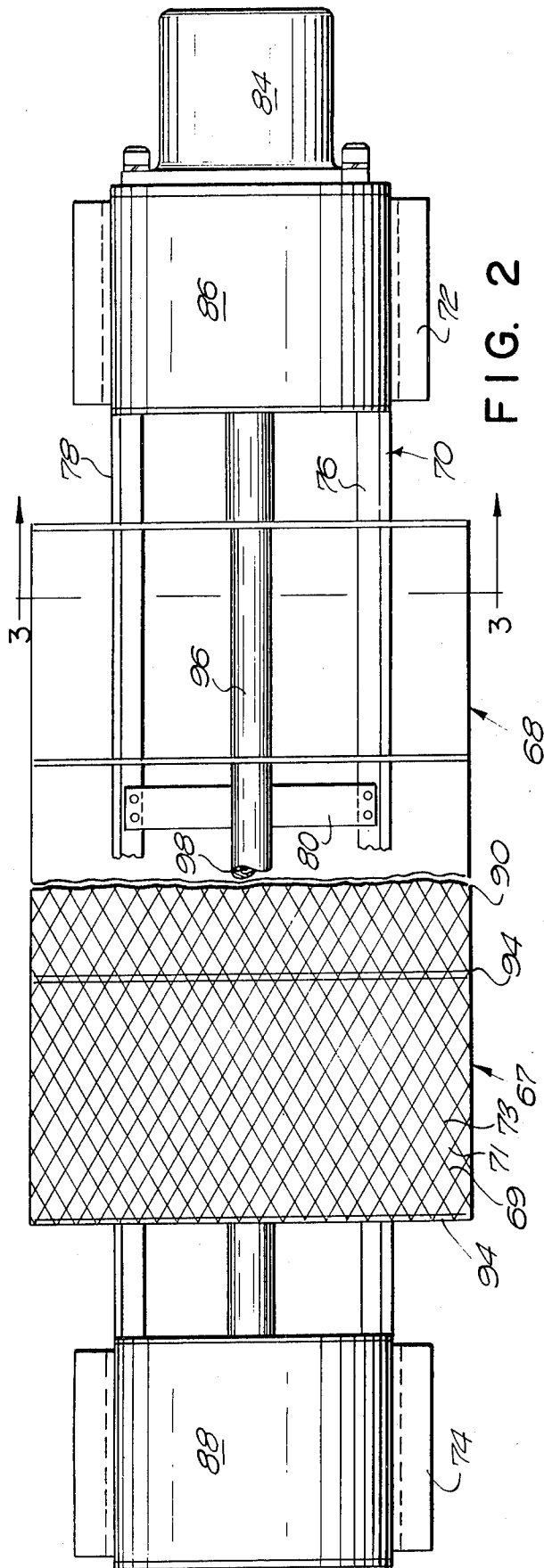


FIG. 4

FIG. 3

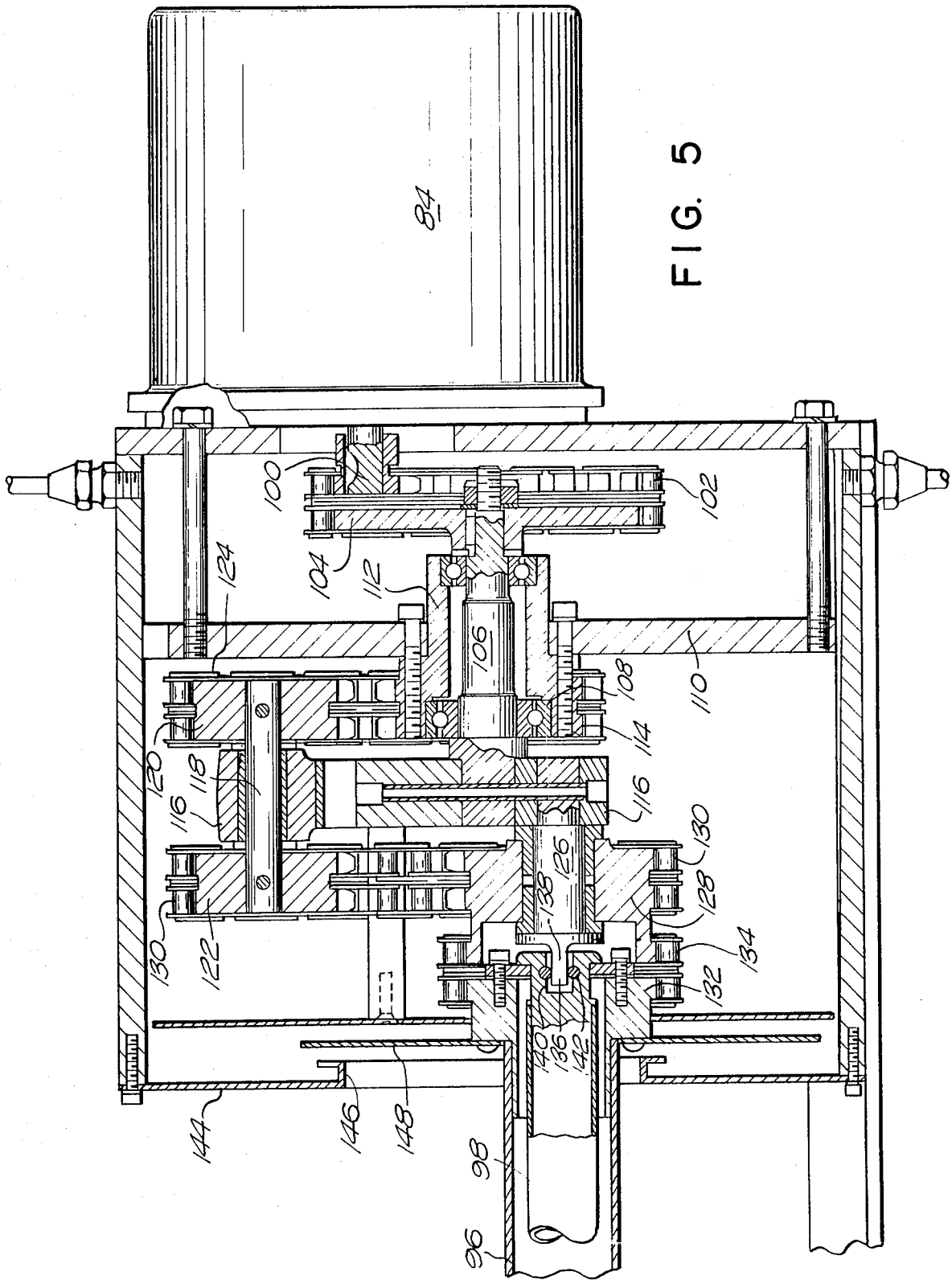
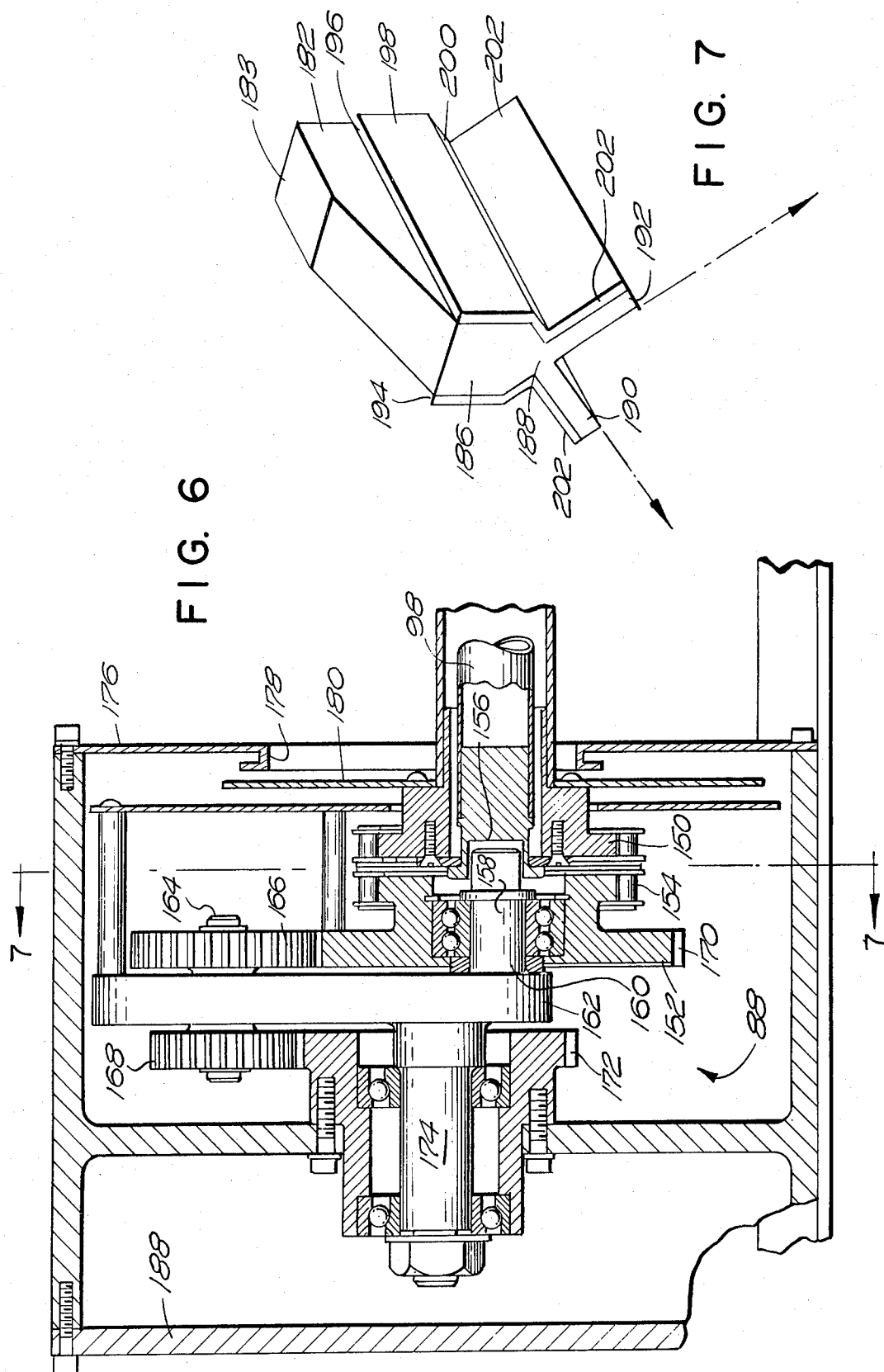


FIG. 5



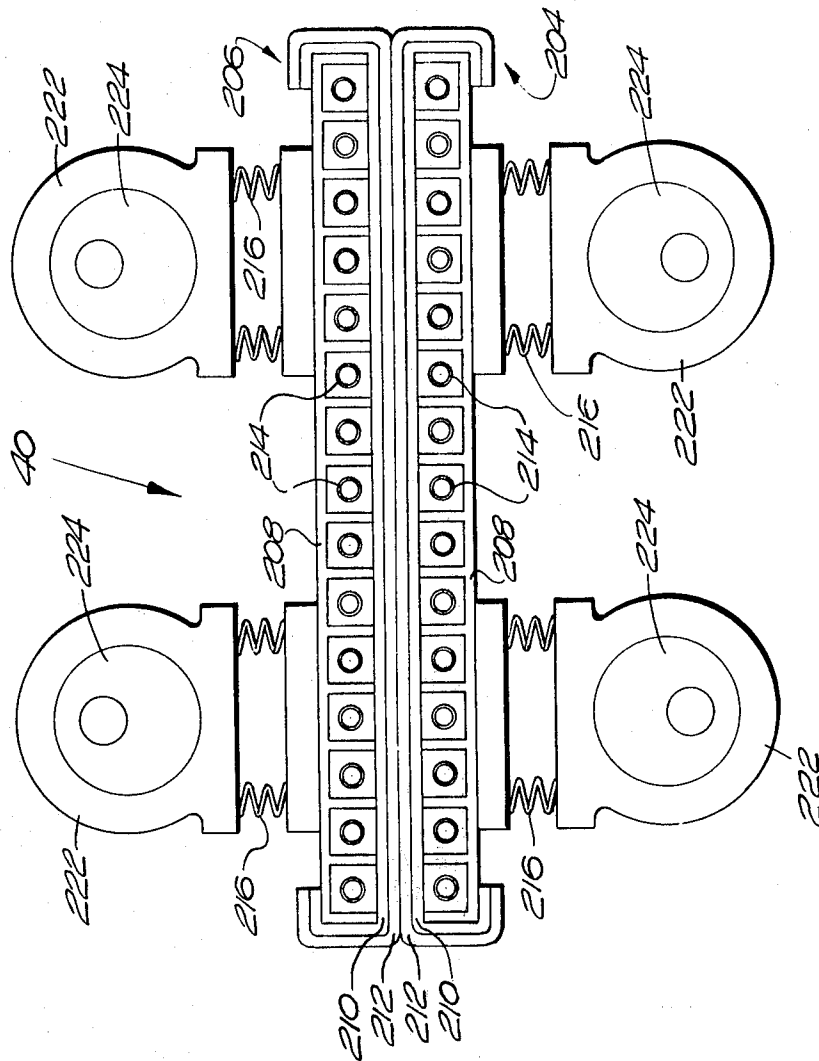


FIG. 8

PROCESS FOR CONDITIONING TEXTILES IN THE PRESENCE OF IMPACTING AND VIBRATING

This is a continuation of application Ser. No. 186,351, filed on Oct. 4, 1971, now abandoned.

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to fibrous sheet materials and, more particularly, to processes and devices involving fibrous sheet materials to which energy is imparted by mechanical impact. It has been shown in U.S. Pat. No. 2,733,498, issued on Feb. 7, 1956, for Method of Fabric Finishing To Reduce Shrinkage And Improve The Hand And Feel Of Cloth, and in U.S. Pat. No. 3,005,250, issued on Oct. 24, 1961, for Machine For Fabric Finishing To Reduce Shrinkage And Improve The Feel And Hand Of Cloth, both in the name of Charles G. Hatay, that certain physical changes, including improved qualities of drape, hand, feel and appearance and increased dimensional stability, moisture absorptivity and texture uniformity may be produced in a fibrous sheet material by a succession of sharp localized impacts.

The foregoing physical changes are believed to involve a randomization of residual stresses that are imparted to a material during its manufacture. During the drawing, combing and spinning steps of producing fiber and yarn and the weaving, knitting or felting steps of producing textile fabrics, different stresses are imparted among the fiber increments. In the production of yarn, for example, it is impossible to so align the fibers that their increments all are subject to similar stresses. And in the production of woven fabric from such yarn, for example, warp and fill fiber increments are crimped about each other in such a way as to introduce additional stresses. Shorter fiber increments (i.e. free lengths of fiber extending between intersections with lengths of contiguous fiber increments) tend to be under greater stress than longer fiber increments because their overall extensibility is less. Consequently, shorter fiber increments exert stress forces tending to pull contiguous fiber increments together so that unevenness of character tends to be present. Various results of such randomization in accordance with the present invention involve the elimination of such unevenness of character. A primary result of such randomization is relaxation and shrinkage for which the illustrated embodiment of the present invention is particularly designed and of which an explanation may be postulated as follows.

During handling and washing of fabrics, in a home washer and dryer for example, the handling weakens the intersurface bonding forces between contiguous fiber increments and the washing causes the interrelated effects of transverse swelling and longitudinal contracting of the fiber increments.

A similar result is produced in accordance with the present invention. Normally, a fabric made of natural fibers is capable of containing a swelling agent such as water in a quantity equal to its own dry weight. This water first is absorbed by imbibition into the fiber increments; next is attracted by adhesion to the surface of the fiber increments and then is retained by capillary action between the fiber increments. If a succession of sharp localized impacts is applied while the water is being removed, the presence of contracting forces exerted by the fiber increments and the weakening of in-

ter-surface bonding forces between the fiber increments gradually cause the fiber increments to assume stability in the form of a natural statistical distribution. However, when humidity is high, the elasticity of the fiber increments is low and the plasticity of the fiber increments is high so that distortion that is unnatural at low humidity may remain at high humidity notwithstanding the impacting treatment. Accordingly, the effect of impacting increases as the moisture content decreases below 25% of the dry weight of the fabric and is particularly noticeable as the point of complete dryness is approached. It is to be noted that complete dryness is difficult to reach because of the increasingly powerful hygroscopicity of fibers at low moisture levels. In prior finishing processes, there has been no desire to reach substantially complete dryness at the end of the wet processing steps because the natural hygroscopicity of any fabric tends to maintain a moisture content of about 5% by dry weight of the fabric under normal ambient conditions.

Certain aspects of the present invention are based upon the fact that combined impacting and drying are most effective when carried out in conjunction with other specific finishing steps. Thus it has been found that if impacting and drying are continued to a point at which the moisture content of the fabric is below its natural moisture content under normal ambient conditions, preferably to the point of bone dryness, and the final finishing steps of calendering, etc. are performed while the fabric is maintained in this state, the effects of combined impacting and drying are remarkably permanent. Evidently this does not necessarily apply to non-hygroscopic fibers which do not necessarily require wetting and drying. And it has been found that distortion of the length to width ratio, which occurs during impacting because the relatively short transverse section of the advancing fabric offers less resistance to shrinkage than does the relatively long longitudinal section, may be prevented by spreading the fabric transversely before impacting.

Other aspects of the present invention are based upon the fact that combined impacting and finishing are most effective when carried out under certain specific conditions. Thus energy may be imparted to the fabric best by impacting components of particular construction. One of the features of such a construction is an impacting web of incremental surfaces presented by elongated elements that are oriented in a plurality of directions for the purpose of randomness and that are intersupported for the purpose of web rigidity. To achieve the best results with the different webs, the momentum of the impact to the web can be regulated either by varying the amplitude of the impacting member or the speed or both. The speed can be regulated individually with known speed regulators between motor and impactor drive, or collectively by changing the frequency of the polyphase current to the drive motors. In very long machines, it has been found advantageous to vary the speed of advance so as to avoid excess accumulation of fabric at any point by accelerating and/or decelerating the impacting members at such points. This change can be automated by applying known web position detectors at strategic points. Also it has been found that the position of the fabric may be controlled while undergoing impacting by streams of gas oppositely directed by vents of particular design. The speed, volume and temperature of the gas is adjustable indi-

vidually to suit the web being treated. And it has been found that the speed of advancement of the fabric with respect to a single rigid web may be controlled by catching folds of the fabric on one or more flexible webs in such a way that the fabric is gathered momentarily before continuing its advance or is allowed to fold in containers at ends of the machine while the web to be treated continuously enters at a lower speed at one end and is removed continuously with similar speed, allowing for shrinkage at the other end of the machine.

Accordingly, objects of the present invention are to provide processes and devices involving the following features, which are significant in themselves as well as in combination: continuing impacting and drying until the moisture of the fabric is below its natural content under normal ambient conditions and maintaining this moisture content during succeeding finishing steps; preventing ultimate distortion of the length to width ratio by increasing the transverse dimension and reducing the longitudinal dimension of the fabric before impacting; effecting impacting by a construction of novel design; and positioning and drying the fabric in a novel manner while the fabric is in a relaxed state.

Other objects of the present invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the processes and devices possessing the features, properties, elements, steps and relations, which are exemplified in the following detailed disclosure and the scope of which will be indicated in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the nature and objects of the present invention, reference should be had to the following detailed description taken in connection with the accompanying drawing wherein:

FIGS. 1a and 1b together are a diagrammatic perspective illustration of a finishing system, for performing a process in accordance with the present invention;

FIG. 2 is a plan view of one of the components of the system of FIG. 1;

FIG. 3 is a cross-sectional view of FIG. 2, taken substantially along the line 3—3;

FIG. 4 is a side elevation of a portion of the component of FIG. 2;

FIG. 5 is an enlarged, sectional, detail view of a part of the component of FIG. 2;

FIG. 6 is an enlarged, sectional, detail view of another part of the component of FIG. 2;

FIG. 7 is a perspective view of another component of the system of FIG. 1; and

FIG. 8 is a sectional view of another component of the system of FIGS. 1 and 1b.

The system of FIGS. 1 and 1b is shown as comprising a rotatable supply mount 30 for a bolt of fibrous sheet material 32, a wetting station 34, a stretching station 36, an impacting and drying station 38, a calendering station 40 and a rotatable take-up mount 39. Suitable pairs of rollers 41, 43, 45 and 47 rotate at appropriate speeds to compensate for the longitudinal contraction of the advancing fabric that occurs in the various stations.

Initially fabric 32 may be introduced directly from prior wet finishing steps or may require wetting before being introduced. In the latter case, a convenient way of wetting the fabric, with sufficient rapidity to permit its advancement through the illustrated system without

delay, is to subject the fabric to an impacting component 42 of the type to be described in detail below and to a series of steam jets 44 directed toward the path of travel of the fabric in order to ensure that the fabric contains at least 25%, by its dry weight, of water. Next the fabric is fed into stretching station 36, which includes pairs of guide rollers 46 for determining the initial width of the fabric in response to vertically directed photodetectors 48 and servos 49 at the edge of the fabric; and a short tenter 50, which includes a pair of endless belts 52 and 54. Each of these endless belts is constrained by a pair of pulley wheels 56 and 58 and is provided with a series of clamps 60. Each of clamps 60 includes a stationary jaw 62 and a pivoted jaw 64. Jaw 64 is biased toward stationary jaw 62 in order to grip the edge of fabric 32 normally but is pivoted away from stationary jaw 62 by a guide 66 in order to release the edge of fabric 32 when in the vicinity of pulley wheels 56 and 58. The distance between pulley wheels 58, 58 is greater than the distance between pulley wheels 56, 56 so that as fabric 32 advances while gripped at its opposite edges by jaws 62 and 64, it is stretched transversely to a predetermined degree. As it is stretched transversely, the fabric is permitted to contract longitudinally.

Impacting and drying station 38 of FIG. 1b includes a plurality of impacting components 68, each as shown in FIG. 2 comprising a web 67 of incremental surfaces. These incremental surfaces are presented by incremental elements that are oriented in two directions as at 69 and 71 for the purpose of randomness and that are interconnected as at 73 for the purpose of rigidity. As will be described below, rigid web 67 is constrained for motion in parallel to itself and in orbit about an axis. This axis is parallel to the direction of elongation of web 67 and perpendicular to the direction of elongation of fabric 32. The motion is such that the force vector parallel to the direction of elongation of the fabric impacts upward and forward motion thereto. In order to limit the speed of the forward motion of the fabric through station 38, the orbital direction of selected impacting components 68 may be reversed by a suitable control in such a way that the magnitude of the resultant force vector parallel to the direction of elongation of the fabric may be controlled. Connected between the adjacent transverse edges of adjacent impacting components 68 are flexible webs 77 which gather any folds of the fabric generated between impacting components 68 that are orbiting in directions by which their force vectors parallel to the direction of elongation of the fabric are directed toward each other. When these force vectors are directed away from each other, the larger force vector determines whether the fabric will move forwardly or rearwardly and the difference in magnitude between the two vectors determine the speed.

As shown in FIGS. 2, 3 and 4 each impacting component 68 includes a base 70 having at its opposite ends a pair of U-shaped braces 72 and 74 and extending therebetween a pair of right-angle ties 76 and 78, which are joined by a plurality of struts 80. Mounted upon brace 72 are a drive motor 84 and a transmission 86. Mounted upon brace 74 is a transmission 88. Transmission 86 and 88 serve to translate motion from drive motor 84 to impacting member 90 in such a way as to maintain the upper face of impacting member 90 in parallelism with itself in all positions. As shown, impacting member 90 includes a web, designated 67

above, of interconnected elements that may be provided by expanded metal, honeycombed metal, etc. This metal is sufficiently rigid to support itself when fixed to a plurality of ribs 94. Projecting through these ribs and affixed thereto is a tube 96, within which rotates a drive shaft 98. It will be observed that, in cross-section, web 67 includes gently diverging halves, which enhance the impacting effect.

As shown in FIG. 5, power is transmitted from drive motor 84 through a sprocket 100 and a chain 102 to a sprocket 104. Sprocket 104 is mounted on an input shaft 106, which is rotatable in a journal 108 that is mounted in a crossplate 110. Journal 108 is contained within a bushing 112 that is provided with fixed external sprocket teeth 114. At the outer end of shaft 106 is keyed a yoke 116. Extending through yoke 116 at a position removed from shaft 106 is a rotatable shaft 118, at the opposite ends of which are a pair of sprockets 120 and 122. Connecting sprocket 114 and 120 is a chain 124. Extending from yoke 116 at a position spaced from shaft 106 and diametrically opposed to shaft 118 is a fixed shaft 126. On to shaft 126 is a rotatable sprocket 128. Sprockets 122 and 128 are connected by a chain 130. Sprocket 128 is connected resiliently to a sprocket 132 for common rotation with sprocket 128. Chain 134 meshes with teeth on both sprockets. Universal pivot 136 is provided by an extension 138 of shaft 126, a bore 140 at the end of shaft 98 referred to above and a resilient collar 142 therebetween.

In operation, motion is transmitted from drive motor 84 through sprocket 100, chain 102, sprocket 104, shaft 106, sprocket 114, chain 124, sprocket 120, shaft 118, sprocket 122, chain 130, sprocket 128, chain 134 and sprocket 132 to drive shaft 98. At the end of transmission housing 86 is a baffle 144 that is provided with an opening 146. Shaft 98 rotates within sleeve 96. The motion of sleeve 96 is orbital within opening 146 about the axis of shaft 106 but without rotation about the axis of shaft 98. A baffle 148 is provided adjacent to baffle 144, there being a source of gas pressure within housing 86 which continually exhausts through the space between baffles 144 and 148 in such a manner as to prevent the entrance into housing 86 of lint from the fibrous sheet material being processed.

As shown in FIG. 6, transmission 88 is driven by drive shaft 98 in the following way. Drive shaft 98 is affixed to a sprocket 150 which in turn is affixed to a sprocket 152 by a flexible coupling in the form of a chain 154 and a universal pivot including a bore 156 at the extremity of shaft 98 and an extension 158 projecting thereinto. Journaled within sprocket 152 is a shaft 160 to which is connected a yoke 162. Journaled in yoke 162 at a position spaced from shaft 160 is a shaft 164. Keyed to opposite ends of shaft 164 are a pair of pinions 166 and 168. Pinion 166 meshed with gear teeth 170 formed on sprocket 152. Pinion 168 meshes with gear teeth 172 which are formed on a stationary bushing, within which rotates a shaft 174 that is affixed to yoke 162 at a position spaced from shaft 160.

In operation, rotational motion is transmitted from shaft 98 to shaft 160, shaft 160 being attached to yoke 162 will rotate yoke around axis of shaft 174. By virtue of the stationary condition of gear 172, gear 168 will be rotated around axis of shaft 164. As gears 168 and 166 are keyed to shaft 164 it will rotate both gears 168 and 166 at the same speed. The ratio of gears 172 to 168

and 166 to 170 is the same. Gear 170 is flexibly connected to sprocket 150 through a chain 154 so that it can maintain orbiting around the axis of shaft 174 without turning around the axis of shaft 160. As above, the inner end of transmission housing 88 is provided with an outer baffle 176 provided with an opening 178. Sprocket 150 is provided at its outer end with an auxiliary baffle 180 that is contiguous with baffle 176. The interior of housing 188 is provided with a compressed gas which continually exhausts through the space between baffles 176 and 180 in order to prevent lint from entering the housing.

It will be observed in FIG. 1b that impacting and drying station 38 also includes a plurality of supply vents 182 and exhaust vents 184 alternately positioned in sequence above and below impacting components 68. As is best shown in FIG. 7, each supply vent 182 provides a main vent 183 and a pair of auxiliary vents 194 and 196. Main vent 183 provides, in sequence, an intake region 186, a throat region 188 and a pair of diverging jet regions 190 and 192. Each auxiliary vent provides, in sequence, an intake region 198, a throat region 200 and a jet region 202. All of these regions are defined by flat sheet metal panels that extend transversely completely across the path of the fabric. Thus streams of relatively high speed, dry hot gas from jet regions 190 and 192 impinge on the advancing fabric along transverse sections extending continuously and completely thereacross. Streams of relatively low speed, dry hot gas from jet regions 202 bound the high speed streams in such a way as to prevent the low pressure of the relatively high speed stream from drawing moisture, before reaching the fabric, from moist gas directed toward exhaust vents 184. These streams can be regulated individually in gas velocity and/or quantity, horizontally and/or vertically and/or obliquely to fit the fabric being treated. As is indicated by phantom lines the obliquely intersecting streams from opposed jet regions 190, 192 generate forces that tend to predeterminedly position the fabric therebetween.

As is best shown in FIG. 8, calendering station 40 is designed to press the fibrous sheet material immediately after impacting and while still in extremely dry condition. This station contains a lower vibrating platen 204 and an upper vibrating platen 206. Each of these platens includes a rigid base 208, a resilient inner layer 210 and a smooth outer layer 212. Each of these platens is heated electrically by suitable resistance elements 214. Each of these platens is connected by springs 216 to mounts 222, which are oscillated by rotating cams 224. By virtue of the resulting vibratory motion, a fabric sheet material may be advanced between layers 212, 212 in such a way as to be calendered without the re-introduction of the stresses eliminated by impacting.

The present invention thus contemplates a sequence of features which are significant in themselves as well as in combination. Since certain changes may be made in the above processes, devices and products without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted in an illustrative and not in a limiting sense.

What is claimed is:

1. A process of treating an elongated fibrous sheet material, said process comprising the steps of ensuring

that said material contains more than **25%** of a swelling agent by weight of said material when dry, transversely stretching said material while permitting longitudinal contraction thereof, overfeeding said material to a drying and impacting zone to compensate for longitudinal contraction thereof and while in said zone directing opposite streams of dry gas at each face of said material in order to bias said material toward predetermined position and in order to dry said material until its content of swelling agent is less than that normal under ordinary ambient conditions, subjecting said material while so biased to a succession of sharp localized impacts from a multiplicity of incremental surfaces with the fabric gathering in folds between adjacent impacting surfaces, and calendering said material after departure from said zone while said content is less than said normal by pressing said material between platens and vibrating said platens such that the vibratory motion thereof has a vector normal to said material.

2. The process of claim 1 wherein said swelling agent is aqueous.

3. The process of claim 1 wherein said swelling agent is water.

4. The process of claim 1 wherein certain of said streams exert a downward pressure on one of said opposite faces and certain of said streams exert an upward pressure on the other of said opposite faces, said downward pressure and said upward pressure being balanced.

5. The process of claim 1 wherein said incremental surfaces orbit.

6. A process of treating an elongated fibrous sheet material containing a swelling agent, said process comprising the steps of transversely stretching said material while permitting longitudinal contraction thereof, overfeeding said material to a drying and impacting zone to compensate for longitudinal contraction thereof and while in said zone directing opposite streams of dry gas at each face of said material in order to bias said material

toward predetermined position, subjecting said material while so biased to a succession of sharp localized impacts from a multiplicity of incremental surfaces with the fabric gathering in folds between adjacent impacting surfaces, and calendering said material after departure from said zone while said content is less than said normal by pressing said material between platens and vibrating said platens such that the vibratory motion thereof has a vector normal to said material.

7. A process of treating an elongated fibrous sheet material, said process comprising the steps of ensuring that said material contains more than **25%** of an aqueous swelling agent by weight of said material when dry, transversely stretching said material while permitting longitudinal contraction thereof, overfeeding said material to a drying and impacting zone to compensate for longitudinal contraction thereof and while in said zone directing opposite streams of dry gas at each face of said material in order to bias said material toward predetermined position and in order to dry said material until its content of swelling agent is less than that normal under ordinary ambient conditions, subjecting said material while so biased to a succession of sharp localized impacts from a multiplicity of incremental surfaces with the fabric gathering in folds between adjacent impacting surfaces to reduce stresses in said fibrous sheet material, and calendering said material after departure from said zone while said content is less than said normal by vibrating means to avoid increasing stresses in said fibrous sheet material.

8. The process of claim 7 wherein said swelling agent is water.

9. The process of claim 7 wherein certain of said streams exert a downward pressure on said material and certain of said streams exert an upward pressure on said material, said downward pressure and said upward pressure being balanced.

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