

[54] **METHODS OF COMPRESSIVELY
TREATING FLEXIBLE SHEET MATERIALS**

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[73] Assignee: **said Walton by said Munchbach**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 115,606, Feb. 16, 1971, Pat. No. 3,810,280.

[52] U.S. Cl. **26/18.6, 162/111, 264/282**

[51] Int. Cl. **D06c 21/00**

[58] Field of Search **26/18.6; 264/282; 162/111, 162/280, 361**

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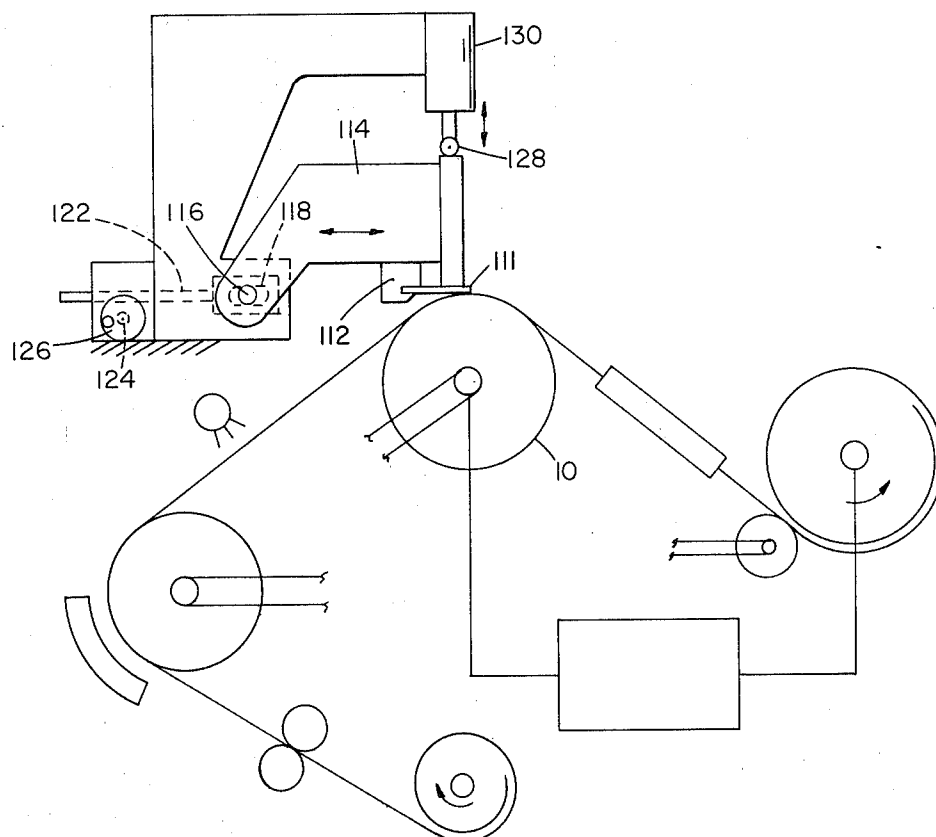
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[57] **ABSTRACT**

A method of initiating compressive treatment of a running length of flexible material by a machine wherein the material is confined against a moving drive surface by a confining surface and then retarded by a retarding surface located downstream of the confining surface and spaced from the drive surface which comprises first pressing the material into driven engagement with the drive surface by pressing the confining surface against it while maintaining the retarding surface in ineffective position and thereafter, while maintaining such driven engagement, moving the retarding surface toward the drive surface to increase the retarding effect until satisfactory running condition is achieved. The thus pressed confining surface may also be shifted bodily upstream while the retarding surface is shifted to engage the material in the region vacated by the confining surface.

2 Claims, 12 Drawing Figures



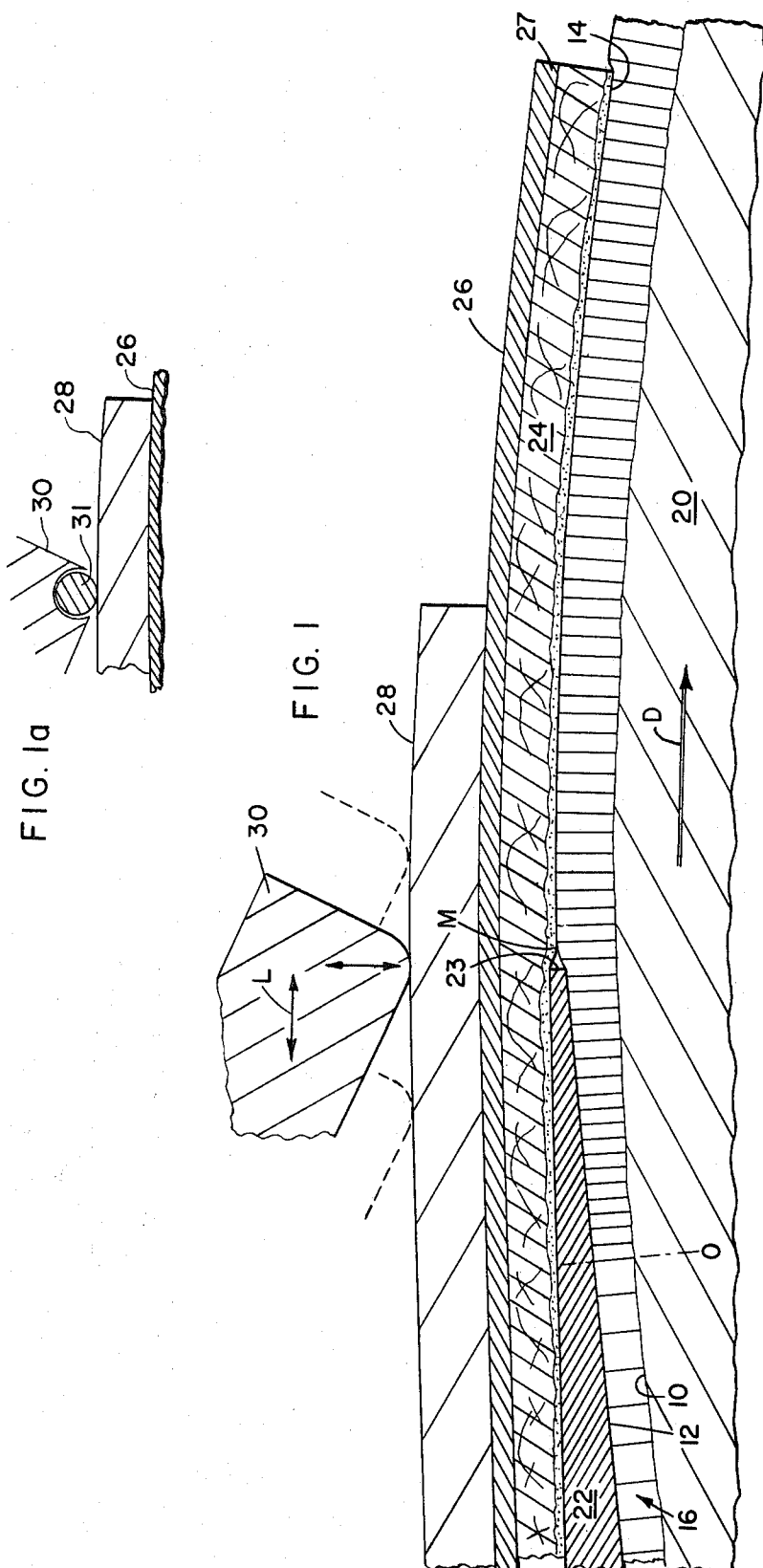


FIG. 2

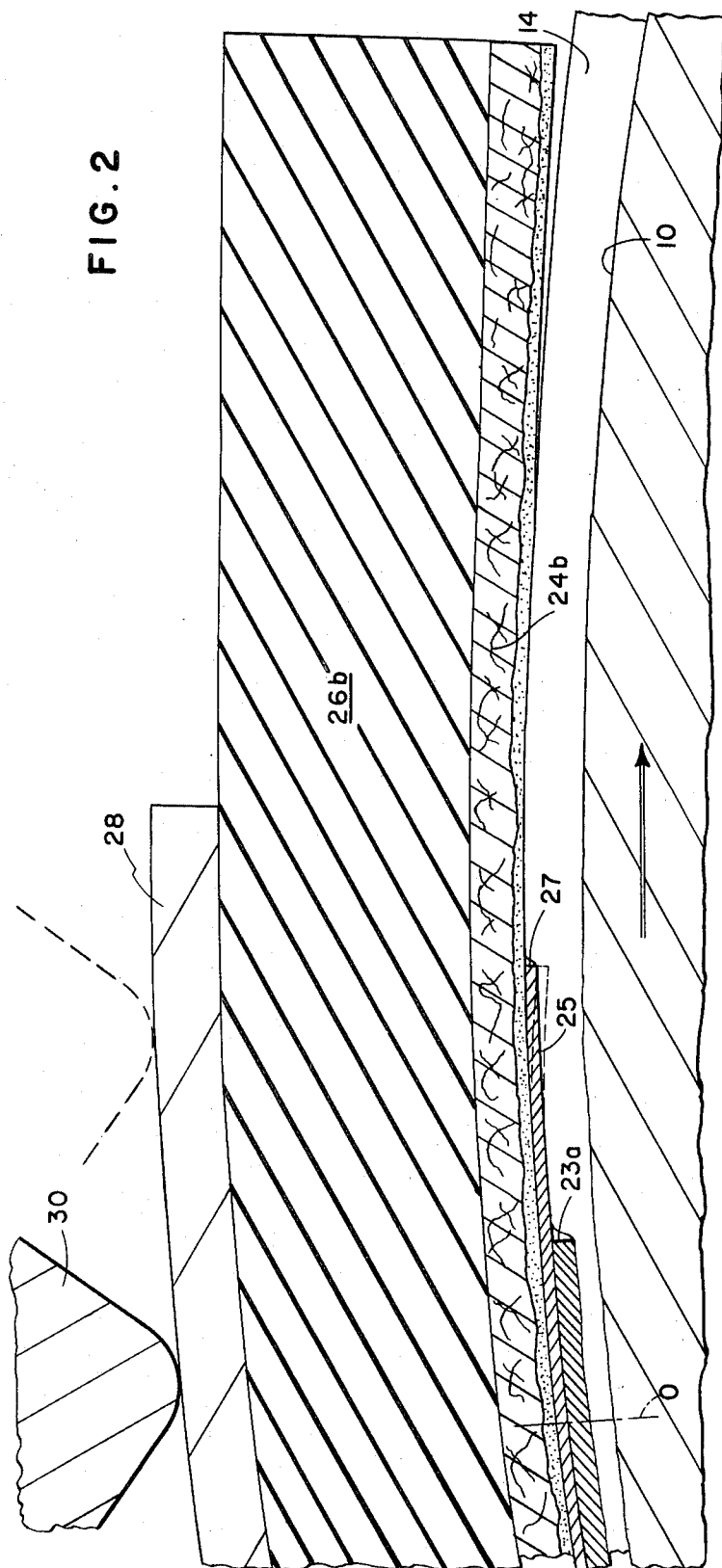


FIG 3

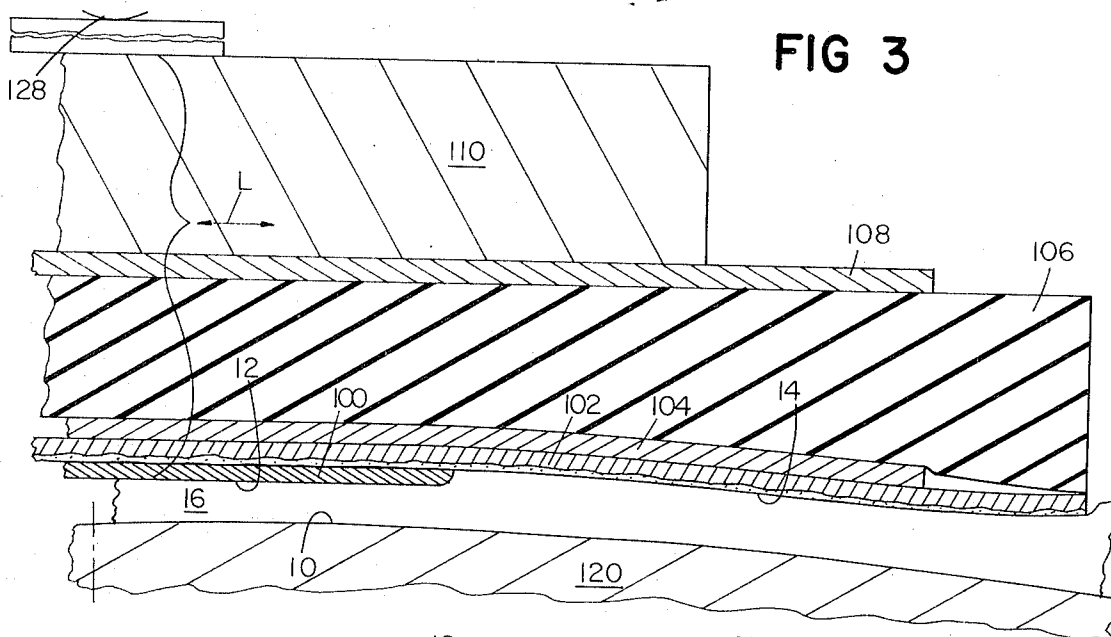


FIG 4

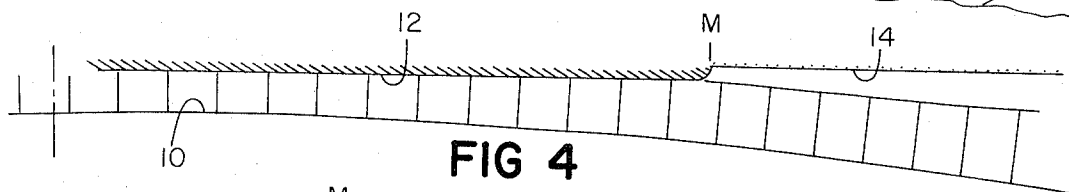


FIG 5

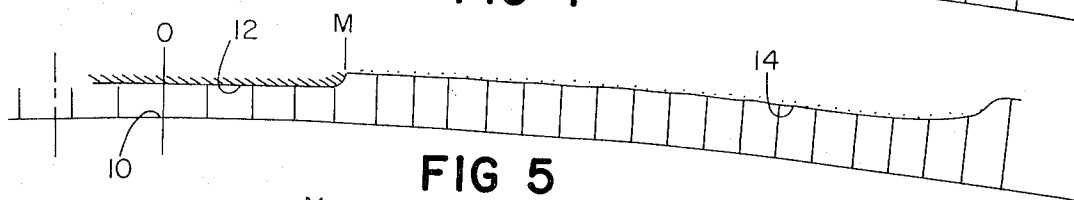


FIG 6

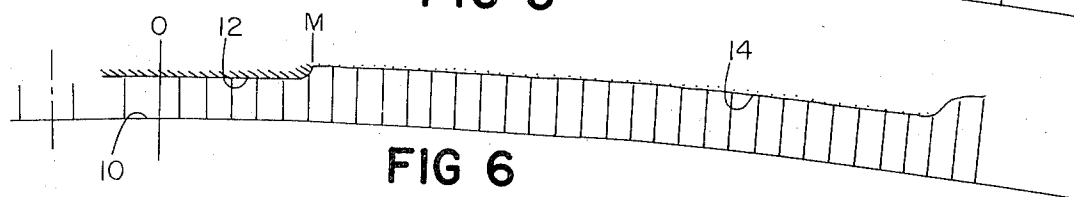


FIG 7

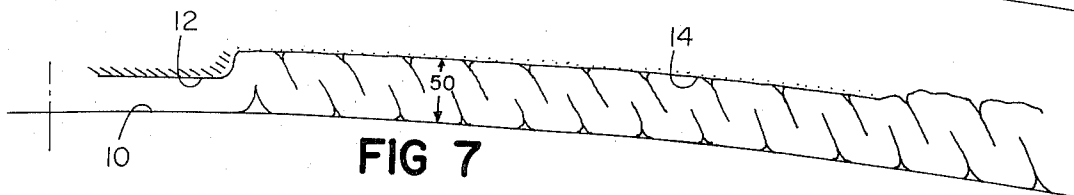


FIG 8

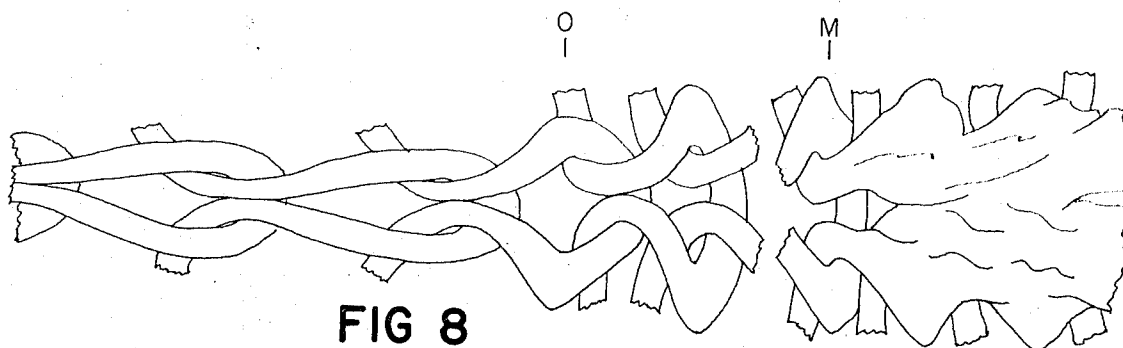


FIG 10

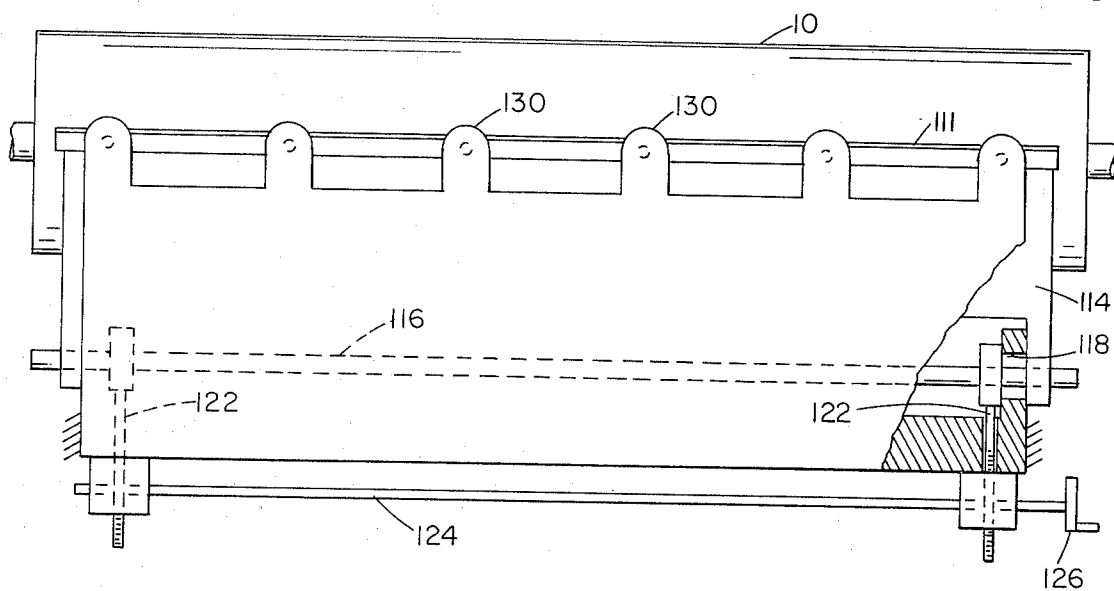
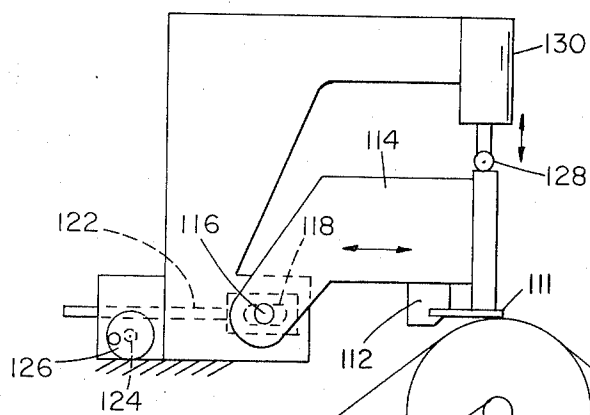
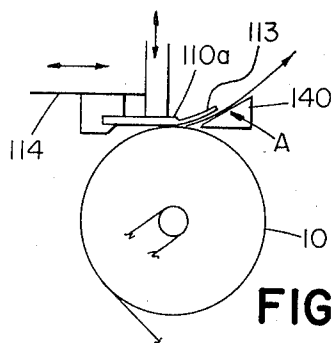


FIG 11

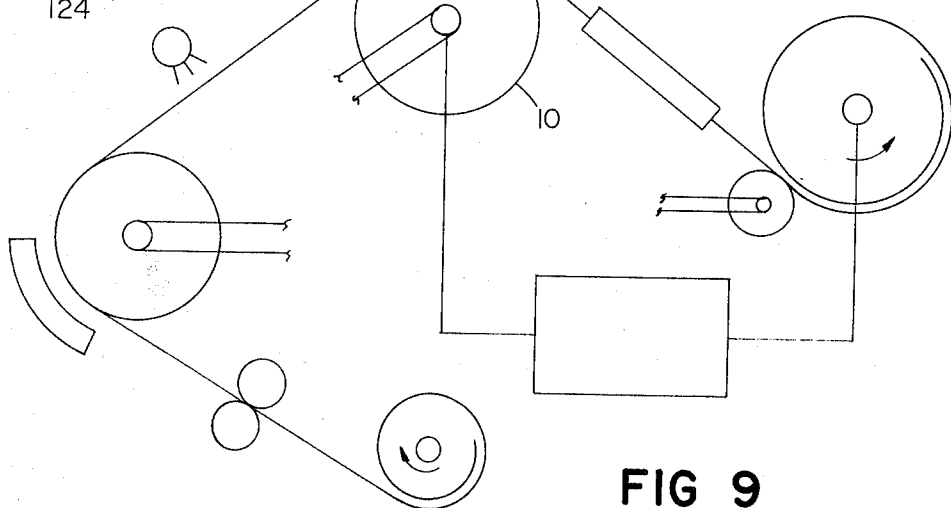


FIG 9

METHODS OF COMPRESSIVELY TREATING FLEXIBLE SHEET MATERIALS

This is a continuation-in-part of our application Ser. No. 115,606 filed Feb. 16, 1971, now U.S. Pat. No. 3,810,280 granted May 14, 1974.

This invention relates to longitudinal treatment of thin materials, especially materials formed of fibers, for the purpose of rearranging the constituents of the materials, e.g. to increase bulk or to soften such materials as nylon tricot and non-woven fabrics or to make woven goods stretchy.

The principle of feeding a thin material against a retarding means (quite old) has been limited in practice due to control and stability problems. In particular the start-up and adjustment of such treatment has been difficult and time-consuming.

One of the previously unsuccessful approaches to this problem (that of confining the material against a drive surface and on the same side of the material as the confining surface engaging it with a retarding surface) is here utilized with important new features which solve these problems.

According to the invention, in a process of establishing a continuous longitudinal compressive treatment of a running length of flexible material comprising pressing the material with a confining surface against a moving drive surface and beyond the confining surface and on the same side of the material engaging the material with a retarding surface, we have provided the improvement comprising initially positioning the confining surface in material-driving position while maintaining the retarding surface in an ineffective position. Subsequently, we cause relative movement of a pressing means generally along the drive surface with respect to the confining and retarding surfaces to position the retarding surface closer to the drive surface to progressively increase the retarding effect. While doing the latter, we continue the pressing of the confining surface so that there occurs at all times travel of the material without slippage relative to the drive surface up to a point O beneath the confining surface, close to but spaced in advance of the beginning point M of the retarding surface, at which point O slip-page of the material relative to the drive surface commences. Then, while continuing to press the confining surface, we bodily shift the latter rearwardly against the direction of travel of the material and retard the material in the region vacated by the shifted confining surface.

In one form of the invention the confining and retarding surfaces are defined by an assembly in which the confining and retarding surfaces lie in substantially parallel planes, the plane of the confining surface being closer to the drive surface and initially the confining surface extending beyond a tangent point with the drive surface. In this form of the invention the step of moving the confining surface rearwardly is accomplished by moving the assembly, the beginning point M of the retarding surface being thereby moved toward the aforementioned point of tangency.

FIG. 1 is a diagrammatic highly magnified cross-sectional view of a preferred embodiment of a machine for practicing the invention;

FIG. 1a is a fragmentary view of a modified presser member as shown in FIG. 1;

FIG. 2 is a view similar to FIG. 1 of another preferred embodiment;

FIG. 3 is a cross-sectional view of another preferred embodiment which includes an assembly which moves tangentially;

FIGS. 4, 5, 6 and 7 are diagrammatic views illustrating various adjustments of the embodiment of FIG. 3;

FIG. 8 is a plan view of a fabric at various stages of treatment;

FIGS. 9 and 10 are side and plan views respectively of the overall machine incorporating the operative elements of FIG. 3 and

FIG. 11 is a side view similar to part of FIG. 9 of another embodiment of the invention.

In FIG. 1 drive surface 10 moves, arrow D, beneath fixed confining and retarding surfaces 12 and 14, driving a web of flexible material 16 to be treated. All surfaces have a uniform widthwise extent corresponding to the width of the web to be treated. The degree of magnification is understood from the fact that actual thickness of material 16 is less than 0.015 inch. Drive surface 10 is curved with radius between 2 and 6 inches, though its curvature does not show clearly at the magnification of the drawing. The degree of compression of the material at its various stages is illustrated in a diagrammatic manner in FIG. 1 by the rectangular sections which represent equal masses of material.

The machine is shown in solid lines in running condition after the treatment has stabilized, (the dotted line position of presser member 30 to the left being at start-up position, and the dotted line position at right being a position for increased retarding effect). Confining surface 12 slippably presses material 16 against drive surface 10 to drive it forward in longitudinally uncompressed condition to point O, the initial point of treatment.

The retarding surface 14 which is rough relative to confining surface 12, begins at M within 1 inch (for textile materials of 0.005 to 0.015 inch thickness, within about ¼ inch) of point O. (In other embodiments, e.g. with stiff materials, the initial point of treatment may be nearly coincident with the initial point of effective retarding surface).

At point O uncompressed material is driven and compressed immediately against a column of (temporarily or permanently) compressed material, the latter being slippably confined by the last portion of surface 12. As the material leaves confinement under surface 12, it expands, and is able to remain in its expanded condition throughout its transit under retarding surface 14. Due to the roughness of retarding surface 14, the retarding action can be maintained with light downward pressure. This avoids refeed due to excessive pressure of the web against the drive surface and undue wear of the retarding surface. From point M the retarding surface 14 lies substantially parallel with the drive surface and does not constrict the compressed material or require it to extrude through a minimum passage.

For defining the confining and retarding surfaces a sandwich of fixed layers extends over the roll from a stationary support (not shown, at the left of FIG. 1). This sandwich comprises primary member 22 defining confining surface 12, a nonresilient fabric 24 having a coated grit facing (e.g. emery cloth) defining retarding surface 14, and a relatively thick and unyielding keeper sheet 28. A spring steel keeper 26 is inserted between keeper sheet 28 and member 24. The entire sandwich extends as a cantilever. A presser member 30 presses

the sandwich toward the roll 20. As indicated by the arrows the presser member is adjustable toward the roll surface to vary its radial pressure and it is adjustable relative to the sandwich back and forth in the lengthwise direction, tangential to roll 20, to vary the point of application. By the latter adjustment the proportion of downward force applied to the confining surface 12 to that applied to retarding surface 14 is variable in an action we refer to as "teeter totter". The forces applied to the confining surface are much greater than those applied to the retarding surface, and an adjustment one way or the other of the presser member of 0.25 inch in the direction of the travel of the material can have a desirable effect in controllably varying the treatment.

In the embodiment of FIG. 1 the primary member 22 is formed from a sheet of Invar metal originally of 0.020 inch thickness, which has been machined with a slope to cause it to taper forwardly from full thickness to end 23 of 0.004 inch over a distance of approximately $\frac{1}{4}$ inch. The retarding emery cloth 24 has an uncompressed thickness of about 0.010 inch, with the rough surface of the emery facing against the top surface of member 22, and the emery extending beyond end 23 a distance e.g. of $\frac{1}{8}$ to $\frac{3}{8}$ inch depending on the treatment and roughness of the emery chosen. The keeper 26 is a length of spring steel of 0.005 inch thickness, and $\frac{1}{2}$ inch width, bent in the widthwise direction on a radius smaller than the radius of the drive surface, and having its width arranged in the direction of travel of the drive surface.

The spring keeper member 26 maintains the retarding surface in the approximate curvature of the drive surface without at any place permitting the spacing under the retarding surface to narrow down to constrict the column in the region of effective retardation. In fact, with this embodiment, although loading of the pressing edge of presser member 30 may be around 50 pounds per linear inch of presser edge (widthwise of the machine) an operator can easily raise the forward edge 27 of the spring keeper 26 with one finger, illustrating the relatively light downward forces required.

In increasing degree of treatment the following retarding surfaces have been employed in the arrangement of FIG. 1 for treatment of knitted and other textiles. All of these retarding materials being emery cloth sold by Behr Manning of Troy, N.Y., under the trade-name Metalite, have a thickness on the order of 0.010 inch.

Description	RMS new	RMS in use
crocus cloth (polishing cloth with fine abrasive grit)	100-130	90-110
500 J	200-240	170-200
400 J	270-300	230-270
320 J	300-500	230-280

where RMS refers to surface roughness measured in RMS microinches using, for example, an instrument available from Micrometrical Division, Bendix Corporation, under the trademark Profilometer; the numbers appearing in the first column refer to the coarseness of the grit, the lower the number the coarser; and "J" is a designation employed by Behr Manning to indicate the nature of the backing material which holds the grit.

Durable fabric of essentially inelastic qualities may be used as a retarding surface in certain instances; one such demonstration employed a tightly woven mesh fabric having a profilometer reading of 450-650 new, 400-450 used. Other materials having gripping characteristics are for example, thin metal mesh or metal or other hard fiber weave in which the crossing elements form projections; finely perforated dimpled or scratched metal plate with the surface discontinuities at the openings forming surface roughness; in some instances a multiplicity of fixed brush or needle-like projections; a rough-surfaced metal plate having, for instance, tiny tungsten carbide particles adhered thereto through the plasma coating technique or more preferably, the gun shot technique. The latter and emery are preferred.

Although a variety of substances may be used to provide the retarder gripping surface, they must in most instances be essentially non-extensible in the direction of travel of the material for proper action. For many treatments it is essential that the retarder member also be resiliently supported in the direction of the thickness of the material, which helps to obtain a self-adjusting proper geometry. Preferably material gripping projections of hard, wear-resistant material are employed and the retarder surface on which they are carried has an elongation of less than 5 percent under tensions of 1000 psi.

Where it is desired mainly to bulk or thicken a textile, and not to shorten it, the length of retarding surface 14 is kept short, i.e. $\frac{1}{8}$ or $\frac{1}{16}$ inch in length, and the thickening occurs at the end of the confining surface 12. The material is subjected to severe shearing forces at its surfaces, causing actual rearward stretching or even localized tearing of the top surface relative to the bottom surface. This results from the bottom surface being engaged by projections of the drive surface which move forward relative to the material, while the retarding surface pulls relatively the other way. These forces and shear distortion cause the material emerging from under such a short extent of retarder to immediately "bloom" into a bulky form.

To commence operation of the embodiment of FIG. 1, the relative tangential position of presser member 30 obviously would be in the left hand dotted position or even further to the left, applying force toward the roll 20 in the direction of the arrows. In such position the retarding surface 14 is relatively ineffective, and confining surface 12 is effective to cause the material 16 to travel with roll 20. The material remains uncompressed in the longitudinal direction, and by following the contour of the roll, will exit from the machine without contacting the retarding surface 14. Once uniform feeding conditions are established in this position presser member 30 can be advanced rightward in the tangential direction (arrow L). As it advances it continues to press confining surface 12 against the roll for driving forward, but it begins also to press retarding surface 14 down toward the roll. A point is reached in which the retarding surface 14 contacts the material 16. The material is then retarded, oncoming material is pressed against it, the material thickens, tending to raise the retarding surface, and at the same time the longitudinally compressed column of material builds back to point O. This point is established by the relative positions and characteristics of the various surfaces, in particular the position of the confining surface, as well

as the nature of the material being treated. It is important to the process that point O be kept in the vicinity of the beginning point M of the retarding surface in order to establish stable treatment conditions.

It will be understood that the tangential movement of the presser is far greater than the actual radial movement of the retarding surface during the adjustment, this serving to remove criticality from the treatment and enabling standards to be set which average workmen can attain.

In the embodiment of FIG. 2 the rubber 26b behind the emery cloth 24b helps conform the emery to the curvature of the drive roll. In cases where the desired effect is to bulk a web, the metal keeper member above the rubber may be very thin, and allow the retarder assembly to flex upwardly. In such instances the portion of the retarding surface nearest the confining surface accomplishes most of the retarding, outward portions serving to buffer the column to ensure uniform treatment across the web width.

In this embodiment two steps of treatment can be accomplished before the material reaches the retarding surface, useful where, as with many knitted fabrics, the material is porous or loose. Densification of the material takes place at initial point O preceding the end 23a of the primary member, a column of longitudinally compressed but not substantially thickened material extending from point O to end 23a. A second extension 25 or "roof" of low friction slippable material, invar or Teflon impregnated blue steel, extends forward. The column of material is guided forward by oblique contact with this low friction surface overcoming any tendency to curl upwards; meanwhile the natural tendency for the material to expand in thickness causes the column to fill the volume under roof 25. This thickened column (now having more resistance to bending because of increased thickness) is then projected forward under edge 27 of the roof, and into exposure with the retarding surface, where it further expands and is napped as described above. This device has also demonstrated the capability of bulking nylon tricot, and is particularly effective when used with a knurled drive roll.

The length of the roof for treating nylon tricot is preferably in the range of about 0.030 to 0.080 inches length; with a drive roll of 4 inch diameter, 0.040 inch roof length is preferred, with a roll of 12 inch diameter, 0.060 inch roof length is preferred.

In certain instances it is advantageous to adjust the presser 30 considerably forward. In this case the extension 25 is bent downward (see dotted lines) and causes more densification to occur. In a similar arrangement, but with a much longer extension 25, the extension itself may serve as the primary and define the point of initial treatment, and by this construction a simple throw-away package of emery and extension may be removably inserted between relatively thick permanent members.

In the embodiment of FIGS. 3-10, there is a sandwich comprising a metal sheet member 100 which defines confining surface 12 and a retarding layer 102 which defines retarding surface 14 (of e.g. emery cloth or a metal surface made rough by tungsten carbide particles). Layer 102 has a portion overlying member 100. There follows in overlying relation metal sheet member 104, silicone rubber layer 106, metal sheet member 108, and pressure plate 110.

Typical thicknesses are given in the table:

Element	Inches
100	.010
102	.010
104	.006
106	$\frac{1}{8}$
108	.008
110	$\frac{1}{8}$

As indicated by the bracket and as seen in FIGS. 9 and 10, this entire sandwich comprises an assembly 111 capable of moving back and forth in the direction tangent to the top of drive roll 120. It is mounted in holder 112 which extends across the width of the machine, and holder 112 is mounted on rotary arms 114. The arms are pivoted on cross-shaft 116, the latter being slidable horizontally in slot 118. Fore and aft motion is achieved by jacks 122 at both ends of the machine, operated in unison by control shaft 124 and hand wheel 126. By this mechanism operation of hand wheel 126 can move the assembly from starting position in which the treatment cavity corresponds to FIG. 4, successively to geometries shown in FIGS. 5 and 6. During this motion plate 110 moves beneath rollers 128 carried on the ends of vertically acting pneumatic cylinders 130, which press the assembly toward drive surface 10.

Referring to FIG. 4, at the initial position the confining surface is adjusted to the right, far beyond the tangent point, such that the retarding surface 14 is ineffective. As the material reaches the end of confining surface 12 and the beginning point M of the retarding surface, it has already expanded to its normal thickness. Retarding surface 14 being at a higher plane than surface 10, the material does not touch it. After this position is used to establish steady driving conditions, assembly 111 is moved to the left to establish the geometry of FIG. 5. It will be seen that the movement carries the beginning point M of the retarding surface closer to the point of tangency hence closer to the surface 10 of the roll, to the point where effective retarding has begun. As in the previous embodiments, the downward pressure on the confining surface 12 remains, hence the material travels without slippage on roll surface 10 up to point O in the vicinity of (here spaced in advance of) the beginning point M of the retarding surface. Thus compressive treatment of the material occurs. FIG. 8 illustrates the effects of the treatment on nylon tricot.

If more severe compression is desired, further movement of the assembly to the position of FIG. 6 is possible.

FIG. 7 illustrates the same assembly being used in a creping operation in which the spacing under the retarding surface is sufficient to form a creping cavity 50 for the particular material chosen, e.g. a non-woven fabric.

In these various instances it is important to note the function of the rubber layer 106. Being squeezed between plate 100 and thick, rigid plate 110, it tends to escape where there is no resistance. Thus it has the tendency to bend the forward portion of the retarding layer 102 downwardly about the roll surface, to a condition in which the expansive tendency of the rubber is dissipated (rightward setting of the assembly) or to a condition in which it is countered by the expansive ten-

endency of the compressed material (leftward settings).

According to the embodiment of FIG. 11 an assembly 110a which can be identical to assembly 111 of FIG. 9 is provided with a stationary sheet form retarder member 113 projecting forwardly therefrom at an angle in the direction of web travel. A stationary retarder element 140 is adjusted in the direction of arrow A into an aligned relation with member 113, the two defining an auxiliary retarding passage.

Many implementations of the broader concepts of the invention are possible and are within the scope of the claims. Thus the presser member 30 can be equipped with rollers 31 at its pressure point, as seen in FIG. 1a.

what is claimed is:

1. In a process of establishing a continuous longitudinal compressive treatment of a running length of flexible material comprising pressing the material with a confining surface against a moving drive surface and beyond said confining surface and on the same side of the material engaging the material with a retarding surface, the improvement comprising initially positioning the confining surface in material-driving position while maintaining the retarding surface in an ineffective position, subsequently relatively moving a pressing means generally along the drive surface with respect to said

confining and retarding surfaces to position the retarding surface closer to the drive surface to progressively increase the retarding effect, while doing the latter, continuing the pressing of the confining surface so that there occurs at all times travel of the material without slippage relative to the drive surface up to a point O beneath the confining surface, close to but spaced in advance of the beginning point M of said retarding surface, at which point O slippage of the material relative to said drive surface commences, and then while continuing to press the confining surface, bodily shifting the latter rearwardly against the direction of travel of the material, and retarding the material in the region vacated by said shifted confining surface.

2. The process according to claim 1 wherein said confining and retarding surfaces are defined by an assembly in which the confining and retarding surfaces lie in substantially parallel planes, the plane of the confining surface being closer to said drive surface, initially said confining surface extending beyond a tangent point with said drive surface, said step of moving said confining surface rearwardly being accomplished by moving said assembly, the beginning point M of the retarding surface being thereby moved toward said point of tangency.

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