Nov. 30, 1965 R. R. WALTON 3,220,057

TREATMENT OF SHEET MATERIALS

Original Filed Nov. 27, 1959 2 Sheets-Sheet 1

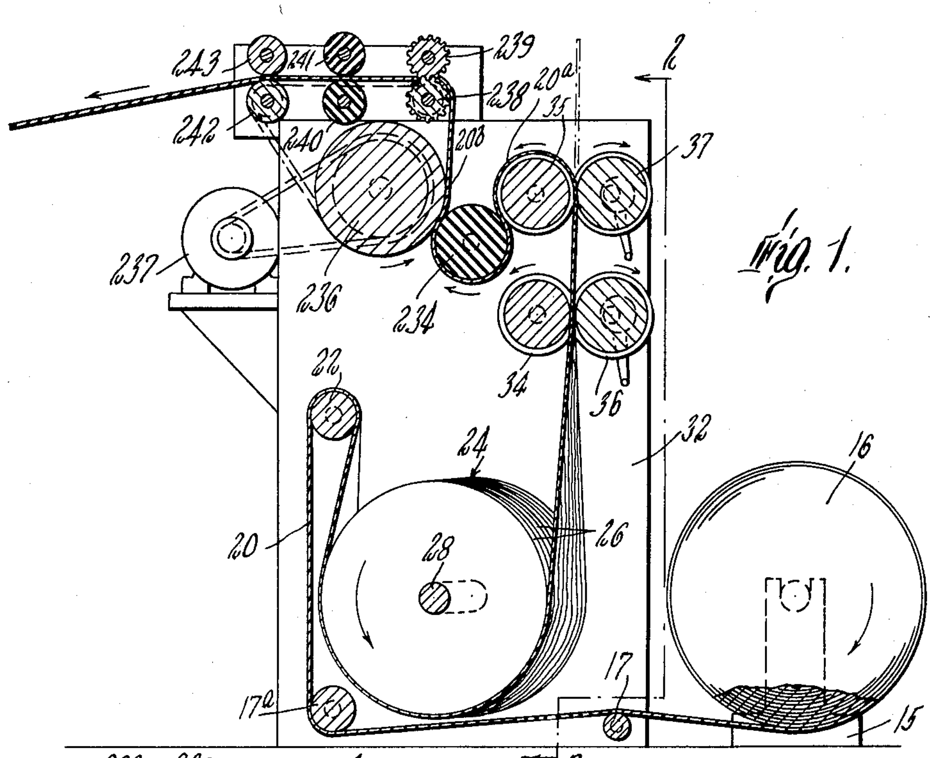

Fig. 1.

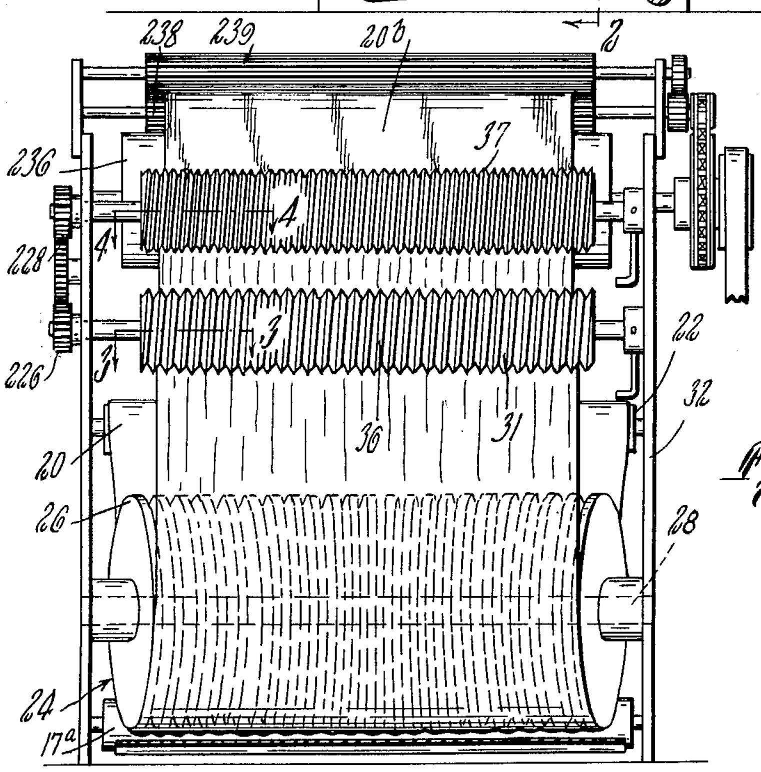

Fig. 2.

TREATMENT OF SHEET MATERIALS

Original Filed Nov. 27, 1959 2 Sheets-Sheet 2

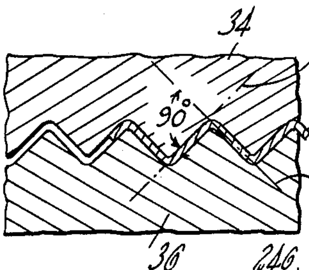

Fig. 3.

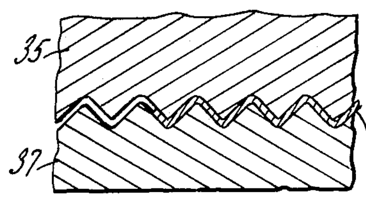

Fig. 4.

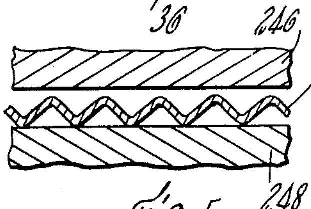

Fig. 5.

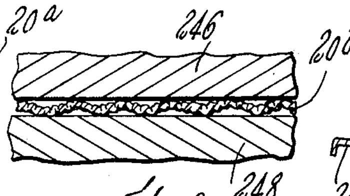

Fig. 6.

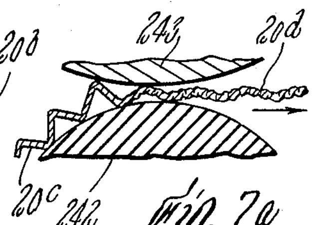

Fig. 7a

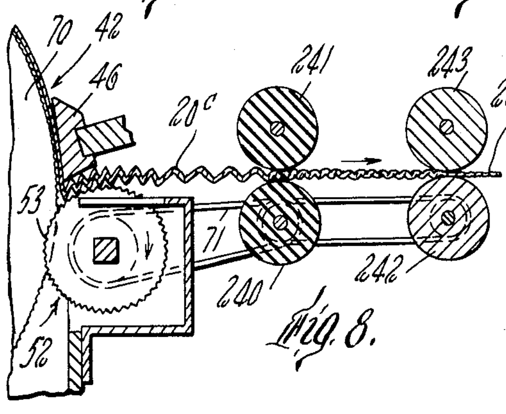

Fig. 8.

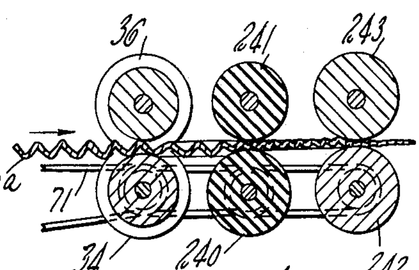

Fig. 9.

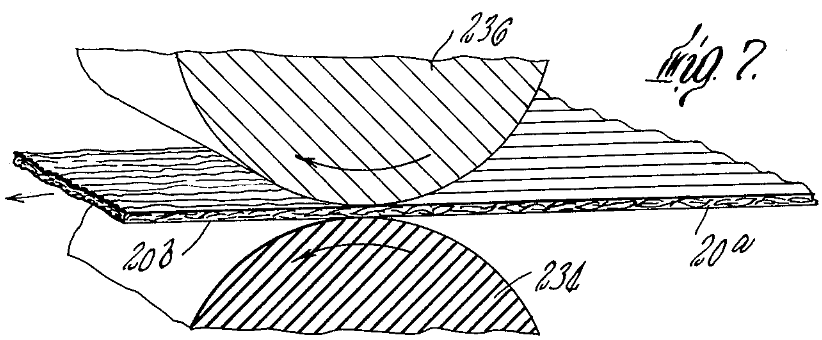

Fig. 7.

United States Patent Office

3,220,057

Patented Nov. 30, 1965

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3,220,057
TREATMENT OF SHEET MATERIALS

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Original application Nov. 27, 1959, Ser. No. 855,630. Divided and this application Oct. 27, 1961, Ser. No. 148,259

10 Claims. (Cl. 18—19)

This application is a division of my co-pending application Serial No. 855,630 filed November 27, 1959.

This invention relates to the compacting together of fibers or other components of webs of paper and other sheet materials in one or both directions and to altering the physical characteristics of sheet materials by producing structural rearrangements therein.

The invention produces a fine, almost invisibly creped stretchy product by imparting one-way or two-way corrugations in the web and subsequently passing it through a nip between rolling curved surfaces.

In accordance with this invention, I first impart regular crepes or corrugations in the web whereby material in each corrugation is displaced at an acute angle to the original plane of the web being treated. For a wide variety of materials, it is preferred that the material in the corrugations lies in planes which intersect each other at angles of approximately 90°, i.e., each increment of material extending from a peak to a valley of a corrugation is disposed at 45° to the general plane of the web being treated. Next, I crush these corrugations flat between opposed surfaces. I have discovered that by doing this under conditions depending upon the thickness, rigidity, and other characteristics of the web, whereby the material is neither smoothed out or folded over into pleats, each corrugation will be broken down into a regular series of extremely fine crepes or crinkles. The degree of fineness of these crepes or crinkles is related to some extent at least to the number of corrugations occurring per unit length in the original corrugation, and to the amplitude of each corrugation.

Still further objects, features and advantages of the invention will become apparent from the following detailed description of a presently preferred embodiment thereof taken in conjunction with the accompanying drawings in which like numerals refer to like parts in the several views and in which:

FIG. 1 is a vertical sectional view through the longitudinal center line of a machine for a fine two-way creping;

FIG. 2 is a front elevation taken on line 2—2 of FIG. 1;

FIG. 3 is a fragmentary sectional view on an enlarged scale taken on line 3—3 of FIG. 2;

FIG. 4 is a view similar to FIG. 3 taken on line 4—4 of FIG. 2;

FIGS. 5 and 6 are diagrammatic representations illustrating a principle of operation employed in converting the corrugated material shown in FIG. 4 to its form of FIG. 6;

FIG. 7 is a fragmentary sectional diagrammatic view showing the mode of operation of squeeze rolls on lengthwise extending corrugations;

FIG. 7*a* is a fragmentary, sectional, diagrammatic view showing the mode of operation of the squeeze rolls acting on widthwise extending corrugations;

FIG. 8 is a longitudinal sectional view on a reduced scale of a portion of a machine according to the invention illustrating how the corrugated product may be taken directly from a transverse creping operation and processed to achieve fine creping;

FIG. 9 is a similar view of a portion of a machine in accordance with FIG. 8 adapted for two-way crepe processing in accordance with the invention.

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The embodiment of FIGS. 1 and 2, for fine almost invisible creping, will first be briefly described. The various components of the machine of the invention may be mounted on a main supporting frame **32**. A stock roll **16** of paper or other sheet material to be creped may be mounted on an auxiliary pedestal **15**. The sheet material **20**, prior to being processed, is fed into the machine over a guide roll **17** and around two additional guide rolls **17*a*** and **22** onto the convex side of a curved roll, indicated generally by the numeral **24** of a side-by-side series of rotatable discs or elements **26** for the purpose of gathering the web widthwise.

Mounted above the concave side of the curved roll **24** are one or more pairs of intermeshing circumferentially grooved refining rolls **34**, **36** and **35**, **37** for forming corrugations of the desired size. The arrangement is such that the web **20** may be passed about the roll **24** from the convex to the concave side thereof and then directly into the nip between the intermeshing rolls **34**, **36** and next between the intermeshing rolls **35**, **37**, having twice the frequency of ribs and grooves. The thus longitudinally corrugated web **20*a*** travels somewhat more than 180° around the roll **35** and then passes into the nip between the surface thereof and the periphery of a resilient roll **234**, of rubber or other suitable material. The latter also engages the surface of the drive roll **236**, and the corrugated web is crushed to its fine longitudinal crepe by passage through this latter nip. The roll **236** may be belt-driven from a motor **237**.

It will be noted that the peripheries of the circumferentially grooved rolls **34**, **36** and **35**, **37** are cut in such a way that they lie in planes **P–1** and **P–2** (FIG. 3) which, as shown, intersect each other at an angle of approximately 90°. The planes of the corresponding surfaces of rolls **35** and **37**, having twice the frequency, are similarly angled. Thus, when the web **20*b*** emerges from between the rolls **35** and **37**, it is longitudinally corrugated, the surfaces of the corrugations lying in planes which intersect each other at angles of approximately 90° and which are arranged at approximately 45° to the general plane of the sheet itself.

The principle of operation is illustrated in FIGS. 5 and 6. If a corrugated sheet having the requisite dimension between peak and valley of each corrugation is crushed between flat surfaces, the corrugations will compress into minute crepes or crinkles rather than being smoothed out completely, or folded over into overlapping pleats. This will occur if the dimension from peak to valley of each corrugation is sufficiently short to provide the needed columnar rigidity. This dimension will, of course, vary depending on the characteristics of the web and the particular angle selected. Preferably the angle of corrugation from the plane of the web should be 45°. In FIGS. 5 and 6 a sheet **20*a***, corrugated in accordance with this principle, is shown disposed between a pair of flat plates **246** and **248**. If these plates are squeezed together, the specially corrugated sheet will assume the finely divided creped condition shown in FIG. 6. In accordance with the invention, I adapt this principle to squeeze the rolls in a manner shown diagrammatically in FIG. 7, wherein the curvature of the rolls is exaggerated relative to the thickness of the material for purposes of illustration. The web, here shown to be fed on a straight line into the nip, is crushed between the rolls **242** and **243** and corrugations are converted into fine crepe as shown at **20*b***. As shown in FIG. 7*a*, the same result occurs when a web having widthwise running corrugations is similarly crushed, thus producing the fine crepe shown in the web at **20*d***.

From what has been said, it will be observed that in the embodiments of FIGS. 1 and 2, the web **20** to be creped is first gathered widthwise by passage approximately 180° about the converging discs **26** in such a manner that stresses and strains are equalized and danger of tearing the material is eliminated. The thus gathered sheet next passes between the first pair of intermeshing rolls **34, 36** whose circumferential ribs are cut at approximately 45° angles to the horizontal so as to impart a crepe thereto in an angled pattern, as indicated in FIG. 3. The corrugations thus formed by the operations of the rolls **34, 36** may be subdivided as many times as desired or feasible, depending on its characteristics, as by subsequent passage between the similarly circumferentially grooved rolls **35, 37** whose alternating circumferential ribs and grooves occur at twice the frequency of those of the preceding pair and are similarly angled. The pairs of rolls **34, 36** and **35, 37** are geared to each other, respectively, by meshing gears **226** and **228**. The intermediate roll **234** of resilient material driven by the roll **236**, serves the function of drawing the web through preceding elements of the machine, first by pulling on the web itself and second, by its frictional engagement with the roll **35**, and also the function of crushing the longitudinally running, specially angled corrugations thereof against both rolls **35** and **236** in succession, so that they are crushed and set as indicated above.

I have found that the circumferentially grooved rolls **34–37** may be most economically as well as accurately manufactured by cutting the grooves in the form of screw threads, the cutting tool being arranged to cut the surfaces at the desired angle, the meshing pairs being threaded in opposit directions. It is, of course, not possible to predetermine the number of grooves per inch or the optimum depth thereof or the optimum corrugation angle for all materials which may be processed in accordance with this feature of the invention. These factors are within the skill and discretion of the operator for any particular web which is to be creped. For example, it will be self-evident that a very thick and rigid paper cannot be corrugated by an extremely finely grooved roll. In such case the material would merely be indented rather than corrugated, and, therefore, no creping would result in the second stage of the machine. As one example of a web which may be processed in accordance with the invention, I have found that a 40 pound sheet of kraft may be very successfully and finely creped, using a frequency of about twenty-four corrugations per inch for the final pair of intermeshing roll **35, 37** in the embodiments of FIGS. 1 and 2. For a much lighter material rolls **35–37** may be used with a much higher frequency of recurring alternating ridges and grooves.

The one-way creped product **20*b***, as seen in FIG. 7 may be withdrawn from the machine or further creped in the other direction by passing the same through an attachment at the discharge side of the machine, as shown, to produce a two-way creped product. After discharge from the nip between the rolls **234** and **236**, the sheet material is fed directly between the pair of intermeshing corrugated rolls **238, 239**, whose ribs run parallel to the roll axis and whose cross-section, as indicated in FIG. **1**, is that of intermeshing pinions. These rolls are so arranged as to produce transverse corrugations angled at about 45° to the plane of the web. The action of the rolls **238, 239** imparts widthwise running corrugations to the already longitudinally creped web. These widthwise corrugations are pressed into a fine crepe by passing first between a pair of rubber or other resilient squeeze rolls **240, 241** and next between a pair of smooth steel squeeze rolls **242, 243.** The rolls **238–243** inclusive may be belt or chain driven from the shaft of the roll **236.**

The creped product, after discharge from between the rolls **242, 243** is characterized by fine crepe running in both directions and a noticeable and desirable two-way stretch.

The invention is useful in combination with the machine of the embodiment of FIGS. 1–24 of copending application Serial No. 855,630, in order to impart to the sheet a special, very fine and almost invisible crepe. This process is also applicable to the creping of sheet materials which have previously been corrugated or creped by a prior art method in either or both directions, provided the following conditions are met, namely: (a) the corrugations are regular rather than irregular in pattern; (b) the corrugations lie in planes, or can be caused immediately prior to processing to lie in planes, which are at a desired angle to the plane of the sheet; and (c) the corrugations are sufficiently fine so that when crushed, the special, very fine crepe will result. The fine creping of an already creped product in accordance with the invention is illustrated in FIGS. 8 and 9.

Referring to FIG. 8 there is shown generally the discharge of a creping machine similar to that of FIGS. 1–24 of my copending application Serial No. 855,630. After the web is lifted off the disc **70** by the action of the rotary takeoff comb **52** comprised of spaced-apart discs **53**, it is nipped between the special resilient squeeze rolls **240, 241** of the invention followed by a pair of smooth steel squeeze rolls **242, 243.** The rolls **240** and **242** may be belt-driven from the roll **52** by means of a belt **71**, the speed ratio being such that the peripheral speed of the rolls **240, 241** and **242, 243** with respect to that of the discs **53** is approximately 1.5 to 1.0. Thus, the rollers **240, 241** will partly pull out the corrugations imparted to the web by the take-off comb **52** so that when they enter the nip between the rolls **240, 241**, the corrugations will lie in planes at the desired angle to the plane of the web proper.

Optionally, according to this feature of the invention, the takeoff comb **52** may be an idler roll, and the pairs of rolls **240, 241** and **242, 243** be driven by a separate drive. I have found that a good transverse creping action on some sheet material is obtainable if the takeoff comb **52** merely idles, being rotated only by having the web **20*c*** pulled thereover by the tension created by driving the nipping rolls **240, 241.** For this type of operation the belt **71** may be shifted from the shaft of the roll **52** to some external source of power (not shown).

If the web **20*c*** discharged by the comb **52** has been only transversely creped, the final product **20*d*** will then be creped substantially in only one direction, longitudinally. A two-way finally creped product may be produced if the web has been longitudinally and transversely creped in accordance with the previous embodiments. Since the discs **53** ordinarily will be spaced apart a considerable distance for ease of manufacturing, it will be evident that the longitudinally extending corrugations in the web will be quite coarse, indeed too coarse to be processed in accordance with this feature of the present invention. Accordingly, I may employ the same intermeshing circumferentially grooved rolls as employed in the embodiment of FIGS. 1 and 2 in order to subdivide the longitudinally extending corrugations sufficiently and to impart to them the desired angle so that they may be subsequently crushed into the unique, very fine crepe which is characteristic of a product processed in accordance with this invention.

A further modification is shown in FIG. 9. Here the first set of rolls 34, **36** corresponds with the similar rolls employed in FIGS. 1 and 2. They are, however, mounted to receive the web **20*a*** after discharge from the roll **42** as in the embodiment of FIG. 8. These rolls are belt driven in the same manner as in FIG. 8 so that their peripheral speed bears a ratio of about 1.5 to 1.0 as compared with the peripheral speed of the take-off comb discs **53**, thus stretching the transverse corrugations to the desired angle. The rolls **34, 36** are followed by squeeze rolls **240, 241** and **242, 243.** Optionally, of course, the rolls **34, 36** may be followed by one or more pairs of more finely divided, circumferentially grooved rolls **35, 37** as shown in FIGS. 1 and 2.

Examples, but not by way of limitation, of advantageous uses which may be made of the apparatus and method of invention include: producing controlled elasticity in one or both directions of various sheet materials; increasing softness or pliability of sheet materials, for example, disposable diaper material and leather; increasing absorbency of toweling; increasing the efficiency of various filter materials; creping some sheets without the necessity of conditioning for plasticity or the use of adherents for adhering to the conventional creping cylinder; simultaneous creping of multiple sheets such as multiwall bagging and electrical insulation; creping of certain difficult sheet materials, such as metallic foils, wire cloth and plastic films, impossible or extremely difficult to crepe by conventional methods; providing sheet materials with desired surface characteristics both functional and decorative; rearrangement of fibers and components of fibrous webs such as bats of wool or cotton as, for example, to equalize tensile strengths in both directions and stabilizing the same; modifying the physical characteristics of woven and nonwoven fabrics, for example, softening and stabilizing and improving the drape or other desired qualities, including relaxation of any internal strains; creping at substantially higher speed than possible by conventional methods; imparting elasticity in the cross-direction to webs such as paper which ordinarily have the least tensile strength widthwise; imparting unusually high degrees of stretch to materials for use in wrappings and the like to facilitate molding around the objects to be wrapped.

While I have herein disclosed and described a presently preferred embodiment of the invention, it will nevertheless be understood that the same is susceptible of modifications and changes by those skilled in the art and therefore the invention is limited only by the proper scope to be afforded the appended claims.

I claim:

1. A machine for longitudinally creping a continuous web which comprises a curved roll composed of a series of side-by-side rotatable elements, revoluble on a curved axis about which said web is passed from the convex to the concave side thereof, said elements adapted to gather said web widthwise with stresses and strains substantially equalized across the width of the web, at least one pair of intermeshing circumferentially grooved rolls spaced from said concave side, means for drawing said web between said intermeshing rolls after it leaves said first-named roll, and a pair of smooth squeeze rolls arranged to receive said web when it is discharged from said intermeshing rolls to crush the corrugations which have been formed therein.

2. A machine as defined in claim 1 including at least two pairs of intermeshing, circumferentially grooved rolls through which said web is passed successively, the last pair of said rolls being provided with a greater number of grooves per unit of length than the rolls of said first pair, the last pair having on the order of 24 or more grooves per inch of roll length.

3. A machine as defined in claim 1 including an intermediate idler roll in engagement with one of the rolls of said intermeshing roll pair, and a drive roll in driving engagement with said idler roll, said drive roll and idler roll comprising said pair of smooth squeeze rolls, said rolls adapted to pass said web between the nip formed between said idler roll and said one roll of said intermeshin roll pair, and to move said web with the surface of said idler roll to the nip between said idler roll and said drive roll.

4. The machine of claim 3 wherein said idler roll is comprised of resilient material.

5. A machine as defined in claim 1 including an intermeshing pair of longitudinally ribbed rolls located at the discharge side of said pair of circumferentially grooved rolls and between which said web is passed for corrugating the same in the widthwise direction, the machine arranged to crush said widthwise corrugations between a pair of smooth squeeze rolls.

6. A machine as defined in claim 5 including a pair of resilient squeeze rolls followed by a pair of hard squeeze rolls located at the discharge side of said longitudinally ribbed rolls and between which said web is passed to crush the widthwise corrugations therein.

7. Apparatus for mechanically conditioning a web comprising corrugating means constructed and arranged to impart linear corrugations to the web uniformly throughout the area of mechanical treatment, said means adapted to impart said corrugations close together and including means to produce peak-to-valley increments sized to resist bodily collapse into pleats under substantial crushing forces applied in the direction perpendicular to the general plane of the web, a crushing means, said crushing means constructed and arranged to progressively uniformly engage said linear corrugations throughout the extent of said peaks and valleys, said crushing means adapted to uniformly apply substantial force in said first direction to press said peaks and valleys toward each other, said corrugating means and said crushing means cooperatively constructed and arranged to cause said substantial force of said crushing means to shorten said peak to valley increments without pleating simultaneously with flattening said increments substantially into the general plane of said web, whereby the dimension of said web in a second direction parallel to said plane of said web and transverse to the length of said corrugations is uniformly reduced, and the components of said web are substantially uniformly set closer together in said second direction.

8. The apparatus of claim 7 wherein said means for imparting parallel regular linear corrugations is adapted to form said corrugations with substantially all of the peak-to-valley increments of said corrugations lying at angles of substantially 45° to the general plane of said web and with adjacent peak-to-valley increments lying at substantially 90° angles with respect to each other and said crushing means includes a pair of crushing rollers adapted progressively uniformly to engage said peak-to-valley increments of said corrugations and to apply substantial force in said first direction to press said peaks and valleys toward each other.

9. Apparatus for mechanically conditioning a web comprising corrugating means constructed and arranged to impart linear corrugations running lengthwise of said web uniformly throughout the area of mechanical treatment, said means including means first to form gross corrugations, and refining means adapted to refine said gross corrugations into fine corrugations lying substantially close together with peak-to-valley increments sized to resist bodily collapse into pleats under substantial crushing forces applied in the direction perpendicular to the general plane of the web, crushing means, lateral restraint means adapted to act between said refining means and said crushing means for restraining said refined corrugations from changing their form, said crushing means constructed and arranged to progressively uniformly engage said linear corrugations across the entire web throughout the extent of said peaks and valleys, said crushing means adapted to uniformly apply substantial force in said first direction to press said peaks and valleys toward each other, said corrugating means and said crushing means cooperatively constructed and arranged to cause said substantial force of said crushing means to shorten said peak to valley increments without pleating simultaneously with flattening said increments substantially into the general plane of said web, whereby the dimension of said web in a second direction parallel to said plane of said web and transverse to the length of said corrugations is uniformly reduced, and the components of said web are substantially uniformly set closer together in said second direction.

10. The apparatus of claim 9 wherein said refining means comprises a pair of intermeshed grooved rolls adapted to establish the final size of corrugations prior

to crushing and said lateral restraint means comprises travelling surface means engaging at least one side of said web throughout at least a substantial portion of the distance from the point of intermeshing of said rolls to the point of crushing.

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