Sept. 4, 1956 R. R. WALTON 2,761,490

CONDENSING OF SHEET MATERIALS

Filed Nov. 9, 1953 3 Sheets-Sheet 1

Fig. 1.

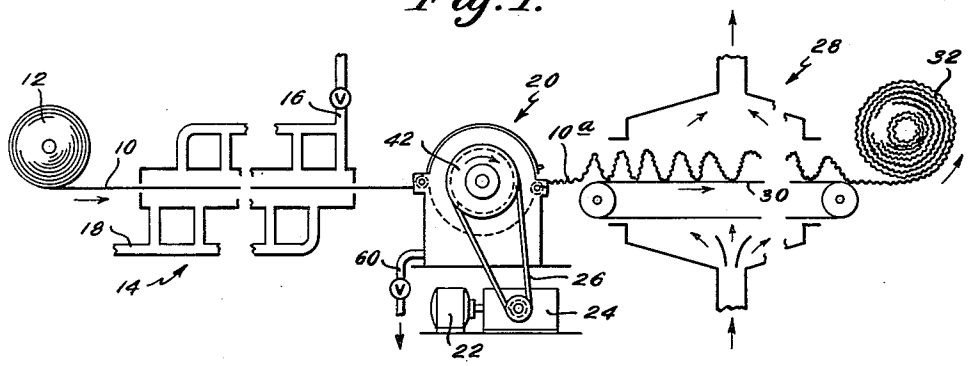



Fig. 2.

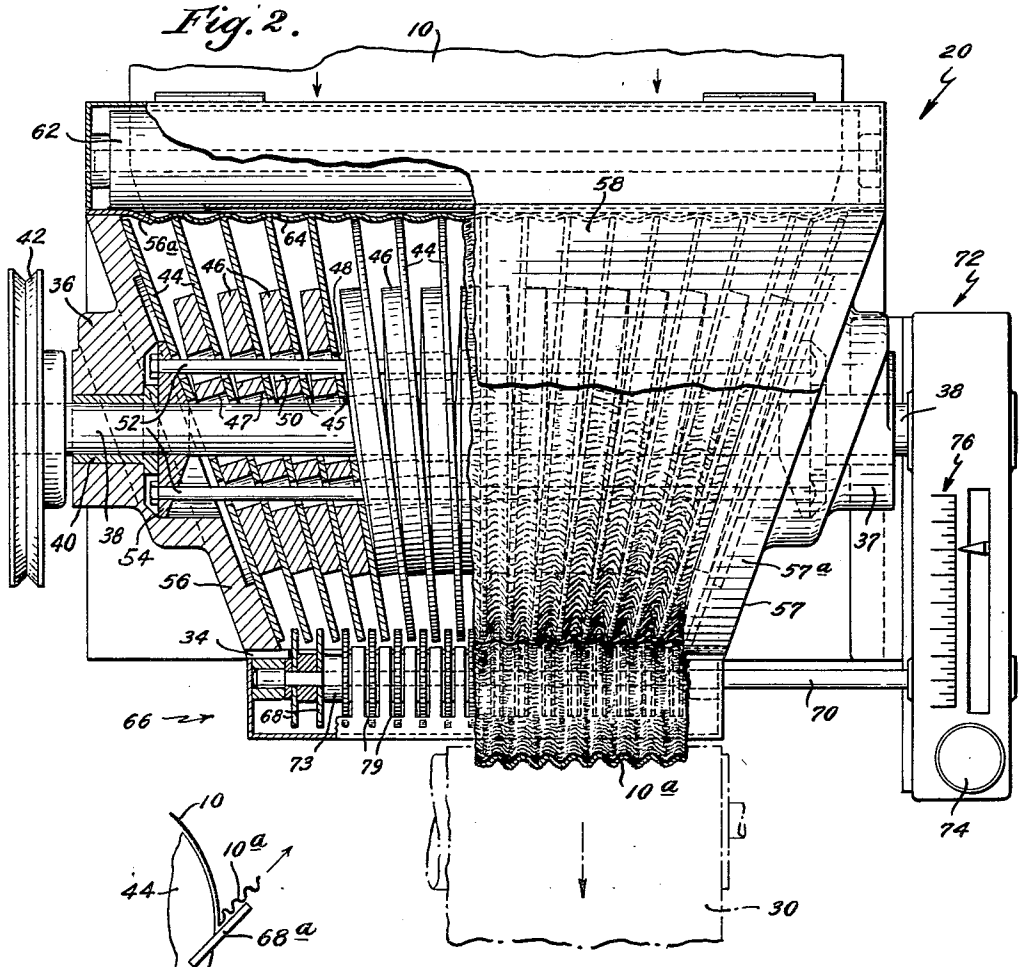






Fig. 10.

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Sept. 4, 1956 R. R. WALTON 2,761,490

CONDENSING OF SHEET MATERIALS

Filed Nov. 9, 1953 3 Sheets-Sheet 2

Fig. 3.

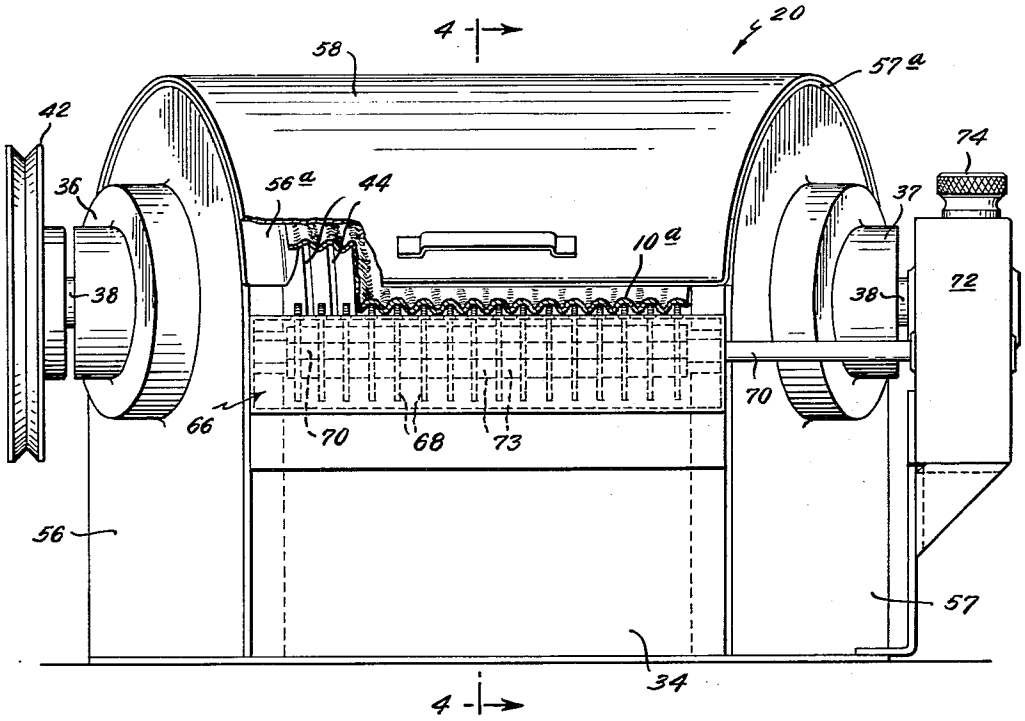



Fig. 6.

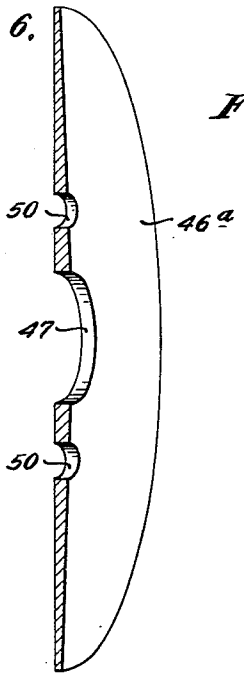



Fig. 7.

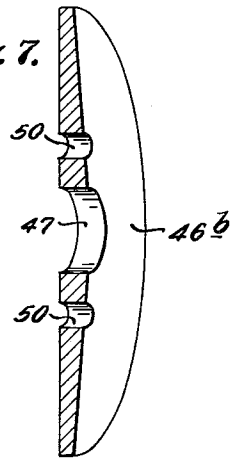
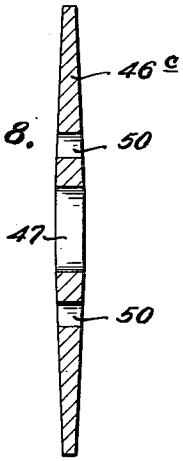



Fig. 8.




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Sept. 4, 1956 R. R. WALTON 2,761,490

CONDENSING OF SHEET MATERIALS

Filed Nov. 9, 1953 3 Sheets-Sheet 3

*Fig. 4.*

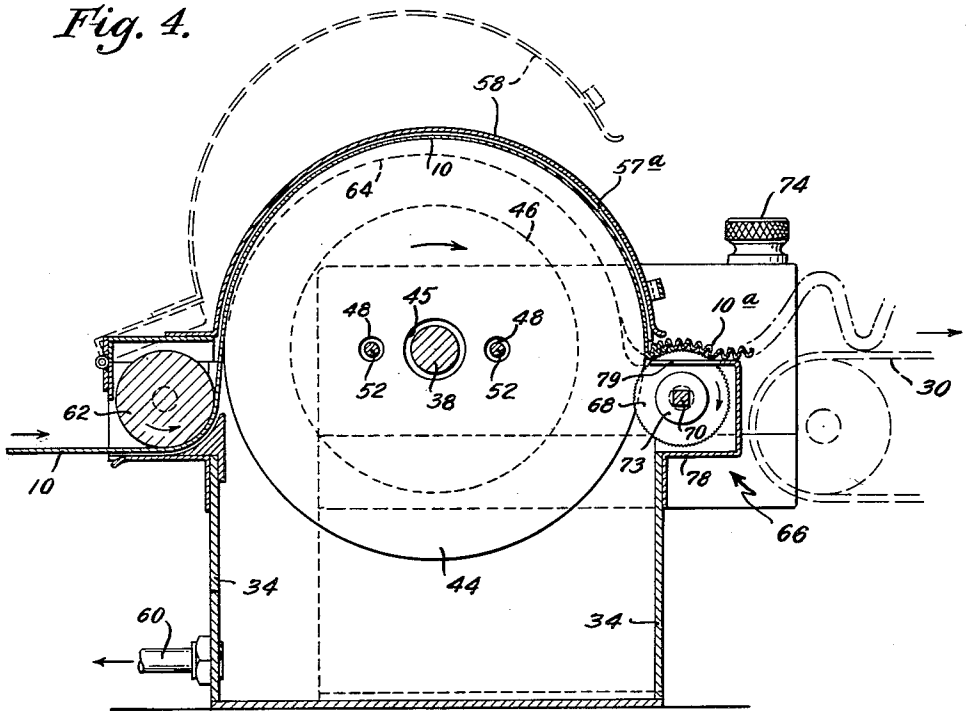



*Fig. 5.*

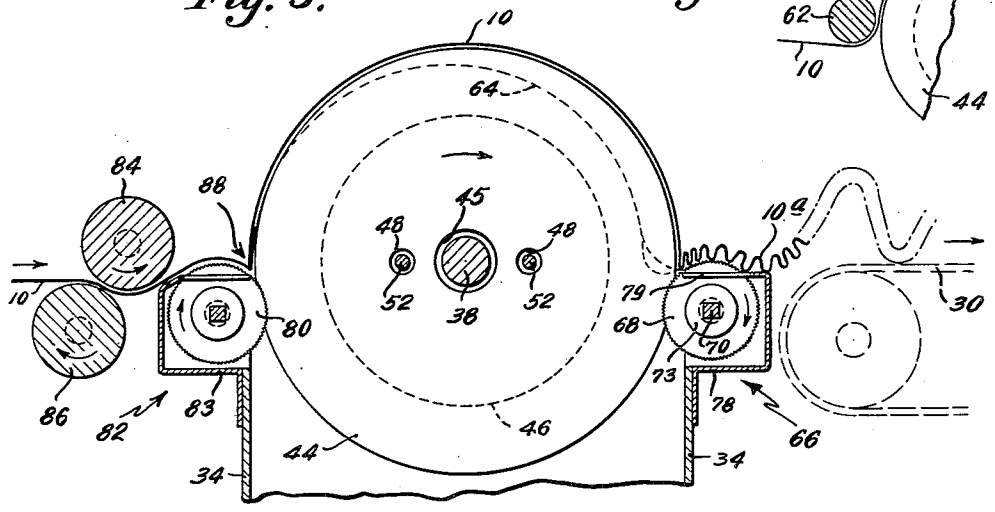



*Fig. 9.*




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*by* A. R. Hulbert *Atty.*

United States Patent Office 2,761,490 Patented Sept. 4, 1956



2,761,490

# CONDENSING OF SHEET MATERIALS

Richard R. Walton, Boston, Mass., assignor, by direct and mesne assignments, of one-fourth to Victor G. Dugal, Milton, Mass., as trustee, and one-fourth to Theodore N. Danforth, Mill Neck, N. Y.

Application November 9, 1953, Serial No. 391,055

15 Claims. (Cl. 154—30)

The present invention relates to the condensing of sheet materials and includes the creping of a web of paper or other deformable sheet material and the compacting together of the fibers or other components of other materials. More particularly the invention is concerned with a new and improved apparatus and process for condensing a sheet material in a single continuous operation either widthwise or lengthwise or, in some cases, in both directions simultaneously.

To avoid confusion in terminology, as used in the present specification and claims, the following definitions will be adhered to:

"Condensing or condensation" of the material refers generally to the creping or crinkling of the material and/or compacting together of the fibers or other components thereof.

"Longitudinal creping" refers to imparting crepes or crinkles which run lengthwise of the material which is therefore "condensed widthwise."

"Transverse creping" refers to imparting crepes or crinkles which run widthwise of the material which is therefore "condensed lengthwise."

The term "web" will be used to denote any running length of sheet material capable of being processed in accordance with the invention.

It is an object of the present invention to provide an improved process and apparatus for changing the degree of condensation of continuous webs, in either a transverse or longitudinal direction, or both, in a manner yielding not only an improved product but more efficient, economical and rapid production.

A further object of the invention is to provide an improved process and apparatus for condensing of webs in which the materials may be condensed both longitudinally and transversely and the degree of condensation in either direction readily controlled.

Still another object of the invention is to provide a novel process and apparatus capable of successfully condensing a web of very low moisture content, thereby either completely eliminating or very substantially reducing the requirements both for initially moistening the web and drying the condensed product.

Still a further object of the invention in one mode of operation thereof is to provide a novel process and apparatus for compacting together the fibers or other components of webs of some materials whether or not any permanent crepe is imparted thereto.

Yet another object of the invention is to provide a novel process and apparatus for successfully condensing webs of certain difficult materials such as those containing glass or other brittle fibers.

Yet a further object of the invention is to provide a novel process and apparatus for simultaneously condensing in one or both directions a plurality of webs in superimposed relation.

In accordance with the invention I pass the web which is to be processed over a series of side-by-side uniformly curved narrow surfaces, herein referred to as principal



surfaces, and during passage thereover I press the web uniformly against these surfaces, as by fluid pressure, thus forcing narrow longitudinal portions of the web partly down between the surfaces. After passage over these principal surfaces, the web is lifted therefrom upon a second series of narrow surfaces interposed between them. In order to change the degree of condensation of the web widthwise, I adjust the angles of the principal surfaces so that they either converge or diverge toward the discharge side. Thus longitudinally extending components of the web will be acted upon by these principal narrow surfaces in a direction transverse of the web. For changing the degree of condensation lengthwise, I either retard or stretch the web by appropriately arranging the discharge elements which extend between the principal surfaces. During passage these principal surfaces furnish the sole support for the web and simultaneously act upon it in the transverse direction. In one form of the invention these elements are arranged at an angle to the direction of travel of the web so that the web will impinge thereagainst and thus be condensed as it leaves the principal surfaces. In another form of the invention the discharge elements take the form of a second series of moving narrow curved surfaces, which may or may not be roughened or interrupted, and which lift the web from the principal surfaces. By operating these take-off surfaces at a peripheral speed slower than that of the web, I condense the web in the direction of its length. Similarly, I may stretch the web by operating the discharge surfaces at a higher rate of speed than that of the impinging web.

Preferably the principal surfaces constitute the peripheries of a series of side-by-side rotating discs, or the like, which are mounted on a common rectilinear axis and which may be tilted axially so as to diverge on one side thereby increasing the distance between their peripheral edges on such side, while correspondingly converging at the other side where the peripheral edges are much closer. Depending on the direction of tilt during passage the web is therefore drawn together into longitudinally running crinkles as the disc edges approach each other or stretched widthwise. Interposed between the edges of the discs beneath the web at the discharge side is a comb providing the narrow surfaces which lift from the principal disc edges the web which has thus been acted upon. The material may also be processed lengthwise by the action of this comb which, if composed of stationary fingers, may be tilted so that the web impinges at an angle thereon to be thereby condensed, or, if composed of rotating wheels, may be operated at a peripheral speed different from that of the principal discs, if slower controllably to condense the web, or, if more rapid, to stretch the web lengthwise. I prefer to employ rotating discs or wheels for my take-off comb and for some materials it is desirable to provide them with knurled edges or peripheral teeth to reduce slippage and grip the material positively. I cause the web to adhere to the principal revolving discs by forcing it against the same uniformly, as by fluid pressure caused by suction applied between the discs and this suction preferably extends also between the elements of the take-off comb. I have found that paper and other materials having similar characteristics may be effectively creped both longitudinally and transversely by condensing it widthwise upon converging discs and condensing it lengthwise upon the take-off comb.

In a somewhat modified form of the invention, I impart to the traveling web an initial transverse crepe or condense it in the direction of its length as it passes onto the principal discs by feeding it to the same by means of an initial series of discs or wheels, similar to those forming the discharge comb, and extending in part between the edges of the principal discs on the input side.

The discs of this initial series may likewise be knurled, if desired, and are likewise driven at a peripheral speed different from that of the principal discs to achieve the desired result as by crimping or compacting or stretching the web along the line where it first encounters the peripheries of the principal discs.

When treating some materials in accordance with the invention, for example in the creping of paper, it may be desirable initially to moisten the web to secure an optimum moisture content. In most cases there is no need to saturate the material and I have found that some types of paper need be only slightly dampened to be creped effectively by means of my novel process and apparatus. The web is dried to some extent by passage over the principal discs, where it is subjected to strong suction, and the balance of the moisture will often evaporate in relatively short time from the crepe web which may be stored in a dry place in the form of loosely wound rolls. In some cases, where the web has a high moisture content, I may discharge the condensed material directly into a drying unit where the moisture is driven off by heat.

By appropriately adjusting the angles of convergence and size and spacing of the principal discs I can control the degree of condensation widthwise and the spacing and characteristics of the longitudinal crepe, if any, imparted. Where the discs are set parallel with each other no condensation widthwise takes place and the material is condensed only in the direction of its length.

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

Fig. 1 is a diagrammatic representation of one form of a complete condensing apparatus including my novel unit as one of the elements;

Fig. 2 is a plan view with portions broken away and partly in section of the condensing unit of the invention shown in the operation of creping a web of paper in two directions;

Fig. 3 is an elevation of the discharge end of the unit shown in Fig. 2;

Fig. 4 is a vertical sectional view taken on the line 4—4 of Fig. 3;

Fig. 5 is a sectional view similar to Fig. 4 showing in somewhat diagrammatic form another embodiment of the invention;

Figs. 6 and 7 are half-sectional elevational views of two different forms of spacing element which may be used between the principal web-supporting discs in the condensing unit;

Fig. 8 is a cross-section of still another form of spacing element, tapered on both sides;

Fig. 9 is a fragmentary sectional view on a reduced scale of the input end of a machine similar to that of Fig. 4 including means for feeding a second web onto the initial web for condensing the two simultaneously; and

Fig. 10 is a fragmentary view on a reduced scale of the discharge end of a modified machine employing a stationary comb take-off.

The overall process will first be described briefly in connection with the diagrammatic representation of Fig. 1 as applied to the creping of a web of paper or the like. The web **10** is provided in the form of a stock roll **12**. The web **10** may be led first through a moistening unit **14**, such as a steam box, wetting trough or spraying unit, the wetting liquid or steam being introduced through the inlet **16** and withdrawn through the outlet **18**. The web, moistened to the desired degree if necessary, is then led into the creping unit **20** (hereinafter more fully described), which is driven by a motor **22** through a gear box **24** and belt **26**. The creped product **10***a* is discharged continuously from the creping unit, and if necessary, introduced immediately into a drier **28**, through which it travels on an endless conveyor belt **30** finally to be wound as a finished roll **32** which will be loose and bulky due to the crinkle imparted to the material by the creping unit. The drying unit **28** may be of any suitable construction or in some cases dispensed with entirely, as where the moisture content is low, in which case drying may be completed merely by forcing hot air through the loose rolls or storing the rolls for a suitable period in a dry place. Neither the optional moistening means nor the optional drying means forms a part of the present invention and neither will be described in detail.



Turning to Figs. 2, 3, and 4, the operation of the novel condensing unit of the invention will be explained in detail as applied to the creping of paper. The unit is mounted in a casing **34** provided with suitable bearing supports **36** and **37** holding bearings **40** in which is journaled a rectilinear main shaft **38**. The shaft **38** is driven by the belt **26** (omitted from Fig. 2) through a pulley **42**.

Mounted to revolve with the shaft **38**, is a series of relatively thin principal web-supporting discs or wheels **44** having central apertures **45** to receive the shaft **38**. Two or more or all of these discs may be separated from each other by a corresponding series of spacers **46** of special configuration having central openings **47** for the shaft **38**. Each disc **44** and spacer **46** is provided with a pair of openings **48** and **50**, respectively, spaced from its axis. When the discs and spacers are assembled, these holes are aligned to receive the rods **52**, the opposite ends of which are attached to flanges **54** which revolve with the shaft **38**. The discs **44**, therefore, will rotate with the shaft **38**, but are nevertheless tiltable upon their axes by reason of the openings **48** and **50**, the degree of tilt being limited by the size of the openings, the taper, if any, and the dimensions both of the discs themselves and the spacers **46**.

The principal discs and spacers are guided by angled end plates **56** and **57** engaging the two outermost discs so that on the side to which the unprocessed web **10** is fed they diverge one from the other at suitable angles, while at the take-off side they converge in a corresponding manner, all as best seen in Fig. 2. The top of the machine is provided with a cover **58** which may be opened as shown in Fig. 4. The cover has clearance at the side or may be provided with openings to admit air to the upper peripheral portions of the discs **44**.

The interior of the casing **34** is connected through piping **60** to a suitable source of suction, such as a vacuum pump, not shown.

The web **10** is fed to the discs **44** by a guide roll **62** rotatably mounted at the input side of the machine. As soon as the web meets the divergent edges of the discs **44**, it is pulled down thereon by the suction action of the vacuum within the device, and, as shown by broken lines in Fig. 4, the portions of the web between the discs gradually are drawn down therebetween as indicated by the broken line **64**. These narrow longitudinal portions of the web are drawn further and further down as the web passes over the discs whose peripheral edges gradually converge as they approach the point of discharge. The web is therefore creped longitudinally by being forced by fluid pressure between the converging narrow surfaces over which it passes. At the edges of the web sealing aprons **56***a* and **57***a* aid in holding the vacuum should the web be too narrow to cover the disc surfaces completely.

The discharge and transverse creping of the already longitudinally creped web are accomplished by a comb assembly **66** which preferably comprises a series of rotating wheels or discs **68** which may be provided with toothed or knurled surfaces. These discs are mounted on a shaft **70** parallel to the shaft **38** and driven by a variable speed transmission unit **72** from the main drive and for convenience separated from each other by separators or spacing elements **73**. The shaft **70** is driven in

the same direction as the shaft 38, but, for condensing purposes, at a predetermined slower speed. The peripheries of the comb wheels 68 extend a short distance between the converging edges of the discs 44 and provide a moving surface which starting from beneath the web lifts it up and takes it off continuously. If the comb wheels are driven at a lower peripheral speed than the principal discs, the web will be condensed against their surfaces during discharge in lengthwise direction and with paper and similar materials this condensation takes the form of transverse crepes. The degree of transverse creping action is thus dependent upon the relative peripheral speeds of the two sets of discs. It is thus possible to achieve any degree of transverse creping action, from zero to maximum, or even stretch instead of condense the web, by adjustment of the speed of rotation of the shaft 70 through the control knob 74. For convenience, an indicator 76 may be provided to indicate the degree of condensation lengthwise, and this may be calibrated in terms of crepes per inch or percentage of condensation of the web, or any other convenient units.

The thus condensed web is discharged by the wheels 68 onto a traveling apron 30 which conducts it through the drying unit if drying is necessary. As best seen in Fig. 4, the wheels 68 of the discharge comb are housed within an auxiliary casing 78 having slots 79 in its cover to permit protrusion of the wheels while helping preserve the partial vacuum within the casing 34. The condensed web discharges from the take-off wheels 68 onto the surface of the cover of the casing 78 and thence to the conveyor 30.

The degree of longitudinal creping or widthwise condensation is dependent upon the angles to which the various discs 44 are tilted and their spacing. By employing discs of varying widths and spacers of various diameters and taper, all as indicated in Figs. 6, 7 and 8, the number of corrugations per inch and the degree of condensation of the material widthwise, may be controlled. For example, it may be desired to impart only transverse creping to the web, i. e., to condense it only in the direction of its length; in such case the discs 44 would be disposed in parallel arrangement, eliminating convergence and divergence, and the condensing would be performed in only one direction by revolving the take-off wheels 68 at the desired angular velocity. In Figs. 4 and 5 the discs 44 may be considered as set at any desired angle with respect to each other to accomplish the result.

In a corresponding manner, only longitudinal creping, i. e., condensation of the material widthwise may be performed by operating the machine adjusted as shown in Fig. 3 but revolving the take-off wheels 68 at the same peripheral speed as that of the discs 44 so that the web is taken off without any condensation, thereby eliminating the transverse creping action entirely. Different effects may be achieved by omitting some of the spacers or using spacers of different sizes and shapes between some of the discs. Likewise the take-off discs 68 need not alternate with the discs 44, but various of them may be omitted. Likewise, the degree of condensation widthwise may be controlled by shifting the angular relation of the take-off comb about the axis of the principal discs. As shown, the input is spaced 180° from the discharge but shifting it toward the input side a number of degrees would correspondingly reduce the widthwise condensation of the web. In like manner the location of the roll 62 may be shifted around the axis of the principal discs 44.

In Fig. 5 a somewhat modified form of the invention is disclosed in which the degree of condensation of the web 10 is initially changed along the line 88 where it is guided onto the revolving discs 44. In this case the initial crimping or condensing unit 82 comprises another set of wheels 80 like those 68, preferably knurled or toothed, mounted within a secondary casing 83 attached to the main housing 34 and the web 10 is fed onto these wheels 80 by a pair of feed rolls 84 and 86.



For condensing the web, the wheels 80 revolve with greater peripheral speed than that of the discs 44 and perform the first crimping operation along the line indicated by the numeral 88. The web then passes around the discs 44, during the course of which motion condensation widthwise occurs and finally still further transverse crimp, if desired, is applied by the final set of wheels 68. It is apparent that in this form of the invention either the discs 80 or the discs 68 may be driven at greater or lesser peripheral speeds than that of the principal discs 44 for achieving a variety of different effects. Thus, it may be found advantageous as to some materials to elongate or stretch the web as it is fed to the machine and to condense it at the discharge end, or vice versa, or it may be found advantageous to condense the web to a lesser degree in each step of a two-step operation to produce a more stable product.

Somewhat the same considerations apply to the degree of condensation of the web widthwise. In operating upon some materials, it will be found impossible or undesirable to produce a permanent longitudinally running crepe. The degree of condensation of these materials widthwise may nevertheless be affected by passage over the principal discs of my novel apparatus. Thus some of them may be permanently stretched by having narrow longitudinal portions thereof pulled by suction down between the principal discs 44 during passage over the machine. Others may be stretched widthwise by reversing the adjustment of the discs so as to feed the web onto the convergent side and to discharge it from the divergent side, in effect running the material through the machine backwards. Likewise, two or more complete machines may be used in series to provide multi-stage condensation.

Employing my novel machine and process, various special crimping effects may be achieved. Some of these are suggested by the different forms of separators or spacers shown in Figs. 6, 7 and 8. For example, the spacer shown in Fig. 6, indicated by the numeral 46*a*, is relatively thin and tapered toward its edges on only one side. On the other hand, the spacer 46*b*, of Fig. 7, is relatively thick but likewise tapered on only one side. The separator 46*c*, shown in Fig. 8, is also relatively thick, but may be thin, and is tapered on both sides. In creping a single web, separators of various different sizes and configurations may be interposed between the discs 44 at different locations. For example, by using relatively thin separators on one side and relatively thick on the other, the web may be longitudinally creped to a very high degree on one side but loosely on the other. By alternating or staggering separators of various sizes, various decorative effects may likewise be achieved.

As another example of the versatility of my new and improved machine and process, it is also possible to drive some of the transverse creping discs at different speeds, thus producing a variety of different effects in the transverse direction.

For condensing some fibrous materials a discharge comb having smooth surfaced wheels may be used, but in such case it may be found that the wheels should be set in relation to the discs so that the wheel peripheries intercept the traveling material at a sharp angle to grip and retard the web as it is lifted from the principal discs. This angle is not of such importance when wheels having interrupted surfaces, such as teeth, are employed, since the sides of the teeth will oppose and retard components of the web for compacting them together.

I have found that the new and improved process and apparatus according to the invention yield superior results both as to economy and speed of production and likewise produce a superior product whether it be a creped paper or other condensed material. The product when creped in two directions is flexible in all directions, very elastic, may fill a large volume and is therefore ideal for use for packaging material for fragile arti-

cles or articles having a delicate finish. Many other uses for a two-way creped product will naturally occur to those skilled in the various arts in which it may be used.

An important advantage of the novel process and apparatus of my invention is the capacity successfully to crepe webs, particularly paper webs, having very low moisture content, scarcely more than the paper might pick up from the atmosphere. For example, I have found, surprisingly enough, that a paper web having a moisture content of only 10 to 12 per cent may be creped tightly and permanently in both directions, while at the same time, a good proportion of what moisture is present is removed by passage of air through the pores of the material while on the creping unit. The crimped product is so bulky and loose that it will dry completely in a short time merely by storage in a dry place; or, if desired, complete drying may be hastened by passing warm air through rolls of the creped material without need for expensive drying apparatus. The crimp in the creped product, as it comes from the machine, is permanently fixed in marked contrast to conventionally processed water saturated material which is limp and delicate to handle. This means that the product as it comes off my novel machine does not require careful handling.

Another advantage of creping a relatively dry web resides in the fact that it is possible to apply a coating of sheet material or a plastic spray directly to the web on the machine or to it at the discharge without the need for first passing the web through a drier, since the coating or sheet will adhere to the dry web.

A surprising result is the success with which I can crepe certain difficult materials according to the invention. Webs composed in whole or in part of brittle fibers, such as sisal or glass, have heretofore generally been found difficult or impossible to crepe successfully because of fracture of the fibers. Using my novel process and apparatus, I have found it possible successfully to crepe even these materials, the creping action being of such a gentle nature as not to damage these types of fibers.

A further advantage of the method and machine of the invention, as illustrated in Fig. 9, is the fact that unusual designs and effects may be achieved by feeding, as by a guide roll 63, onto the upper surface of the web as it enters the creping unit some other sheet material 11 of different qualities of color or design and causing such secondary material to be creped with the principal web simultaneously as the two pass over the discs. The second web 11 need not be bonded to the web 10. I have found that a plurality of some types of webs, may be creped simultaneously in superimposed relation and later separated if desired thereby increasing the production of the machine by a factor of two or more. Metal foils and papers may be creped simultaneously to provide a highly decorative laminated product which need not be bonded by any adhesive. I have also found that in creping paper a secondary sheet of moistened decorative paper may be laid on the original sheet as it enters the input side of the machine and it will be firmly affixed to the primary web during the creping process to form a creped laminated product of special characteristics.

The apparatus and method according to the invention have a wide application in industry, packaging and cushioning being only two of a variety of uses for the creped product. For example, a strong heavy paper highly creped both longitudinally and transversely will be very tightly crimped, bulky and elastic and may be used, among other things, as an inexpensive floor covering. A crimped product creped either longitudinally or transversely or both is suitable for use as a protective wrapping and for this purpose it optionally may be attached, as by gluing, to a flat sheet of paper or laminated in between a pair of sheets. When creped in both directions, it is likewise flexible and stretchable in any direction and may be bent around corners easily and effectively for wrapping purposes or stamped into cups, containers, boxes or the like.

Condensing machines according to the invention may readily be fabricated to produce a product of any desired width. For example, there is no problem in selecting discs and spacers of suitable size for producing a finished web thirty-six inches across from an uncreped sheet material twice that width, more or less. By appropriate adjustments, the tightness of crepe, number of crepes, and percentage of crepe in either direction may be readily controlled. If desired, in some cases two or more of my creping units may be placed in a series, the first machine producing an initial crimp in either or both directions and the second machine producing a further crimp as desired. There appear to be some advantages in creping paper alternately in each direction in a series of separate steps. Apparently, each succeeding crimp tends to lock the preceding crimp in place. A two-way creped product formed in this manner appears to have unusual properties of resilience, being superior in some respects to materials which have been creped in a single stage operation.

Turning from sheet materials to which it is desired to impart a permanent crimp or crepe in either one or two directions, there are other materials, soft materials for example, not susceptible of being permanently creped, whose characteristics nevertheless may be changed by processing in accordance with the novel process and apparatus of the invention. I have found that the fibers or other components of such sheet materials may, under certain conditions, be shifted relative to each other, thereby permanently changing the appearance and compactness as well as the length of the material in one or more directions. Thus by providing toothed take-off wheels and operating them at lower peripheral speeds from that of the principal discs, the components of the web which run widthwise of the web will be compacted against each other. Conversely, if these wheels be operated at a higher speed, these components will be separated further from each other and the material thus stretched lengthwise and made looser. I have observed an analogous phenomenon with respect to the reaction of the lengthwise components of webs which I have tested. However, the compacting effect produced by the converging peripheries of the principal discs may in some cases be offset to a degree by the stretching of the material by being sucked down between the edges of the discs by fluid pressure. A wide variety of different effects upon the lengthwise components of the web may be achieved by tilting the discs at various angles as desired.

For most purposes I have found it preferable to lift the web from the principal discs by means of a rotating comb which facilitates adjustment, simply by changing the speed of the discs, to accomplish various different results outlined above. However, for some purposes transverse creping (or condensing of the material lengthwise) may be satisfactorily accomplished merely by lifting the web from the principal discs at the discharge by means of a stationary comb having fingers projecting beneath the peripheries of the discs. As shown in Fig. 10, the web 10 is passed over the principal discs 44 and impinges against and is condensed by the projecting elements or fingers 68*a* of a stationary comb. The web is discharged in the form of a transversely creped product 10*a*. The characteristics of the transverse crepe or crimp thus imparted are determined by the angle of the discharge elements 68*a* with respect to the path of travel of the web 10 and within practical limits this angle may be adjusted by the operator to achieve the desired results.

While I have herein disclosed and described a presently preferred embodiment of the invention, it will neverthe-

less be understood that the same is capable of numerous modifications and changes by those skilled in the art nevertheless within the scope of the appended claims. For example, in the various forms of the invention it is evident that I may substitute equivalent devices for providing the requisite narrow curved peripheral surfaces against which the web is pressed as well as the feeding and discharge devices and that I am not limited to the specific forms of discs herein disclosed and described but only by the scope of the appended claims.

I claim:

1. Apparatus for changing the degree of condensation of a traveling web which comprises a series of side by side rotatable discs, a rectilinear shaft rotatably mounted axially of said discs upon which said discs are tiltably mounted for rotation therewith, guiding elements for tilting said discs so that they diverge at one side and converge at another side of said series, means for feeding said web onto the peripheral surfaces of said discs at one side of said series, means for applying pressure uniformly to the outer surface of said web as it passes over said discs for pressing said web against said peripheral surfaces to force narrow longitudinal portions thereof between such surfaces as said web advances, and discharge elements extending between said discs at another side of said series for lifting said web therefrom.

2. Apparatus for condensing a traveling web which comprises a series of side by side rotatable discs, a rectilinear shaft upon which said discs are tiltably mounted for rotation therewith, guiding elements for tilting said discs so that they diverge at one side and converge at the other side of said series, means for feeding said web onto the peripheral surfaces of said discs at the divergent side, means for applying fluid pressure to the outer surface of said web as it passes over said discs for pressing said web uniformly against said peripheral surfaces to force narrow longitudinal portions thereof between said surfaces for condensing the same widthwise as said web advances, and a discharge comb comprising a series of movable members having portions extending between said discs at the convergent side of said series for lifting said web therefrom.

3. Apparatus for condensing a traveling web which comprises a series of side by side rotatable discs, a rectilinear shaft upon which said discs are tiltably mounted for rotation therewith, guiding elements for tilting said discs so that they diverge at one side and converge at the other side of said series, means for feeding said web onto the peripheral surfaces of said discs at the divergent side, means for applying fluid pressure to the outer surface of said web as it passes over said discs for pressing said web uniformly against said peripheral surfaces to force narrow longitudinal portions thereof between such surfaces for condensing the web widthwise as it advances, a discharge comb comprising a plurality of rotatable members having portions extending between said discs at the convergent side of said series for removing said web therefrom, and a drive for driving said members at a peripheral speed less than that of said discs but in the same direction for condensing said web in the direction of its length.

4. Apparatus for condensing a traveling web which comprises a rotatably mounted rectilinear shaft, a drive for driving said shaft at a predetermined speed, a series of side by side rotatable discs tiltably mounted on said shaft for rotation therewith, spacing elements separating at least some of said discs from each other, a casing partly enclosing said discs, guides mounted at opposite ends of said shaft and bearing against the outermost discs for tilting said series of discs so that they diverge at one side and converge at the other side of said series, a guide roll rotatably mounted adjacent the divergent side of said series and guiding said web onto the peripheral surfaces of said discs, said casing having an outlet for connecting its interior to a source of suction for partially exhausting the air from between said discs for pressing said web uniformly against said peripheral surfaces by external pressure thereby to force narrow longitudinal portions thereof between said peripheral surfaces for condensing said web widthwise as it advances and a discharge comb mounted adjacent the convergent side of said series, said comb having a plurality of discharge elements extending at least partly between said discs for lifting said web therefrom.

5. Apparatus for condensing a traveling web which comprises a rotatably mounted rectilinear shaft, a drive for driving said shaft at a predetermined speed, a series of side by side rotatable discs tiltably mounted on said shaft for rotation therewith, spacing elements separating at least some of said discs from each other, a casing partly enclosing said discs, guides mounted at opposite ends of said shaft and bearing against the outermost discs for tilting said series of discs so that they diverge at one side and converge at the other side of said series, a guide roll rotatably mounted adjacent the divergent side of said series and guiding said web onto the peripheral surfaces of said discs, said casing having an outlet for connecting its interior to a source of suction for partially exhausting the air from between said discs for pressing said web uniformly against said peripheral surfaces by external pressure thereby to force narrow longitudinal portions thereof between said peripheral surfaces and to condense said web widthwise as it advances, a rotary discharge comb mounted adjacent the convergent side of said series, said comb comprising a plurality of rotatable discs extending at least partly between said first-named discs for removing said web therefrom, and a drive for rotating said comb with said discharge discs revolving in the same direction as said first-named discs but at a lower peripheral speed for condensing said web in the direction of its length.

6. Apparatus for condensing a traveling web which comprises a rotatably mounted rectilinear shaft, a drive for driving said shaft at a predetermined speed, a series of side by side rotatable discs mounted on said shaft for rotation therewith, spacing elements separating at least some of said discs from each other, a casing partly enclosing said discs, a guide roll rotatably mounted adjacent one side of said series for guiding said web onto the peripheral surfaces of said discs, said casing having an outlet for connecting its interior to a source of suction for partially exhausting the air from between said discs for pressing said web uniformly against said peripheral surfaces by external pressure, a rotary discharge comb mounted adjacent another side of said series, said comb comprising a plurality of rotatable discs extending at least partly between said first-named discs for removing said web therefrom, and a drive for rotating said discharge discs in the same direction as said first-named discs but at a lower peripheral speed for condensing said web in the direction of its length.

7. Apparatus for condensing a traveling web which comprises a rotatably mounted rectilinear shaft, a drive for driving said shaft at a predetermined speed, a series of side by side rotatable discs tiltably mounted on said shaft for rotation therewith, spacing elements separating at least some of said discs from each other, a casing partly enclosing said discs, guides mounted at opposite ends of said shaft and bearing against the outermost discs for tilting said discs so that they diverge at one side and converge at the other side of said series, a series of wheels rotatably mounted adjacent the divergent side of said series for feeding said web onto the peripheral surfaces of said discs, a drive for driving said wheels in the same direction as said discs and at a higher peripheral speed for initially condensing said web in the direction of its length as it is fed onto said discs, said casing having an outlet for connecting its interior to a source of suction for partially exhausting the air from between said discs for pressing said web uniformly against said peripheral

surfaces by external pressure, thereby to force narrow longitudinal portions thereof between said peripheral surfaces for condensing said web widthwise as it advances, and a device arranged adjacent the convergent side of said series for removing the condensed web therefrom.

8. Apparatus in accordance with claim 7 in which said device for removing the web from said series of discs comprises a second series of wheels extending at least partly between said discs at the convergent side thereof and a drive for revolving the same at a lower peripheral speed than that of said discs for further condensing the web in the direction of its length.

9. Apparatus for condensing a traveling web in the direction of its length comprising a series of side by side rotatable discs, a drive for rotating the same, mechanism for feeding said web onto said discs, a device for exhausting air from between said discs to create suction for forcing said web by external air pressure against the peripheries thereof during passage thereover, a series of movable discharge members interposed between said discs at the discharge side thereof, said discharge members having gripping surfaces at a sharp angle to the direction of travel of said web operating to engage and retard portions of said web as it is lifted from said discs for compacting the same together, and wall means interposed between said discharge members to isolate the web-engaging portions thereof from said suction.

10. Apparatus in accordance with claim 9 in which said discharge members comprise a series of toothed wheels and said gripping portions comprise surface areas of the teeth thereof and in which said wall means comprises a slotted casing, said wheels protruding through the slots thereof.

11. Apparatus for changing the degree of condensation of a traveling web which comprises a series of side by side rotatable discs, a drive for rotating the same, guiding means for tilting said discs so that they diverge at one side and converge at another side of said series, mechanism for feeding said web onto the peripheral surfaces of said discs at one side, suction means for exhausting the air from between said discs for pressing said web uniformly against said peripheral surfaces to force narrow longitudinal portions thereof between such surfaces as said web advances, a discharge comb comprising a plurality of rotatable wheels having portions extending at least partly between said discs at another side of said series for removing said web therefrom, and a drive for driving said wheels at a peripheral speed different from that of said discs but in the same direction.

12. Apparatus for condensing a traveling web which comprises a series of side by side rotatable discs, a drive for rotating the same, mechanism for feeding said web onto the peripheral surfaces of said discs at one side, suction means for exhausting the air from between said discs to create suction for pressing said web uniformly against said peripheral surfaces by external air pressure as said web advances, a discharge comb having portions extending at least partly between said discs at another side of said series for lifting said web therefrom, said comb presenting surfaces directed at an angle to the direction of travel of said web for condensing the same in the direction of its length and wall means interposed between said portions of said comb substantially isolating the same from said suction.

13. Apparatus for changing the degree of condensation of a traveling web which comprises a series of side by side rotatable and tiltable discs, a drive for rotating the same, guiding means for tilting said discs so that they diverge at one side and converge at another side of said series, a series of wheels extending in part between said discs for feeding said web onto the peripheral surfaces thereof at one side, a drive for driving said wheels at a different peripheral speed from that of said discs, suction means for exhausting the air from between said discs for pressing said web uniformly against said peripheral surfaces to force narrow longitudinal portions thereof between such surfaces as said web advances, a discharge comb comprising a second series of rotatable wheels having portions extending at least partly between said discs at another side of said series for removing said web therefrom, and a drive for driving said last named wheels at a peripheral speed different from that of said discs but in the same direction.

14. Apparatus for changing the degree of condensation of a traveling web which comprises a movable device presenting a series of side by side mutually spaced curved narrow peripheral surfaces, a drive for said device for moving said surfaces within mutually spaced curvilinear paths, mechanism for feeding said web onto said peripheral surfaces at one location thereon, means for creating suction within said device for pressing said web uniformly against said peripheral surfaces by external air pressure to force narrow longitudinal portions thereof partly between such surfaces as said web advances, a discharge comb comprising a series of wheels having portions extending at least partly beneath said peripheral surfaces at a location spaced from said feeding mechanism for lifting said web therefrom, a slotted housing for said comb, said wheels protruding through said slots, said housing including walls isolating the web-engaging portions of said wheels from said suction, and a drive for driving said wheels in the same direction as but at a different peripheral speed from that of said peripheral surfaces.

15. Apparatus for condensing a plurality of traveling webs which comprises a series of side by side rotatable discs, a rectilinear shaft upon which said discs are tiltably mounted for rotation therewith, guides arranged to tilt said discs so that they diverge on one side of said series and converge on the other side thereof, means for feeding said webs in superimposed relation onto the peripheral surfaces of said discs at the divergent side of said series, means for applying fluid pressure to the outer surface of the uppermost web as said webs pass over said discs for pressing said webs uniformly against said peripheral surfaces, a discharge comb comprising a plurality of rotatable wheels having portions extending at least partly between said discs at the convergent side of said series for removing said webs therefrom, and a drive for driving said wheels at a peripheral speed less than that of said discs but in the same direction for condensing said webs simultaneously in the direction of their length.

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