

July 17, 1962

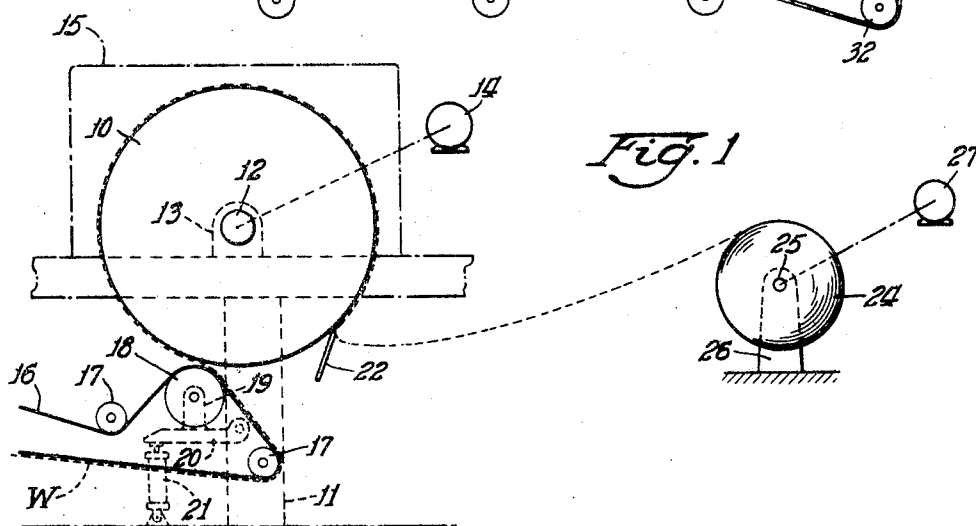
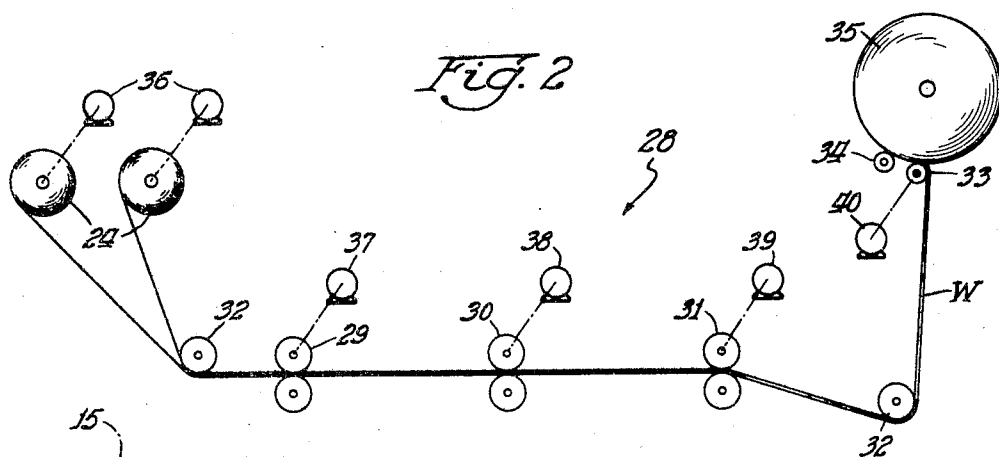
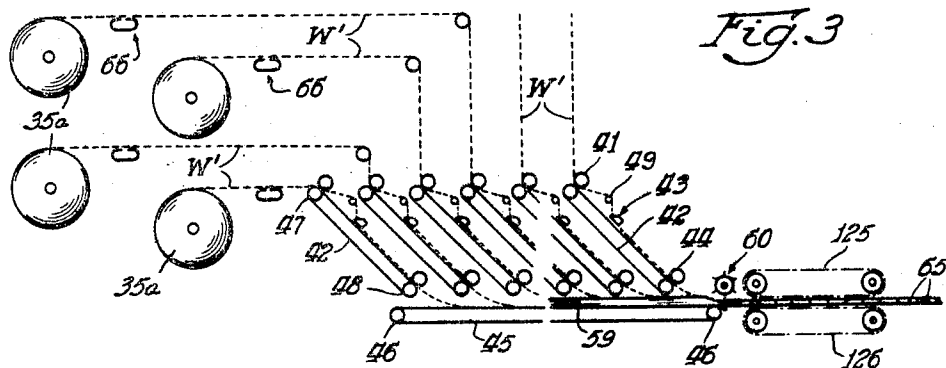
LE ROY L. PETERSON

3,044,228

CELLULOSIC PRODUCT AND METHOD FOR MAKING SAME

Filed April 22, 1960

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

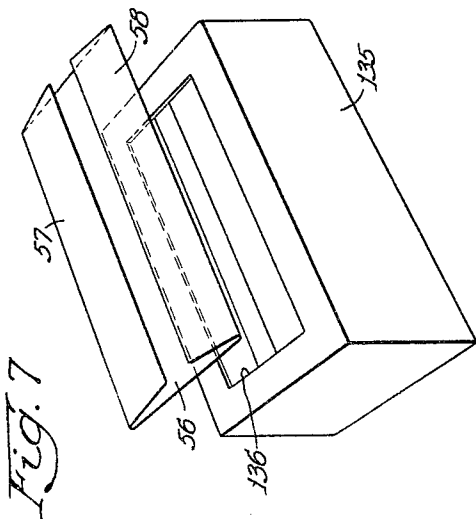
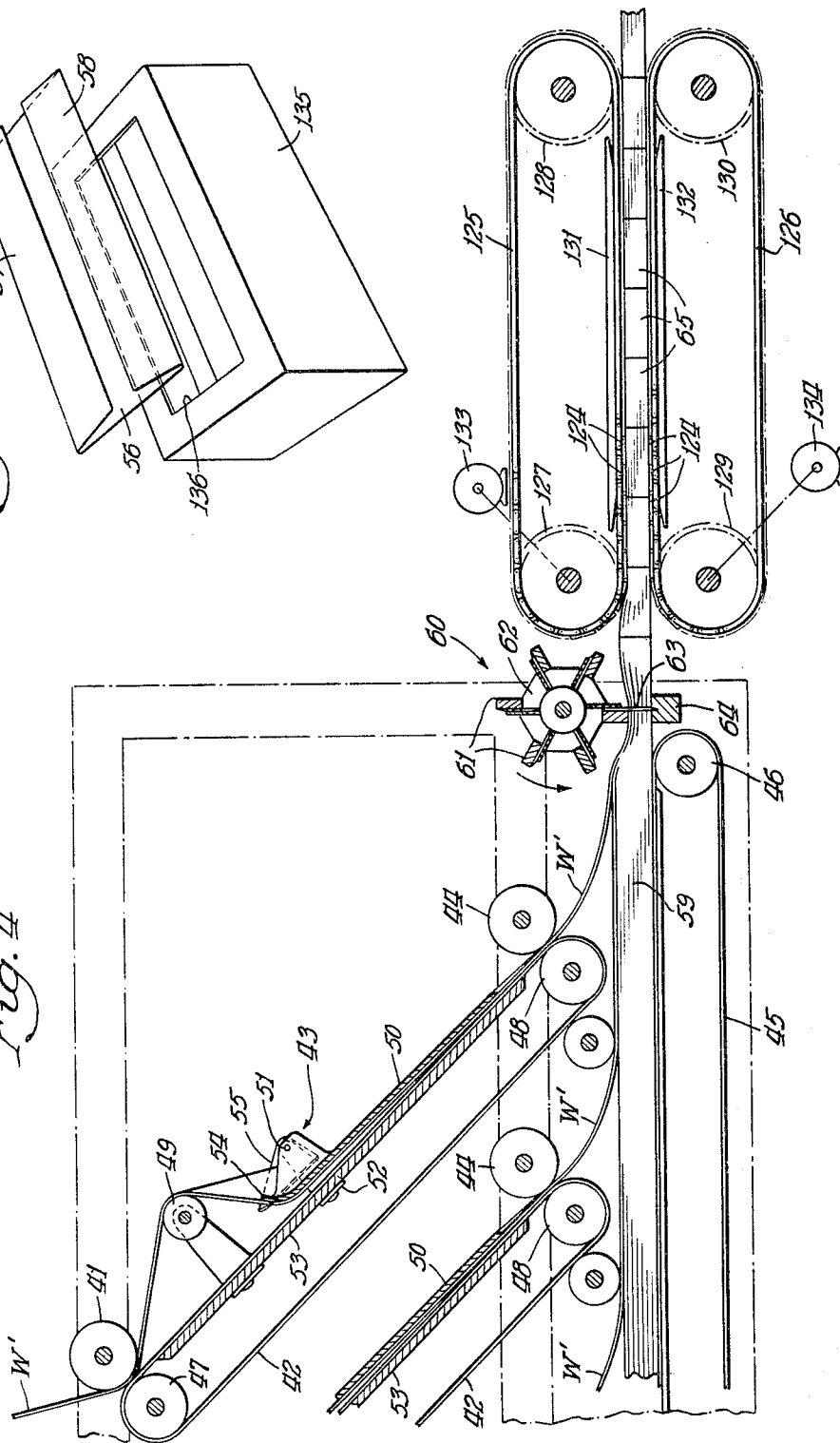
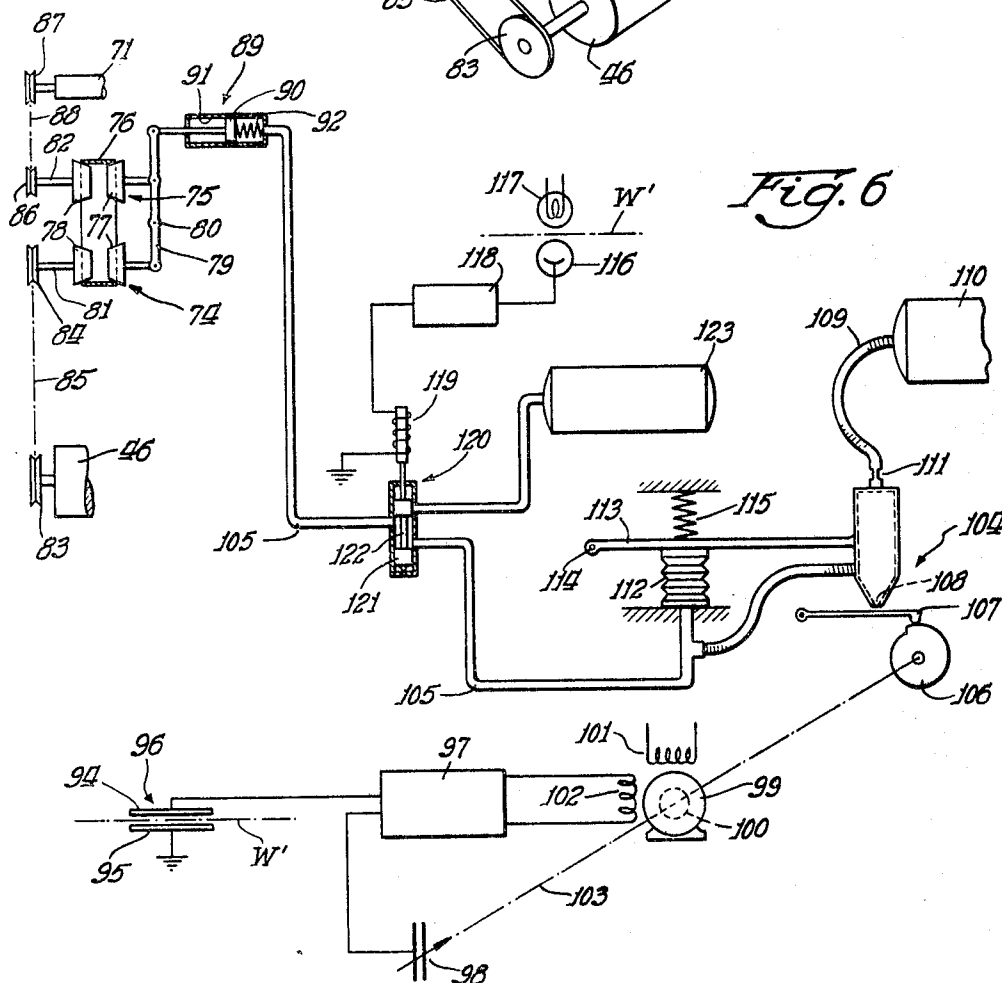
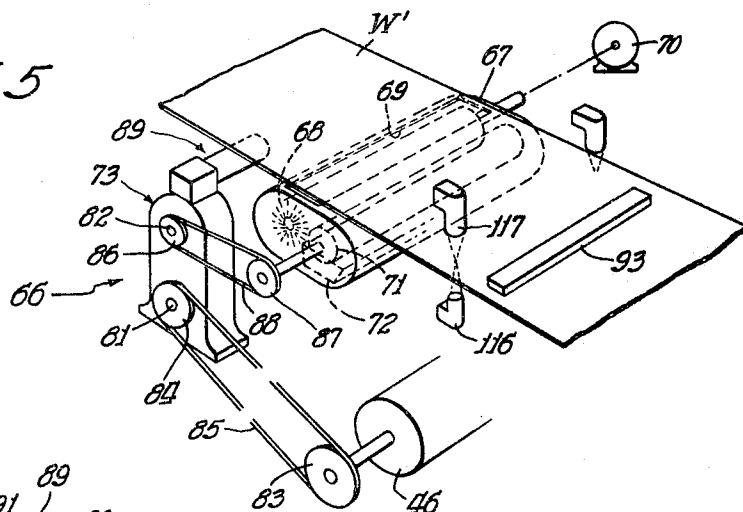


Fig. 4



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3,044,228 CELLULOSIC PRODUCT AND METHOD FOR MAKING SAME

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Filed Apr. 22, 1960, Ser. No. 19,982

4 Claims. (Cl. 53-24)

The invention relates to paper tissues, particularly of the type suitable for facial usage, and to methods of making, converting and packing such tissues.

Facial tissues comprising creped paper sheets of a basis weight (uncreped) of about 6 to 10 pounds per ream (2880 square feet) and usually of two ply construction have in recent years come into widespread usage. Ordinarily, the tissues are boxed in a paperboard dispensing carton, and the tissues are folded in some manner within the carton. The tissues, for example, may each be C-folded, that is, each tissue may have a fold on each edge overlapping a central portion of the tissue. The cartons may be provided with dispensing openings in their tops, and a user reaches through the dispensing opening of a carton in order to grasp one of the tissue folds to withdraw the uppermost tissue through the dispensing opening for usage.

Assuming that the carton is about waist high, with the carton being located on a table, for example, and the user being seated, only the fingers and the fore part of the palm are generally used, if there is not to be undue stretching or contortion on the part of the user, to reach through the dispensing opening of the carton for tissues near the bottom of the carton, so that the height of the carton for such selection of tissues at the carton bottom is limited to about 4 inches. Tissues of facial grade as so C-folded generally have a height of nearly an inch for each 100 single ply tissues or 50 double ply tissues, and therefore the number of tissues available from a carton of the height of 4 inches that allows such easy dispensing is limited to about 400 single ply tissues or 200 double ply tissues.

It is an object of my invention to materially increase the number of tissues that may be packed into a carton of such size that allows easy dispensing; and, more particularly, it is an object of my invention to compress the tissues prior to packaging them in order to obtain this result.

As is disclosed in a co-pending application, Serial No. 111,417 filed on May 9, 1961 by LeRoy Peterson and Kenneth Enloe as joint inventors, improved quality facial tissues are obtained by limiting the moisture content of the tissue, as it is taken from the papermaking machine and is calendered and stretched, to less than about 5 percent, and subsequently adding moisture just prior to winding the tissues into hard rolls, prior to folding and compressing. The pressure that must be applied to a stack of tissues for compressing the stack to a predetermined ultimate height decreases as the moisture content of the tissues increases, so that the compressing mechanism may be less rugged to obtain the same results with high moisture content of the tissues. It has been found, however, that if the moisture content of the tissue is above approximately 6 percent while the tissue is being stored as so called hard rolls, prior to folding of the tissue, that the tissue becomes relatively hard and stiff; and, therefore, it has been proposed in the above mentioned application that the moisture content of the tissue in hard roll form prior to folding and compressing be maintained below 6½ percent.

It is another object of the present invention to provide a mode of adding moisture to the tissue prior to compressing it, that is improved with respect to that disclosed in

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said prior application, so that improved tissue quality for facial uses, particularly improved softness, smoothness and lack of stiffness, is obtained; and, in this connection, it is an object to add sufficient moisture to the tissue so that the tissue has approximately 10 percent moisture content at the time of compression. Preferably, according to my invention, the moisture may be added to the tissue just previous to its being folded, and the compressing and folding are preferably continuous, so that the compressing takes place at the moisture content attained just prior to the folding operation whereby less rugged compressing equipment may be used corresponding to the increased moisture content of 10 percent.

The invention consists of the novel constructions, arrangements, devices and methods to be hereinafter described and claimed for carrying out the above stated objects, and such other objects, as will be apparent from the following description of a preferred mode of practicing the invention, illustrated with reference to the accompanying drawings, wherein:

FIG. 1 is a diagrammatic side view of the terminal end of a papermaking machine;

FIG. 2 is a diagrammatic elevational view of a calendering rewinder for paper produced by the papermaking machine;

FIG. 3 is a diagrammatic side view of a paper folder, cutter and compressor and moisture adding mechanisms for the webs that are folded;

FIG. 4 is a fragmentary side view on an enlarged scale of the folder, cutter and compressor;

FIG. 5 is a perspective view on an enlarged scale of one of the moisture adding mechanisms;

FIG. 6 is a schematic illustration of a control system for the moisture adding mechanism; and

FIG. 7 is a perspective view of a carton packed with the folded tissues produced by the devices illustrated in the previous figures.

Like characters of reference designate like parts in the several views.

Referring now to the drawings, the paper converting apparatus as illustrated includes a conventional Fourdrinier type papermaking machine having a so called Yankee drier drum 10 at the terminal end of the machine. A supporting frame 11 is provided for the drum 10. A shaft 12 extends through the drum, and the drum is rotatably supported by means of bearings 13 for the shaft 12 which are secured to the frame 11. The drum 10 is rotated by a conventional drive mechanism, such as a motor 14, which is drivingly connected to the shaft 12. A heating hood 15 is secured to the frame 11 and extends around the upper portion of the drum 10. Suitable hot air inlets and outlets are provided in the hood for the entry and discharge of the air or other heating medium applied to the hood.

The wet paper web W to be dried is carried by a felt web 16 which travels around felt rolls 17. The paper web is forced against the surface of the drum 10 by a pressure roller 18 which is rotatably mounted in brackets 19 secured to an arm 20. The arm is pivoted to the frame 11, and the pressure roller 18 is forced against the surface of the drum 10 by a hydraulic piston and cylinder assembly 21 that acts against the arm 20.

The paper web W is removed from the surface of the drum 10 by a doctor blade 22 which is held in contact with the surface of the drum 10 by any suitable mounting mechanism. The web W of creped wadding from the drum 10 is wound into a so called "soft roll" 24 formed on a mandrel 25 which is rotatably supported on a standard 26. The mandrel 25 is driven by an suitable driving mechanism, such as a motor 27.

In converting of tissues for cleansing or facial purposes, a so called rewinder 28 is utilized. Tissues are

preferably made of two plies of the creped tissue stock; and, therefore, to provide a two ply web, two rolls 24 are rotatably mounted in the rewinder to permit withdrawal of the respective webs, with one web being superpositioned on the other. The rewinder includes sets of calender rolls 29, 30 and 31, idler rolls 32, and a pair of rolls 33 and 34 adapted to contact a so called "hard roll" 35 of the web W which has passed through the rewinder. The soft rolls 24 are each driven from a suitable prime mover, such as an electric motor 36; and each of the rolls 29, 30 and 31 are respectively driven from other prime movers such as electric motors 37, 38 and 39. The roll 33 is driven by a prime mover, such as an electric motor 40.

The tissue subsequent to being calendered in the rewinder 28 is folded by the mechanism illustrated in FIG. 3. The webs W' are drawn from the hard rolls 35a and pass around rolls 41 on to a plurality of conveyer belts 42 which are provided with means for folding the webs W' indicated generally by the reference numerals 43. The hard rolls 35a are simply segments of the hard rolls 35 which have been cut into the segments by any suitable means, and the webs W' are the relatively narrow webs from these segments. The webs then pass under rollers 44 on to a main conveyer belt 45 disposed over rolls 46, the various webs being fed serially to the conveyer 45 in accordance with the length of the conveyer 45 and the number of rolls and feeding conveyer belts 42 provided therefor. Each of the conveyer belts 42 passes over pulleys 47 and 48 located opposite the rolls 41 and 44 and is driven by any appropriate driving mechanism at a speed identical with that of the conveyer belt 45.

The web W' from a roll 35a passes between a roller 41 and a belt 42 passing over the pulley 47, then leaves the belt 42 to pass over a roller 49 which is elevated above the belt 42. Under the combined influence of a roller 44 and the adjacent belt 42, the web is then drawn downwardly over a forming plate 50 supported immediately above the upper surface of the belt 42 by means of a rod 51 mounted in brackets 52 upon an inclined plate 53 which serves to support the upper portion of the belt 42.

The forward end 54 of each of the forming plates 50 is curved upwardly to receive the web W' moving downwardly from the associated roller 49. The width of each of the forming plates 50 is made equal to the desired width of the folded tissue. As the web passes over the roller 49 and downwardly under the forming plate 50, the outer edges of the web encounter forming plates 55 of more or less triangular shape, so located with respect to the web that they cause the outer edges of the web to be folded inwardly over the upper surface of the forming plate 50. The plates 55 may conveniently be mounted upon the rod 51, as shown.

The folded web of material then passes downwardly past the end of the forming plate 50 under the roller 44 and on to the moving conveyer belt 45. Each of the webs W' is thus folded by a forming board 50 into C-folded shape having a central portion 56 and two side folds 57 and 58 extending over the central portion 56; and the action of the plurality of folding boards disposed one behind the other is to provide a stack or sausage 59 comprising a plurality of C-folded webs W' disposed one on top of the other.

The tissue stack 59 is cut longitudinally by means of any suitable cutting mechanism such as the guillotine cutter 60 illustrated in FIG. 4. The cutter 60 comprises a plurality of pressure feet 61 mounted on a wheel 62 that is rotated along with the conveyer 45 so that the pressure feet 61 contact the tissue stack 59 one after the other as the conveyer 45 propels the stack 59 forwardly. A cutter knife 63 is disposed on one side of each of the pressure feet 61 and is actuated by any suitable mechanism, so that it moves toward a platen 64 as the associated pressure foot comes opposite the platen 64 for thereby

severing the stack 59 into individual clips 65 of C-folded tissues.

Moisture is applied to each of the webs W', prior to movement of the web over its respective forming board 50, by means of a moisture adding system 66. Each system 66 includes a housing 67 having a rotary brush 68 therein and having a slot 69 in its upper surface beneath the web W'. The brush 68 is driven at a constant speed by any suitable driving mechanism, such as an electric motor 70. A water pick up roll 71 is so positioned in the housing 67 that the bristles of the rotary brush 68 have a running clearance with the roll 71. A water trough 72 is disposed beneath the roll 71. Water is maintained in the trough 72 at a predetermined level by means of any suitable water supply and level controlling mechanism (not shown), the water level being such that the roll 71 has its lower peripheral surface in the pool of water in the trough.

The roll 71 is driven in timed relationship with movement of the web W', as from one of the rolls 46. A variable speed drive mechanism 73 is provided in the drive between the roll 46 and the roll 71. The drive mechanism 73 may be of any suitable type and may comprise a drive pulley 74, a driven pulley 75 and a belt 76 extending around the pulleys 74 and 75. Both of the pulleys 74 and 75 are formed of opposite separable tapered parts 77 and 78, and the belt 76 is of the V type so that its sides match the taper of the parts 77 and 78. The parts 77 are movable axially in unison by means of a lever 79 pivoted at 80 so that one of the parts 77 moves in one direction while the other moves in the opposite direction.

The pulley 74 is mounted on a shaft 81, and the pulley 75 is mounted on a shaft 82. Pulleys 83 and 84 respectively mounted for rotation with the roll 46 and the shaft 81, together with a belt 85, provide a driving connection to the pulley 74 from the roll 46. Pulleys 86 and 87 respectively fixed with respect to the shaft 82 and the roll 71, together with a belt 88, provide a driving connection from the pulley 75 to the roll 71. The lever 79 is actuated by means of an air pressure responsive motor 89 comprising a piston 90 reciprocable in a cylinder 91. A spring 92 is disposed between one end of the cylinder 91 and the piston 90.

The variable speed drive mechanism 73 is controlled by a capacitance responsive head 93 positioned in contact with the paper web W' just as the web leaves its hard roll 35a, subsequent to passage of the web beyond the housing 67. The head 93 comprises a plurality of opposite spaced plates 94 and 95 constituting a condenser 96, with a web W' between the plates of the condenser constituting the dielectric. As will be understood, the capacity between the plates 94 and 95 increases with increases in the moisture in the paper web between the plates 94 and 95. One of the plates 94 is grounded, and the other plate 95 is connected to the inlet end of an amplifier 97. Another condenser 98, which may be termed a reference condenser, is also connected to the inlet end of the amplifier 97. A motor 99, having an armature 100, an energizing winding 101, and a control winding 102, has its winding 102 connected to the output end of the amplifier 97. The armature 100 is connected by shafting 103 with the variable element of the condenser 98, and the arrangement of the motor 99 and the amplifier 97 is such that the armature 100 is rotated in one direction or the other so as to move the variable element of the condenser 98 in such a direction and with such a degree of movement that the capacity of the condenser 98 corresponds with the capacity of the condenser 96. The position of the movable element of the condenser 98 thus corresponds to and is indicative of the capacity of the condenser 96 and thus the degree of moisture that exists in the web W'.

The motor 99 is connected to a pneumatic controller 104 which functions to change the air pressure in a con-

duit 105 connected to the cylinder 91 so as to change the speed ratio through the mechanism 73 in accordance with changes in web moisture. The pneumatic controller 104 comprises a cam 106 that is drivingly connected with the shafting 103 of the motor 99. A follower arm 107 rides on the cam 106 and is adapted to control the air discharged from a nozzle 108 in the end of an air conduit 109 which is connected to a source of air pressure 110. The conduit 109 has a restriction 111 in it, and the conduit 105 is connected to the conduit 109 between the restriction 111 and the nozzle 108. A bellows 112 is connected at one end to the conduit 105 and is fixed from axial movement on this end. The other end of the bellows is fixed to an arm 113 that is pivoted at 114, and a compression spring 115 acts on the arm 113 oppositely to the bellows. The conduits 109 and 105 are flexible in the portions so indicated so as to allow the nozzle 108 to move along with the arm 113 as it follows the cam 106.

Light responsive mechanism is used to detect breaks in the web W' for automatically reducing the speed of the roll 71 when such breaks occur. This mechanism comprises a photo-cell 116 positioned beneath the web W' and an opposite light source 117 positioned above the web W'. The photo-cell 116 is connected by means of a conventional amplifier 118 with an electromagnet 119 that is effective on a valve 120. The valve 120 comprises a piston 121 having a circumferential groove 122 therein which is so disposed that when the electromagnet 119 is de-energized, the valve 120 completes the conduit 105. The valve 120 is connected to a source of air pressure 123; and the valve is so arranged that, when the electromagnet 119 is energized, the source of air pressure 123 is connected to the motor 89 through a portion of the conduit 105.

The tissue subsequent to being cut into the clips 65 is compressed by the mechanism illustrated in FIG. 4 for example. This compressing mechanism comprises a plurality of platens 124 mounted on chains 125 and 126. The chain 125 extends around sprockets 127 and 128, and the chain 126 extends around sprockets 129 and 130. A cam 131 is provided for acting on the chain 125, and a cam 132 is provided for acting on the chain 126. Opposite sprockets, such as the sprockets 127 and 129, are driven by any suitable mechanism, such as by the motors 133 and 134.

The tissue clips 65, subsequent to being compressed by the machine illustrated in FIG. 4, are packed into cartons 135 each of which has an opening 136 in its top. The clips are so placed in the cartons 135 that the folds 57 and 58 are on the top, so that a person may reach through the opening 136 and grasp either of the folds 57 or 58 of the top-most tissue for the purpose of removing it from the carton 135.

In operation, the Fourdrinier papermaking machine functions in the well known manner, carrying the web W on the felt 16 that passes over the rolls 17 and 18. The web W is transferred at the roll 18 on to the drum 10, and the web W is then doctored off the drum 10 by the blade 22 and is wound on to the mandrel 25 for forming the soft roll 24. Steam under pressure is applied to the drier drum 10 for heating the drum so as to partially dry the web W as it passes around the drum 10. The speed of the papermaking machine and the temperature of the drum 10 are so controlled that a predetermined amount of moisture remains in the web W as it leaves the drum at the blade 22. Preferably, the web W shall have a moisture content of less than 4 percent, and the moisture content shall desirably be in the range of 3 to 4 percent, as the web is doctored off the drum 10. The moisture in the web W may be determined by conventional measuring methods, such as by weighing the web prior to complete voiding of moisture from the web, as by heating, and subsequent to such evacuation. It will be understood that the moisture content may be decreased

by increasing the temperature of the drum 10 and/or decreasing the speed of the papermaking machine, while an increase in moisture content may be obtained by decreasing the temperature of the drum 10 and/or increasing the speed of the machine. The blade 22, as with conventional operation, crepes the web W to a certain extent as the web is doctored off the drum 10, and the creping may be on the order of 120 percent, that is, the web is decreased in length by the action of the blade 22 to less than $\frac{1}{2}$ its length when in position on the drum 10. The doctor blade 22 in its action crinkles the web in creping it, producing peaks and valleys in the web, with the peaks being relatively sharp and high compared to the thickness of the paper.

The rewinder 28 may be used with either one, or more of the rolls 24 simultaneously. If two plies are desired in the finished tissue, two of the rolls 24 are used as is illustrated. Web W is drawn from the two rolls 24 and is passed consecutively between the rolls 29, 30 and 31 and is finally wound into the hard roll 35. The pairs of rolls 29, 30 and 31 have a pressure nip between them so as to compress and calender the web as it passes between the rolls. Furthermore, the various rolls in the rewinder 28 which are connected to the motors 36 to 40 are so driven thereby that the web is stretched as it passes through the rewinder, the total stretch being preferably such as to decrease the creping from the 120 percent previously mentioned to about 20 percent. The web has thus been again stretched, practically back into its original length, being only 20 percent shorter as it is wound on the hard roll 35 than its original length. The restretching of the web by the rewinder and the calendering action by the rolls 29, 30 and 31, acting with pressure on the web as it passes between the rolls, have the effect of rendering the tissue quite soft and limp; so that the tissues have these desirable qualities for use as a facial tissue. Incidentally, practically all of the stretching, about 95 percent of it in such a rewinder is preferably done between the soft rolls 24 and the first pressure rolls 29; and the subsequent press rolls 30 and 31 function principally as calender rolls, so that the web is not only soft and limp but in addition has a smooth surface.

The folder illustrated in FIG. 3 functions to provide the stack 59 of C-folded webs W'. Each of the webs W' passes between rolls 41 and 47 and from thence over a roll 49 to the triangular forming plates 55 and the upwardly curved forward ends 54 of the forming plates 50. The forming plates 55 turn over folds 57 and 58 of the web W', and the inclined forward part 54 of the forming board 50 maintains the central portion 56 of the web in flat condition. The web W' in its C-folded form then passes between the rolls 44 and 48 which function to provide a permanent crease in the web at its edges, and the webs W' as so folded run on to the conveyer 45 in the form of the tissue sausage 59.

The cutting mechanism 60 is then effective to cut the stack 59 into the clips 65. The pressure feet 61 contact the sausage 59 at spaced points as the wheel 62 rotates with movement of the stack 59; and whenever a pressure foot 61 is opposite the platen 64, the corresponding knife 63 is moved downwardly to contact the platen 64 and thus cut the web W' into the clips 65.

The moisture adding system for each of the rolls 35a is so set as to add moisture to the web W' from that roll so that it has a moisture content of 4 percent to 12 percent and preferably about 10 percent. The brush 68 is driven at a constant speed by the motor 70, and the brush 68 makes brushing contact with the roll 71 that functions as a metering roll. Water is maintained at a constant level in the trough 72 with the roll 71 dipping into the pool of water, and the brush 68 contacting the roll 71 picks up water from the surface of the roll 71 and throws it through the slot 69 in the housing 67 on to the web W'. The speed of rotation of the roll 71 is varied in order to vary the amount of water picked up by the roll 71 from

the trough 72 and transferred on to the brush 68, thus to vary the rate at which water is thrown by the brush 68 through the slot 69 on to the web W' and to vary the increase of moisture thus provided in the web W' by the system 66. The capacitance head 93 functions as a sensing unit to increase the speed of rotation of the roll 71 if the web W' is too dry thereby increasing the moisture applied to the web to bring its moisture up to the predetermined desired value and functions oppositely to reduce the speed of rotation of the roll 71 for decreasing the amount of water applied to the web W' when the moisture content in the web W' is too high.

The head 93 as above described, includes opposite plates 94 and 95, and if there is too little moisture in the web W', the capacity between the plates is unduly low. The amplifier 97 functions, if the capacity of the condenser 96 is too low, to correspondingly decrease the capacity of the condenser 98 by correspondingly rotating the armature 100 of the motor 99. The rotative position of the movable part of the condenser 98 is, incidentally, indicative of the relative moisture that exists in the web W'. The armature 100 in rotating turns the cam 106 drivingly connected to it correspondingly and opens the nozzle 108 to a greater extent, due to the movement of the lever 107 following the cam 106. Air under pressure is supplied to the conduit 109, and when the nozzle 108 is thus opened to a greater extent, the air pressure in the conduit 109 between the restriction 111 and the nozzle 108 is reduced. The air under pressure in the conduit 105 connected to this portion of the conduit 109 is applied on to the piston 90 in the cylinder 91 for changing the action of the speed changing unit 73, and this reduction of air pressure in the conduit 105 allows the spring 92 to be effective to move the piston 90 to the left as seen in figure.

The bellows 112 which is under the air pressure in the conduit 105 is under these conditions less effective in its action counter balancing the spring 115, so that the spring 115 returns the nozzle in close proximity to the follower 107 with the nozzle 108 and bellows moving with the lever 113 about the pivot 114. Equilibrium is thus effected between the force on the lever 113 due to the spring 115 and the force on the lever due to the bellows 112, maintaining the pressure in the conduit 105 at a certain predetermined lower value corresponding to the rotation of the cam 106.

The solenoid 119 is assumed to be de-energized under the conditions just described, and the conduit 105 is thus complete between the nozzle 108 and the piston 90. The reduction in air pressure in the conduit 105 causes the spring 92 to be effective to move the piston 90 and lever 79, and to move the movable pulley parts 77 in opposite directions to decrease the effective diameter of the pulley 75 and increase the effective diameter of the pulley 74. Assuming that the speeds of the rolls 46 and thus the pulleys 83, 84 and 74 and the drive shaft 81 remain without change; the speeds of the shaft 82, the pulleys 86 and 87, and the roll 71 are thus increased. The roll 71 thus draws more water from the pond within the trough 72, and the brush 68 removes this increased amount of water from roll 71 and throws it onto the web W' so as to increase the moisture in the web W'. Thus, the capacitance sensing head 93, in sensing a decreased amount of moisture in the web W', is effective to increase the speed of the roll 71 through the connecting electrical and pneumatic systems so as to increase the moisture in the web W to make up the deficiency in moisture and return it to a predetermined value.

Conversely, if the moisture in the web W' is too great, the parts of the capacitance sensing head 93 and the electrical and pneumatic control systems controlled by the head 93 function oppositely to reduce the speed of the roll 71 and thereby reduce the amount of water thrown onto the web W' by the brush 68 so as to decrease the

moisture within the web W' to its desired predetermined value.

The function of the photo-cell 116 is to cause a reduction in speed of the water pickup roll 71 if a break in the web W' should occur, so that an unduly great amount of water is not thrown off by the brush 68 under these conditions. If the web W' breaks, the photo-cell 116 is energized, and it is effective through the amplifier 118 to energize the solenoid 119. The solenoid 119, when energized, moves the valve piston 121 so as to connect the source of air pressure 123 with the motor 89 through a part of the conduit 105. The air pressure is thus increased on the piston 90 and moves the piston 90 against the action of the spring 92 so as to increase the effective diameter of the pulley 75 and decrease the effective diameter of the pulley 74. The change speed unit 73 is thus effective to reduce the speed of the roll 71 under these conditions.

The electrical and pneumatic forces of the moisture adding systems for all of the rolls 35a are so set that the brushes 68 spray just sufficient water through the slots 69 to raise the moisture content of the webs W' uniformly and within the range of 4 to 12 percent and preferably to about 10 percent.

The clips 65, after being cut, pass between the platens 124 which are brought together by the cams 131 and 132, so that the clips are compressed to a considerably lower height than before such compression. The clips re-expand to some extent after passing out from between the platens 124, and the tissue clips 65 are then packed into the cartons 135.

The tissue is maintained at a moisture content below 4 percent and preferably between 3 to 4 percent when it is passed through the rewinder 28, since the calendering action of the rewinder 28 squeezes out the web, stiffens it and flattens it if the moisture content of the web is much above this value. Such squeezing, stiffening and flattening would produce a facial tissue which is obviously unsuitable for facial usage. Some of the stiffening action may be due to the fact that undue moisture content of the wadding in and of itself tends to unduly release the creping of the web. Sufficient tension must be maintained on the web in order to obtain a uniform hard roll 35, and this tension also is effective to pull out the creping at high moisture levels of the webs W causing stiffening and flattening. Furthermore, it is quite often necessary to store the hard rolls 35 prior to usage of them in folding the tissue. If the hard rolls have a relatively high moisture content such as in the vicinity of 9 to 10 percent, it has been found that the tissue tends to compress itself particularly at the core during storage, and when so compressed the tissue hardens and stiffens. Therefore, the web W is run through the rewinder 28 and is stored in hard roll form having a relatively low moisture content of 4 percent or below. At this moisture content, the rewinder functions as intended, namely, to smooth the tissue and render it soft and limp; and the tissue remains in this condition when stored in hard rolls with this moisture content.

I have found that improved quality tissues are obtained if, at compression, the tissue moisture content is relatively high, in the range of 4 percent to 12 percent and preferably about 10 percent. Since such a high moisture content would be undesirable in the tissue during calendering by the rewinder 28 and storage in the form of the hard rolls 35; according to the invention, the moisture is added to the web to raise it to about 10 percent moisture content as the tissue is drawn from the hard rolls 35a. The steps of folding, cutting and compressing the tissue is a continuous process, and therefore the compression is performed on the tissue at this moisture content. Compressing the tissues at this relatively high moisture content allows relatively low pressures and light and relatively cheap compressing machinery to be used. The tissues have better quality when compressed at the high

moisture content, as distinguished from the results at compression at relatively low moisture contents, particularly in having more smoothness recovered by the compressing (due to more of the crepe being pressed out); and, at the same time, there is less sheet stiffness. The sheet is limper due to being calendered at low moisture levels; and, when compression takes place, the sheet is limper as a final product. As an additional advantage, I have found that there is less subsequent growth in height of the tissue clips 65 when they are compressed at relatively high moisture contents as compared to low moisture contents. Therefore, there is much less likelihood that, when the tissue clips are packed into the cartons 135, they will eventually crowd the cartons.

As an example of the magnitudes contemplated, if the clips 65 are made of 800 tissues or 400 two-ply tissues, they may be compressed to fit into a carton that is 4 inches high. The clips may initially, subsequent to cutting, have a height of 7 inches and the compressor as shown in FIG. 4 may be set to compress the clips to a height of 2 inches to 2½ inches at 20 to 100 pounds per square inch, with the web having a 10 percent moisture content. After the platens 131 move out of forceful contact with the clips 65, the clips re-expand to some extent, to 3¾ inches, for example, which is a reduced clip height allowing the clips to fit loosely in the 4 inches cartons 135 with a slight clearance. The clips continue to expand to a slight extent but not sufficiently so that the clips will bulge the cartons or cause dispensing troubles.

The tissues as illustrated in FIG. 7 are C-folded, that is, two folds 57 and 58 have been brought over the main part 56 of each tissue. In order to obtain the individual tissues for use from a carton 135, a person reaches through the opening 136 to grasp one of the folds 57 and 58. The maximum distance an ordinary person may comfortably extract a tissue through an opening 136 in the top of the carton 135 is about 4 inches, assuming the user is in a sitting posture and the carton is on an adjacent table about waist high, in view of the fact that under such conditions the user does not insert his arm or even his full hand through the opening 136 but only uses his fingers and the fore part of his palm in extracting the tissues. Compressing C-folded tissues so as to reduce the clip height to less than 4 inches from about an 8 inches initial uncompressed height allows the user to have approximately 400 extra tissues or 200 double ply tissues for usage out of the same carton without necessitating the use of a carton which is substantially twice as high (8 inches for 800 tissues or 400 two ply tissues) which would not allow a person to extract the lowermost tissues toward the bottom of the carton in the manner above described due to excessive carton height.

The invention thus contemplates a carton containing a compressed stack of C-folded tissues which has a considerably greater number of individual tissues than would be possible to pack within the same size carton if the tissues were uncompressed. A practical depth of such a carton is about 4 inches beyond which the height becomes impractical for reaching into the carton to pull out tissues near the bottom of the carton. The C-folded tissues naturally dispense from such a carton by reaching into the carton, as distinguished from interfolded tissues each of which is automatically pulled to partially protrude through a top opening in the carton by the prior tissue. Five hundred to 800 sheet packages of tissues are considered very desirable in comparison with present packages of uncompressed tissues in 4 inch high cartons which contain only 400 tissues. Larger numbers of tissues in cartons obviously have the advantage that they require fewer purchases and have a price advantage for the purchaser. Five hundred to 800 sheet packages of uncompressed tissues are not practical with C-folded tissues since the package would be so deep that it would be very inconvenient to remove the tissues.

However, if according to the invention the stacked clips of tissues are compressed to a package height of approximately ½ the uncompressed height, these counts become practical. For a 4 inch high carton, which is considered to have a maximum practical depth for easy dispensing, 800 compressed tissues may be packed within the carton, requiring only 3¾ inches. Correspondingly, 500 compressed tissues would require only 2¾ inches, and 600 compressed tissues would require only 2½ inches. Corresponding carton sizes would be respectively 2½ inches and 3 inches, allowing a slight clearance between the top of the tissue clips and the top of the carton. Compressing, according to the invention, makes it possible to give the consumer a lower price and the increased convenience of a package with an increased number of sheets. At the same time, the quality of the compressed tissues is higher, as has been pointed out.

I wish it to be understood that the invention is not to be limited to the specific constructions, arrangements, devices and methods above described, except only insofar as the claims may be so limited, as it will be apparent to those skilled in the art that changes may be made without departing from the principles of the invention. In particular, it will be apparent that other modes of compressing the tissues may be utilized, such as by means of hydraulic presses or rotating rolls between which the tissues may be passed. It will also be apparent that other modes of applying moisture may be utilized prior to the folding operation, such as by utilizing humidified air steam showers on the webs W'.

Other conventional modes of compressing that might be utilized also include the use of banding or baling devices. It will also be apparent that folding devices other than the type illustrated in FIG. 3 might be utilized. The invention contemplates that preferably moisture be added subsequent to storing the tissue in hard roll form and before compressing. It is not necessary that the tissue be cut into clips prior to the compressing step, and the cutting may be done subsequently by locating the cutter 60 behind the compressing device, if desired. Although a specific type of moisture sensing device 93 is described in connection with the specific type of moisture adding mechanism, it will be apparent that other conventional moisture sensing devices in connection with other conventional moisture adding mechanisms may be used if desired.

I claim:

1. In a method of making paper tissue, the steps which comprise, removing paper tissue from the drier drum of a papermaking machine with the paper tissue having a relatively low moisture content of about four percent or less, calendering the tissue and winding it into a roll at this relatively low moisture content, unwinding the tissue from the roll and folding it into a stack and thereafter compressing the tissue stack, and adding moisture to the tissue subsequent to its unwinding and prior to its compression.

2. In a method of making paper tissue, the steps which comprise, removing paper tissue from the drier drum of a papermaking machine with the paper tissue having a moisture content of 3 to 4 percent, calendering the tissue and winding it into a roll at this moisture content, unwinding the tissue from the roll and folding it into a stack and thereafter compressing the tissue stack, and adding moisture to the tissue subsequent to its unwinding and prior to its compression to bring the moisture content of the tissue in the range of 4 to 12 percent.

3. In a method of making paper tissue, the steps which comprise, creping paper tissue from the drier drum of a papermaking machine with the paper tissue having a moisture content of 4 percent or below, calendering and stretching the creped tissue so as to remove some of the creping and thereafter winding the tissue into a roll, unwinding the tissue from the roll and folding it into a stack and thereafter compressing the tissue stack, and

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adding moisture to the tissue subsequent to its unwinding and prior to its compression to bring the moisture content of the tissue into a range of 4 percent to 12 percent.

4. In a method of making paper tissues, the steps which comprise, creping paper tissue from the drier drum of a papermaking machine with the moisture content of the tissue being 4 percent or below, calendering and stretching the creped tissue so as to remove some of the creping and winding it into a roll at this moisture content, unwinding the roll and applying moisture to the tissue as it is unwound to bring its moisture content in the range of 4 percent to 12 percent, thereafter folding the tissues into a stack and compressing the stack to sub-

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stantially reduce the height of the tissue stack and cutting the tissue stack into tissue clips.

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