Nov. 11, 1969 C. T. BANKS 3,477,658

PAPERMAKING METHOD AND APPARATUS

Filed Aug. 2, 1967 2 Sheets-Sheet 1

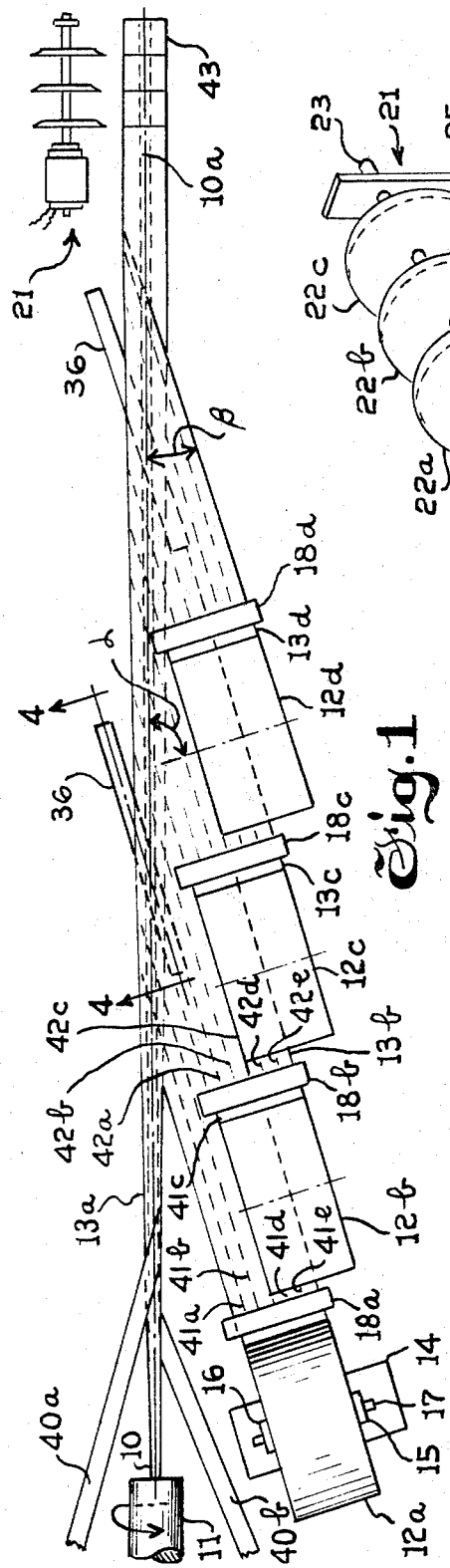

Fig. 1

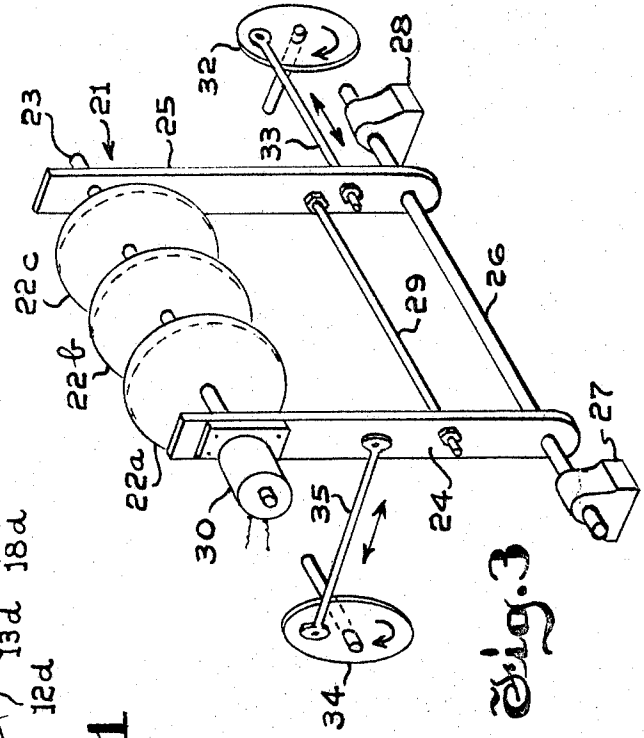

Fig. 3

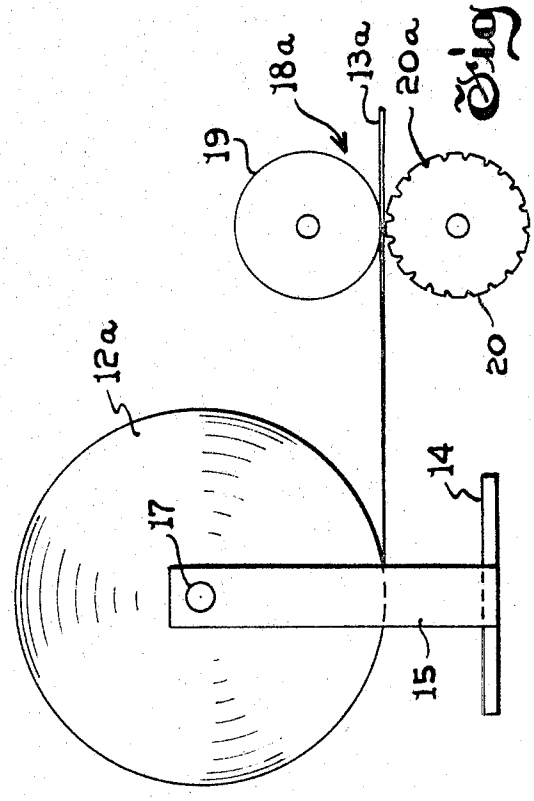

Fig. 2

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PAPERMAKING METHOD AND APPARATUS

Filed Aug. 2, 1967 2 Sheets-Sheet 2

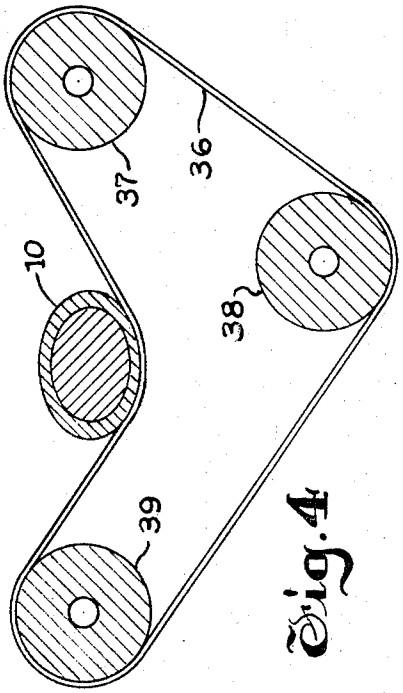

Fig. 4

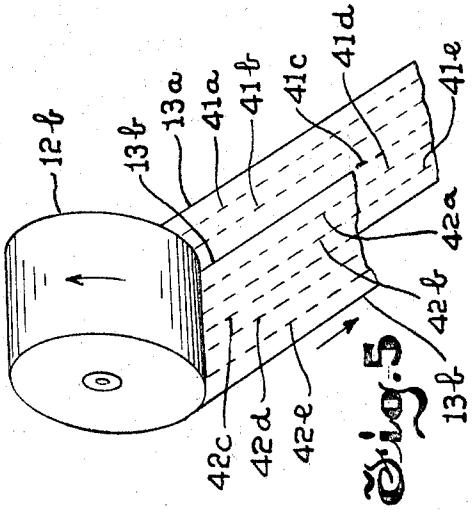

Fig. 5

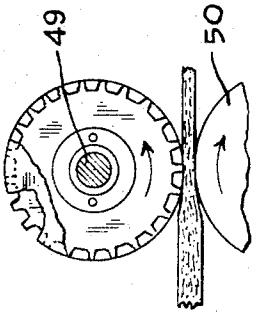

Fig. 8

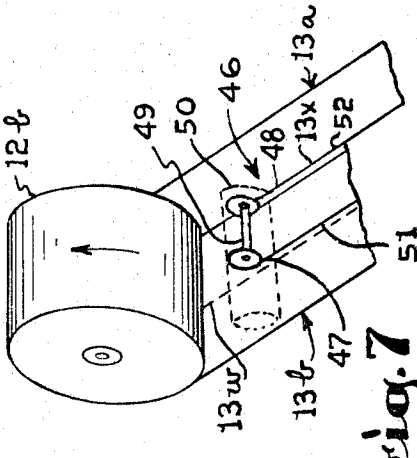

Fig. 7

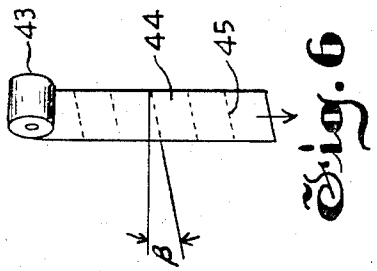

Fig. 6

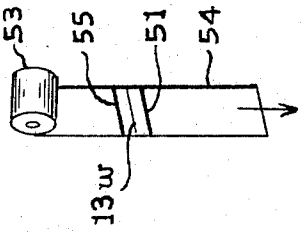

Fig. 9

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3,477,658

PAPERMAKING METHOD AND APPARATUS

Charles T. Banks, Neenah, Wis., assignor to Kimberly-Clark Corporation, Neenah, Wis., a corporation of Delaware

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Int. Cl. B65h 19/20
U.S. Cl. 242—56 18 Claims

ABSTRACT OF THE DISCLOSURE

A winding apparatus for producing a roll of two-ply sheet material comprising an elongate mandrel, a series of supply rolls of single ply sheet material positioned so that the sheet material winds onto the mandrel at a relatively small acute angle measured from the axis of the mandrel with the web from each of the rolls partially overlapping the web from an adjacent roll, a perforator for perforating each of the webs with longitudinal perforate lines with the perforators and supply rolls being so disposed that side edges and lines of perforation of successive webs wound onto the mandrel are in register, and a cutter for cutting off segments of the sheet material as so wound on the mandrel. A pair of embossing discs may be substituted for each perforator.

My invention relates to apparatus for winding paper. More particularly, the invention relates to winding apparatus for producing rolls of the two-ply sheet material in which the plies have perforation lines in register so that sheets of two-ply material may be readily detached from a completed roll.

It has previously been a common practice in producing rolls of toilet tissue or toweling to wind on to a core a wide width of web which is perforated on lines running at 90° to the length of the web, with the web traveling directly to the core at 90° with respect to the longitudinal center of the core. After a desired diameter of toweling or tissue has been so wound onto a core, winding is discontinued and the long cylindrical length of wound paper is cut into segments so as to produce individual relatively short consumer length rolls. The toweling and tissue is preferably so wound in two plies, and the transverse perforation lines of the two plies are in register so that two-ply sheets of the toweling or tissue may be detached individually from a completed relatively short length roll.

It is an object of the present invention to provide an improved method and apparatus for continuously winding a series of sheet material webs on a mandrel so that a cylinder of the wound material travels off the mandrel for cutting into consumer length rolls. It is contemplated that the webs shall be so perforated and so laterally positioned in overlapping relation that the consumer length rolls may have sheets of two-ply product detachable individually from them; and, in lieu of the perforating it is contemplated that the webs may be embossed together in their overlapping portions so that the consumer length rolls may be unwound as a two-ply continuous web.

Briefly, the invention contemplates in a preferred form the winding of single ply webs of paper or other sheet material onto a mandrel with the webs extending at a small acute angle to the axis of the mandrel and with consecutive webs partially overlapping so as to provide a cylinder of wound paper traveling longitudinally off the end of the mandrel. The individual webs are perforated on longitudinal lines as they travel onto the mandrel, and the perforations and side edges of consecutive webs are in register. The completed cylinder of paper is sawed off the mandrel into short lengths; and, due to the registry of the perforation lines of consecutive webs, the individual relatively short length roll segments so provided may be unwound as a two-ply product, with the perforations providing individual sheets of two-ply product that may be detached from the remainder of the roll.

The invention consists of the novel methods and constructions 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 form of the invention, reference being made to the accompanying drawings, wherein:

FIG. 1 is a plan view of a winding apparatus embodying the principles of the invention and including a plurality of web supply rolls from which web is wound onto a mandrel, perforating slitter mechanisms for the individual webs, and a cut-off saw for cutting off the wound paper from the mandrel into relatively short consumer length segments;

FIG. 2 is a side elevational view of the slitter mechanism for one of the webs;

FIG. 3 is a perspective view of the cut-off saw;

FIG. 4 is a sectional view taken on line 4—4 of FIG. 1;

FIG. 5 is a perspective view of two of the webs unwinding from their supply rolls as they travel onto the mandrel;

FIG. 6 is a perspective view of one of the relatively short consumer length rolls being unwound;

FIG. 7 is a view similar to FIG. 5 showing a modification of the invention in which embossing apparatus is substituted for one of the slitter mechanisms;

FIG. 8 is a side elevational view of the embossing apparatus; and

FIG. 9 is a view similar to FIG. 6 with the short consumer length roll being produced by the apparatus shown in FIG. 7.

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

Referring now to the drawings and to FIG. 1 in particular, the illustrated winding apparatus may be seen to comprise a rotary shaft or mandrel **10** which is connected to and is driven by a rotary arbor **11**. A series of paper rolls **12***a*, **12***b*, **12***c*, **12***d*, etc., are located at one side of the rotary shaft **10**, and the axis of each of these rolls is at an angle α measured from the longitudinal center of the shaft **10** looking in a direction normal to the axes of the rolls **12***a*, **12***b*, etc., and normal to the axis of the shaft **10**. The angle α is somewhat less than a right angle, such as 65° or 75°, for example. Paper webs **13***a*, **13***b*, **13***c*, **13***d*, etc., are respectively supplied from the rolls **12***a*, **12***b*, **12***c*, **12***d*, etc.; and, as the shaft **10** is rotated, the webs wind onto the shaft **10** and on each other at an angle β measured from the logitudinal center of the shaft **10** in the same manner as the angle α. The angle β is complementary to the angle α and may thus be about 15° or 25°.

Each of the rolls **12***a*, **12***b*, etc., is suitably supported, such as by means of a standard **14** having spaced upwardly extending pedestals **15** and **16** receiving between them an axle **17** extending through the center of the paper roll.

Gang slitters **18***a*, **18***b*, etc., are provided respectively for the webs **13***a*, **13***b*, etc. Referring to FIG. 2 showing a side elevational view of the slitter **18***a*, each of the gang slitters comprises a hard surfaced rotary drum **19** and a series of spaced slitter wheels **20** located directly below the drum **19** and each having a pressure nip with the drum **19**, Each slitter wheel **20** has a plurality of spaced notches **20***a* in its periphery and otherwise each slitter wheel is sharpened to a knife edge on its periphery.

The winding apparatus operates to produce a continuous roll of paper at the end **10***a* of the shaft **10**, and this continuous roll is sliced into segments by means of a traveling cut-off saw **21**. Referring to FIG. 3, the saw **21** comprises a series of spaced peripherally sharpened cutter

wheels 22*a*, 22*b* and 22*c* each fixed on a shaft 23 which is rotatably disposed in a pair of swing arms 24 and 25. A shaft 26 extends between and is supported by suitable pedestals 27 and 28, and the shaft 26 extends through the arms 24 and 25 so that these arms may swing about the shaft 26. The arms 24 and 25 are tied together by any suitable means such as a tie bar 29, and an electric motor 30 is fixed onto the swing arm 24 and has its armature connected to the shaft 23 for driving the shaft 23 and the cutter wheels 22*a*, 22*b* and 22*c*.

The swing arms 24 and 25 as held together by means of the tie bar 29 constitute a carriage 31 the parts of which move together, and this carriage is reciprocated along the shaft 26 by any suitable means such as an eccentric 32 connected by means of a tie rod 33 with the carriage 31. The carriage 31 is swung about the shaft 26 by any suitable means, such as an eccentric 34 connected by means of a tie rod 35 with the swing arm 24.

The shaft 10 may be extremely long, and it should therefore be supported at a number of places between its end 10*a* and the arbor 11. The shaft 10 may be supported at each of these places by means of a supporting belt 36 (see FIG. 4) extending around rolls 37, 38 and 39 which are rotatably disposed on fixed axes by means of any suitable supporting structure (not shown). Preferably, one of these rolls of each set of the rolls is driven to provide a source of power for winding the paper webs 13*a*, 13*b*, etc., on the mandrel 10 and on each other.

In operation, as the shaft 10 and belts 36 are driven, a pair of strips 40*a* and 40*b* of relatively thick core paper are wound initially onto the core 10 adjacent the arbor 11. The edges of the strips 40*a* and 40*b* abut and together produce a continuous cylindrical core of the relatively thick core paper on the peripheral surface of the mandrel 10. The web 13*a* from the paper roll 12*a* is wound onto the external surface of the core produced by the strips 40*a* and 40*b*; and, as the web 13*a* unwinds from the roll 12*a*, it passes through the gang slitter 18*a*. Each of the wheels 20 of the slitter 18*a* produces a longitudinal slit in the web 13*a* to thus provide spaced slits 41*a*, 41*b*, 41*c*, 41*d* and 41*e* in the web 13*a*. Since each of the wheels 20 is provided with spaced notches in its periphery, these slits are not continuous but have spaced paper bonds separating the cut portions of the slits, so that the slits in reality constitute perforation lines.

The web 13*a* is wound onto the mandrel 10 so that the edges of its convolutions abut and so that the web 13*a* forms a continuous cylinder to the end 10*a* of the mandrel. The web 13*b* from the roll 12*b* is wound on top of the web 13*a* as the mandrel 10 rotates, and the convolutions of the web 13*b* likewise abut. The web 13*b* is perforated in slits 42*a*, 42*b*, 42*c*, 42*d* and 42*e*, and the roll 12*b* is so positioned axially with respect to the roll 12*a* that the web 13*b* partially overlaps the web 13*a*. One end of the roll 12*b* is in exact alignment with the slit 41*c* and the subsequent slits 42*a*, 42*b* and 42*c* are respectively in exact alignment with the slits 41*d*, 41*e* and an edge of the web 13*a*, as is shown in FIG. 5 illustrating the overlap of the webs 13*a* and 13*b*. Subsequent webs 13*c*, 13*d*, etc. from subsequent paper rolls 12*c*, 12*d*, etc., each partially overlap the web from the previous roll in the same manner, and each of the slits in these webs 13*c*, 13*d*, etc., is in an exact alignment with a slit or with the web edge of either the previous web or the subsequent web.

As the mandrel 10 rotates, the continuous roll of paper from the webs 13*a*, 13*b*, etc., winding onto the mandrel 10 and onto each other builds up in conical shape along the length of the mandrel 10 until the end 10*a* of the mandrel 10 is reached. The rolled paper is then in the shape of a cylinder, and it moves off the mandrel end 10*a* in this shape, since the core strips 40*a* and 40*b*, as well as the paper webs 13*a*, 13*b*, etc., are wound in a helix onto the mandrel 10. The cylindrical roll of paper is then cut into segments by means of the saw 21 so as to provide the individual paper rolls 43 (see FIG. 6) which are segments of the cylindrical paper roll which has been built up on the mandrel 10. The cutter wheels 22*a*, 22*b* and 22*c* are continuously driven from the motor 30, and the eccentrics 32 and 34 are constantly rotated so that the wheels 22*a*, 22*b* and 22*c* are moved through the cylindrical paper roll as the roll travels off the mandrel end 10*a*. Due to the eccentric 32, the cutter wheels 22*a*, 22*b* and 22*c* have the same axial speed during their cutting action as the paper cylinder moving off the mandrel end 10*a*, and the eccentric 34 swings the carriage 31 out of cutting position to bring the cutters 22*a* to 22*c* out of cutting relationship with the paper when the eccentric 32 is effective to move the carriage 31 back again to an original cutting position closer to the mandrel end 10*a*.

The last paper roll (not shown) in the series of paper rolls 12*a*, 12*b*, 12*c*, etc., is preferably of half the width of the other paper rolls, so that the paper web that is unwound from this last roll is completely in overlying relationship with a lateral portion of the preceding web. The longitudinal slits 42*a*, 42*b* and 42*c* are in exact alignment with the slits 41*d* and 41*e* and the side edge of the previous web 13*a*, and the same relationship exists between each subsequent web and the preceding web; therefore, this method of winding produces a two-ply tissue web 44 off the roll segment 43 having transverse perforations 45 which extend at the angle β with respect to a side edge of the web 44 and which are in exact register in the two plies so that individual two-ply segments of the web 44 may be easily detached.

The apparatus and method for making individual rolls of transversely perforated paper as above described is particularly suitable for making toweling or toilet tissue, both of which are basically tissue paper which has been creped off the heated drier drum of the papermaking machine so that it has a substantial stretch. This stretching quality of the paper assures that the paper webs wind smoothly onto the mandrel 10 with the wound paper on the mandrel being in the form of an elongated cone to the end 10*a* of the mandrel 10 and being in cylindrical form beyond the end of the mandrel 10.

The supply rolls 12*a*, 12*b*, 12*c*, etc. may, of course, vary considerably in axial length; however, supply rolls between four feet in length and ten feet in length may well be used. The distances in a finished roll 43 between the slits or perforations 45 may, of course, be varied as desired, and the axial length of a finished roll 43 may well be varied; however, if it is desired to make toilet tissue rolls of 4½ inches in axial length, for example, with the distance between the transverse slits 45 also 4½ inches, rolls 12*a*, 12*b*, etc., approximately ten feet in length would in this case, have about 25 of the perforate slits 41*a*, 41*b*, etc., for the complete axial length of the roll in lieu of only the five slits 41*a*, 41*b*, 41*c*, 41*d* and 41*e* that are illustrated for the roll 12*a*, for example. Assuming that toilet tissue rolls of 500 two-ply sheets are desired from the apparatus; in this case, the length of the shaft 10 would be somewhat more than 200 feet, with the angle β being 25°. The angle β can also be varied within wide limits, such as 10° to 45°, for example, and 25° is a suitable comprise with which the perforation lines 45 extend nearly directly across the finished web 44.

A plurality of belts 36 should preferably be used, spaced every five or ten feet apart and underlying the mandrel and the paper thereon along the length of the mandrel 10 for supporting the weight of the mandrel and paper. Power is preferably applied to all of the belts 36 by drivingly rotating one of the rolls 37, 38 or 39 for the particular belt; and, in fact, all of the power for winding the paper may be derived from the belts 36, and the mandrel 10 may be stationary. Since the belts 36 extend in the same direction as the webs 13*a*, 13*b*, 13*c*, etc., with respect to the axis of the mandrel 10, namely, at the angle β with respect to the mandrel axis, each of the belts 36 drives the particular web 13*a*, 13*b*, 13*c*, etc., with which it is in contact in the longitudinal direction of movement of the particular web. Whether or not the mandrel 10 is driven, it will be understood that the paper webs

after being wound on the mandrel **10** travel longitudinally of the mandrel; and, in order to facilitate this longitudinal movement of the webs on the mandrel **10**, the core paper strips **40***a* and **40***b* may be suitably lubricated, as for example, by applying a small amount of oil constantly onto the strips or by applying a suitable powder, such as lycopodium powder, onto the surfaces of the strips **40***a* and **40***b* which make direct contact with the mandrel **10**.

Particularly in the case in which the mandrel **10** is stationary, the mandrel **10** may be undercut, that is, reduced somewhat in diameter toward its end **10***a*, in order to reduce the friction of the core strips **40***a* and **40***b* on the surface of the mandrel. The belts **36** closer to the end **10***a* of the mandrel may also be run at slightly slower speeds than the belts **36** closer to the arbor **11** so as to reduce the binding effect on the mandrel **10** by the core strips **40***a* and **40***b*, particularly in the case in which the mandrel **10** is stationary. It will be also understood, of course, that power may be applied to the individual webs **13***a*, **13***b*, **13***c*, etc., prior to the webs completing their travel to the mandrel **10**, such as by applying power onto the rolls **12***a*, **12***b*, **12***c*, etc., tending to unwind the webs from the rolls.

In view of the fact that the last web supply roll of the series **12***a*, **12***b*, **12***c*, etc., has one end in register with a side edge of the web from the preceding supply roll, the end of a two-ply composite web is on the outer face of a completed roll **43**, and continued unrolling of the roll **43** is with a continuous two-ply web until the roll **43** is exhausted. The staggering of the webs **13***a*, **13***b*, **13***c*, etc., assures that the two-ply web **44** as it is unwound from the roll **43** is continuous, and in particular, although the side edges of the various webs **13***a*, **13***b*, **13***c*, etc., are coincident with certain of the transverse perforation lines **45** in the web **44**, the connecting bonds of the particular perforations assure that the two-ply web **44** as withdrawn from the roll **43** is continuous.

Paper of the type that is, in particular, contemplated for use with the present invention is toilet tissue, which is a creped tissue having a drier basis weight (single ply, in uncreped condition) of 7 to 8 pounds per ream of 2,880 square feet, for example. The tissue is creped off of the steam heated drier drum of the papermaking machine so that it has a crepe ratio of 1.2 to 1.4, for example. The crepe ratio in paper is the length of the paper on the drier drum of the papermaking machine, without creping, divided by the final length of the paper. For example, if paper has a one foot drier length and a final length of ten inches in creped condition, the crepe ratio is 12/10, or 1.2. This type of paper, in particular, also has a very different strength in the machine direction, that is, in the direction in which the paper travels through the Fourdrinier papermaking machine, over the steam heated drier drum of the machine and in which it is wound in rolls such as, for example, into the rolls **12***a*, **12***b*, **12***c*, etc., as compared to the strength of the paper in the transverse or cross machine direction. Paper of this type may, for example, be able to withstand 10.4 ounces per inch per ply before breakage in the machine direction or longitudinally of the web while it is only able to withstand 2.4 ounces per inch per ply in the cross machine direction before breakage. The ratio of the machine direction strength to the cross machine direction strength thus is 10.4/2.4 or about 4 to 1.

As is apparent from the description of the winding apparatus, the perforations **45** of the finished web **44** are provided by the longitudinal slits **41***a*, **41***b*, etc., as well as by the side edges of the individual webs **13***b*, **13***c*, etc. These slits **45** thus extend exactly in the machine direction (although they extend at the small angle β with respect to the longitudinal direction of the two-ply web **44** as it is unwound from the consumer length roll **43**); and, therefore, the paper bonds provided by the spaced notches **20***a* in the slitter wheels **20** are very easily broken so that, in usage, it is very easy to separate the individual sheets defined by the perforations **45** from the remainder of the roll **43**. As will be understood, the force applied by the user tending to separate the individual sheets from the roll **43** is applied substantially in the cross machine direction of the tissue paper used in the roll **43**, this being the direction in which the paper is particularly weak; and, therefore, the bonds easily break. Consumer length toilet tissue rolls as produced by conventional apparatus and methods have the tissue paper unwinding from the roll in the machine direction (as the paper is produced on the papermaking machines). Therefore, greater force must be utilized in detaching the individual sheets from conventionally made toilet tissue rolls due to this fact; and in addition, the paper is more likely to shred longitudinally due to the greater strength in the paper bonds separating the individual sheets of ordinary tissue when the tissue is made conventionally. The fact that the transverse perforations **45** in the finished web **44** extend in the machine direction of the paper, thus, is advantageous.

The fact that the tissue paper tears so much more easily in the cross machine direction than in the machine direction may also be utilized for providing consumer length rolls of toilet tissue or paper toweling in which there are no transverse perforations, but instead the easy separability of the webs in the cross machine direction or in the longitudinal direction as the paper is disposed on the consumer length rolls according to the invention may be relied on so that individual pieces of paper may easily be torn from the remainder of the roll of paper as desired.

In this case the gang slitters **18***a*, **18***b*, etc., are dispensed with, and each of these slitters is replaced by an embossing device **46** (see FIGS. 7 and 8). Each of the embossing devices **46** comprises two identical embossing wheels **47** and **48** which are rotatably mounted and are axially fixed on a fixed cross shaft **49** supported by any suitable framework (not shown). The embossing wheels **47** and **48** and shaft **49** are all disposed above a pair of webs, such as the webs **13***a* and **13***b*, that proceed from the supply rolls **12***a* and **12***b*, as shown in FIG. 7, with the embossing wheels both being effective on the upper surface of one-half of the web **13***b*. The wheel **47** is located quite close to a side edge **13***w* of the web **13***a*, and the embossing wheel **48** is located quite close to the side edge **13***x* of the web **13***b*. A relatively long roll **50** is disposed beneath the embossing wheels **47** and **48**, and the peripheries of the wheels **47** and **48** are spaced only slightly with respect to the surface of the roll **50**, so that as the webs **13***a* and **13***b* travel from the rolls **12***a* and **12***b* onto the mandrel **10**, the wheels **47** and **48** provide embossed lines **51** and **52** in the webs **13***a* and **13***b* that are quite close to the edges **13***x* and **13***w*, respectively, of the prior web **13***a* and of the subsequent web **13***b*. The embossed lines **51** and **52** effectively connect and fasten the webs **13***a* and **13***b* together transversely of the webs.

The particular type of embossing wheels **47** and **48** that are utilized is not particularly important as long as they provide embossed lines extending longitudinally of the webs and are effective to bond the webs together along the lines of embossment. Embossing wheels of the type shown in Nobbe U.S. Patent 3,074,324, dated Jan. 22, 1963, may be effectively utilized; and this patent may therefore be referred to for details of the embossing wheels.

A consumer length roll **53** of tissue produced utilizing an embossing apparatus **46** substituted for each of the perforating devices **18***a*, **18***b*, etc., is illustrated in FIG. 9; and, as will be observed, the web **54** from the roll **53** is continuous as the web is pulled from a roll **43** as during usage. The web **54** is a two-ply web, as is the web **44**. The machine direction of the paper, which is that direction in which the paper is produced on the papermaking machine and as it is rolled into the rolls **12***a*, **12***b*, etc., extends transversely of the web **54**, being only at a small angle equivalent to the angle β illustrated in FIG. 6, with

respect to the exact transverse dimension of the web **54** as it comes from the roll **53**. Both plies of the web **54** are continuous as drawn from the roll **53** except in the places where the longitudinal side edges, **13***w* and **13***x* for example, exist; and, at these places in the web **54**, as at the side edge **13***w*, there exist two lines of embossing, such as lines **51** and **55** (see FIG. 9), which assure that the web **54** remains a two-ply web and that the plies do not separate. In view of the fact that the machine direction of the tissue is nearly transverse of the web **54**, individual pieces of the two-ply web **54** may be easily broken and torn away from the remaining web on the roll **53**, and perforating may be dispensed with. As will be quite apparent, this would be very difficult if the machine direction strength of the paper were in the longitudinal direction of the web **54**; since, under these conditions, the web **54** would tend to shred lengthwise.

Although I have specifically mentioned tissue webs which have a very substantial difference of about 4 to 1 between the strengths in the machine direction and in the cross machine direction, I find that improved results are obtained if less than this difference exists in the strengths in the machine direction and cross machine direction. Satisfactory and easy disassociation of the individual pieces of the tissue webs, both with and without perforating, is obtained if the machine direction strength of the paper is substantially more than the cross machine direction strength of the paper, such as 2 to 1.

What is claimed is:

1. In a method for producing rolls of sheet material which is slit on lines extending transversely of the sheet material as it is unwound from the roll, the steps which comprise, winding along the length of a winding axis at an acute angle with respect to the axis a series of longitudinally slitted sheet material webs with each subsequent web toward the end of the axis overlapping the prior web in the series for a part of the width of the prior web, and cutting off segments of the webs as so wound so as to produce the sheet material rolls.

2. In a method as set forth in claim **1**, the longitudinal slits in said sheet material webs being discontinuous so as to constitute longitudinal perforations in the webs and the longitudinally perforated webs being wound on each other so that a longitudinal perforation and one side edge of each subsequent web in the series of webs is in alignment with a longitudinal perforation and a side edge of the prior web in the series.

3. In a method as set forth in claim **1**, the longitudinal slits in said sheet material webs being discontinuous so as to constitute longitudinal perforations in the webs and the longitudinal perforations being equally spaced with respect to each other, said longitudinally perforated webs being wound on each other so that a plurality of longitudinal perforations and one side edge of each subsequent web in the series of webs is in alignment with a plurality of longitudinal perforations and a side edge of the prior web in the series.

4. In a method for producing rolls of sheet material which is perforated on lines extending transversely of the sheet material as it unwound from the roll, the steps which comprise, perforating on longitudinal lines a plurality of webs of sheet material as the webs are unwound from supply rolls of the webs, winding along the length of a mandrel at an acute angle with respect to the axis of the mandrel a series of the longitudinally perforated sheet material webs drawn from the supply rolls with each subsequent web toward the end of the mandrel overlapping the prior web in the series for a part of the width of the prior web and with a side edge and a plurality of longitudinal perforations of the subsequent web being aligned with a side edge and a plurality of longitudinal perforations in the prior web, and cutting off segments of the webs as so wound on the mandrel so as to produce the sheet material rolls.

5. In a method as set forth in claim **4**, said longitudinally perforated sheet material webs being wound onto said mandrel by moving the webs longitudinally toward the mandrel and spirally winding the webs about the mandrel while at the same time moving the webs as so wound on the mandrel longitudinally of the mandrel toward an end of the mandrel.

6. In an apparatus for producing rolls of sheet material which is perforated on lines extending transversely of the sheet material as it is unwound from the roll; the combination of a mandrel; a series of supply rolls of sheet material web disposed along the length of the mandrel from which the webs may be wound on to the mandrel; each of said webs being perforated on spaced longitudinal lines; said supply rolls being so disposed with respect to each other and being angularly so disposed with respect to the axis of the mandrel that the web from each supply roll travels onto the mandrel at an acute angle with respect to the axis of the mandrel, with the web from each successive supply roll in the series overlapping part of the width of the web from a prior supply roll in the series and with a perforate line and a side edge of the successive web being in register with a perforate line and a side edge of the prior web; and means for cutting off segments of the webs as so wound onto the mandrel so as to produce the sheet material rolls.

7. In an apparatus as set forth in claim **6**; said series of supply rolls being on axes that are parallel to each other and the supply rolls being so disposed that a plurality of the longitudinal perforations and a side edge of the web from each successive supply roll is in register with a plurality of perforations and a side edge of the prior supply roll in the series.

8. In an apparatus as set forth in claim **6**; said series of supply rolls being on axes which are parallel to each other and which extend at a relatively large acute angle with respect to the axis of the mandrel whereby the acute angle at which the web passes from each supply roll onto the mandrel is a relatively small acute angle.

9. In an apparatus as set forth in claim **6**; and means for drawing the webs from said supply rolls and winding the webs onto said mandrel and including a belt underlying the mandrel and disposed in contact with a web from one of said supply rolls which is being wound onto said mandrel; a plurality of belt support rolls for movably disposing said belt so that it extends at said acute angle with respect to the axis of the mandrel; and means for driving one of said belt support rolls and thereby driving the belt.

10. In an apparatus as set forth in claim **6**; said segment cutting means including a plurality of spaced peripherally sharpened cutter wheels fixed on a shaft; a carriage for rotatably holding said shaft; a motor for driving said shaft; a second shaft for mounting said carriage so that the carriage may both reciprocate along and swing on said second shaft; eccentric means for reciprocating said carriage and cutter wheels along said second shaft; and eccentric means for swinging said carriage and cutter wheels about said second shaft; said eccentric means being synchronized with each other so that the cutter wheels are swung into cutting relation with the webs as wound on said mandrel and the cutter wheels move along with movement of said webs longitudinally of said mandrel as the cutting action occurs.

11. In an apparatus for producing rolls of two-ply sheet material which is perforated on lines extending transversely of the sheet material as it is unwound from the roll, the combination of a mandrel, a plurality of supply rolls of single ply sheet material, means for mounting said supply rolls of sheet material in a series on one side of said mandrel on axes that extend at a relatively large acute angle with respect to the axis of the mandrel and so that the webs may be unwound from said supply rolls in partially overlapping relation to travel on the mandrel at a relatively small acute angle

with respect to the mandrel axis, a perforating mechanism for the web from each of said rolls producing a plurality of equally spaced longitudinally extending perforate lines in the web as it is unwound from its respective supply roll and the perforating mechanism for the rolls being so arranged and the rolls being so disposed on their axes that a plurality of perforate lines and a side edge of the web from each subsequent roll in the series is in register with a side edge and a plurality of perforate lines in the web from the prior roll in the series, a plurality of belts underlying said mandrel and disposed in contact with certain ones of the webs as they are wound onto said mandrel from their respective supply rolls, a plurality of belt support rolls for movably mounting each of said belts so that it extends at the same small acute angle with respect to the axis of said mandrel as said webs are wound onto the mandrel, means for driving one of said belt support rolls for each of said belts so as to pull the webs from their supply rolls onto the mandrel, and means for cutting segments of the webs as so wound onto the mandrel so as to produce the two-ply sheet material rolls.

12. In a method for producing consumer length rolls of sheet material web, portions of which may be easily disassociated from the remainder of the web as the web is unwound from the roll; the steps which comprise; winding along the length of a winding axis at an acute angle with respect to the axis a series of sheet material webs each drawn from a web supply roll with each subsequent web toward the end of the axis overlapping the prior web in the series for a part of the width of the prior web; each of said webs in said supply rolls being stronger longitudinally than transversely; and cutting off segments of the webs as so wound so as to produce the consumer length.

13. In a method as set forth in claim **12**, said sheet material webs being perforated on longitudinal lines and the longitudinally perforated webs being wound on each other so that a longitudinal perforation and one side edge of each subsequent web in the series of webs is in alignment with a longitudinal perforation and a side edge of the prior web in the series.

14. In a method as set forth in claim **12**, each of said webs in said supply rolls being at least four times as strong longitudinally as transversely.

15. In a method as set forth in claim **12**, each of the webs in said supply rolls being at least twice as strong longitudinally as transversely and said steps also comprising, fixing together each subsequent web to the prior web in the series adjacent a side edge of the subsequent web and adjacent a side edge of the prior web so that the web in the consumer length rolls may be wound off the rolls as two-ply webs.

16. In a method as set forth in claim **12**, each of the webs in said supply rolls being at least twice as strong longitudinally as transversely and said steps also comprising, embossing together each subsequent web to the prior web in the series adjacent a side edge of the subsequent web and adjacent a side edge of the prior web so that the web in the consumer length rolls may be wound off the rolls as two-ply webs.

17. In an apparatus for producing rolls of sheet material web, portions of which may be easily disassociated from the remainder of the web as the web is unwound from the roll; the combination of a mandrel; a series of supply rolls of sheet material web disposed along the length of the mandrel from which the webs may be wound onto the mandrel; said sheet material web in said supply rolls being substantially stronger longitudinally than transversely; said supply rolls being so disposed with respect to each other and angularly so disposed with respect to the axis of the mandrel that the web from each supply roll travels onto the mandrel at an acute angle with respect to the axis of the mandrel with the web from each successive supply roll in the series overlapping part of the width of the web from a prior supply roll in the series; and means for cutting off segments of the webs as so wound onto the mandrel so as to produce the sheet material rolls.

18. In an apparatus for producing rolls as set forth in claim **17**, and a perforating mechanism for the web from each of said supply rolls producing a plurality of equally spaced longitudinally extending perforate lines in the web as it is unwound from its respective supply roll and the perforating mechanisms for the supply rolls being so arranged and the supply rolls being so disposed on their axes that a plurality of perforate lines and a side edge of the web from each subsequent supply roll in the series is in register with a side edge and a plurality of perforate lines in the web from the prior supply roll in the series.

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LEONARD D. CHRISTIAN, Primary Examiner