MANUFACTURING FLEXIBLE DRINKING STRAWS

Inventor: Anton Jivoin, 4307 N. Hamlin St., Chicago, Ill. 60625

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36 Claims, 17 Drawing Figures

ABSTRACT

The method herein disclosed is to groove the straw circumferentially, one groove at a time, progressively part way toward one end of the straw, starting inwardly from the other end, the grooves having sides of unequal length for snapping over center in flexing or straightening the straw. The machine involves one drum on which the grooving is performed, and a second drum on which the grooved straws are subjected to endwise compression to close the corrugations in the grooved portion and define reentrant folds.

36 Claims, 17 Drawing Figures
MANUFACTURING FLEXIBLE DRINKING STRAWS

This invention relates to a novel method and machine for making flexible drinking straws, more particularly the peculiarly corrugated ones disclosed in Harp et al. U.S. Pat. No. 3,499,224, wherein each of the corrugations is defined by a circumferential groove having sides of unequal length, and these corrugations, when the straw is contracted lengthwise, defining reentrant overlapping folds. Each of these folds, in flexing the straw to a desired extent opened with a "pop" as the fold goes past dead center, thereby holding the mouthpiece beyond the corrugations at any given set position.

The development of the straw was one thing, the development of a satisfactory method and machine for its successful commercial production has been quite another matter, as shown by the fact that they could not be made fast enough for good profit, but, worse still, a high percentage of these new straws obtainable on the market so far have not operated as intended. It is, therefore, the principal object of my invention to provide a new method and machine which not only give much faster and more profitable production (as high as 600 per minute or more) but, what is more important, all of the straws are uniformly good and there are practically no rejects and no straws that fail to operate right in the hands of the average consumer.

The invention is illustrated in the accompanying drawings, in which:

FIG. 1 illustrates a straw in use made in accordance with this invention and indicating in dotted lines the degree of its flexibility to suit every requirement;

FIGS. 2 and 3 are enlarged sectional and side elevational views, respectively, of the flexible portion of a straw, to show the construction and also illustrate the operation;

FIG. 4 is an enlarged section of the flexible portion of a straw shown straight, as in full lines in FIG. 1;

FIGS. 5 and 6 serve to illustrate by full lines and dotted lines in each the "popover" action which is a novel feature of this straw and which incidentally required special handling of the forming of the corrugations in the manufacture of the straws if they are to perform properly as intended.

FIG. 7 is a front view of a machine for making the straws shown in FIGS. 1-6, embodying my invention;

FIG. 8 is a cross section on line 8-8 of FIG. 7;

FIG. 9 is a front view taken from the right-hand side of FIG. 8;

FIG. 10 is a longitudinal section on the line 10-10 of FIG. 8 and FIG. 10A is a detail on line 10a-10b of FIG. 10;

FIGS. 11 to 15 illustrate the steps in the production of a straw, starting with the plain straw of polyethylene or other suitable thermoplastic material shown in FIG. 11, which is first, while on the first drum, applied to a mandrel, as in FIG. 12, and grooved as in FIG. 13, then stripped off the mandrel and dropped onto the second drum as in FIG. 14, and finally compressed lengthwise while on the third drum as in FIG. 15 to close all of the corrugations and define reentrant overlapping folds as seen in FIG. 14, and

FIG. 16 is a diagrammatic view showing one of the carrier mandrels and the cooperating stationary track member, whereby the corrugations are roll-formed in the walls of the straws progressively outwardly toward the mouthpiece end so that every corrugation is identical with all the rest on every straw to insure good operation, dotted lines being used to indicate the corrugated wall portion of a straw roll-formed by passing of the mandrel over the track member in the direction indicated by the arrow to the left of the track member.

The same reference numerals are applied to corresponding parts throughout the views.

Referring first to FIGS. 1-6, the flexible drinking straw shown at 17 with which my invention is involved is as to a novel method and machine for its better and more profitable production is generally similar to that shown in Harp, et al. U.S. Pat. No. 3,499,224, the present one 17 being preferably made of polyethylene with a straight cylindrical mouthpiece end portion 18 and another straight cylindrical end portion 19 adapted to be entered in the mouth of a bottle 20 and provided of sufficient length to reach the bottom thereof, leaving exposed in outwardly spaced relation to the mouth of the bottle the flexible cylindrical intermediate portion 21. The latter portion has a plurality of corrugations spaced between circumferential grooves 22, the two sides 23 and 24 of each corrugation being of unequal lengths, the side 23 being shorter than the side 24. As sold, usually so many per box, the straws 17 are, of course, straight, with the flexible portion 21 of each contracted lengthwise so the sides 23 and 24 define reentrant overlapping folds 25 as seen in FIGS. 1 and 2. The straws are flexed, of course, when used, as illustrated by dotted line showing in FIG. 1, and also by FIGS. 2 and 3. It is in the flexing of the straw that the popover feature illustrated in FIGS. 4 and 6 plays an important role in holding the mouthpiece 18 yieldably in whatever angle it is set. This is by reason of the short side 23 on one side of each of the various folds or corrugations 25 involved in the flexing (a few for a small flex, more for a larger flex) having to snap or "pop" over dead center as the straw is flexed far enough. FIG. 5 shows in full lines how the short side 23 has gone from the dotted position to the full line position near dead center in the flexing, while FIG. 6 shows the popover from the dotted line position near dead center to the full line position past dead center. Obviously, it then requires application of some force to cause the parts to take their first position as the sides 23 must again be snapped over dead center, and hence this popover feature has made this type of straw preferable to the older ones having only flexibility without the desirable new feature mentioned.

Referring now to FIGS. 7 to 16 for an understanding of my novel method and machine for making these flexible drinking straws, attention is called first to FIGS. 11-16 which illustrate the method. FIG. 11 shows a straw blank B of polyethylene or other suitable material. FIGS. 12, 13 and 16 show how, in accordance with the first step of my invention, the blank B is applied over the first of two mandrels 26 and 27 for the roll-forming of the flexible portion 21, progressively outwardly toward the mouthpiece end 18 as illustrated in FIG. 16 to provide all of the circumferential grooves 22 exactly alike and all of the corrugations 23-24 exactly alike. Then, as seen in FIG. 14, the grooved blank is stripped off the mandrel 26, and, as seen in FIG. 15, mandrel 27 has its pointed reduced end portion 28 entered in the mouthpiece end 18 of the grooved blank and the straw is subjected to endwise pressure by the annular shoulder 29 abutting the end of the mouthpiece to close all of the corrugations and form the overlapping reentrant folds 25 as they appear in FIGS. 1 and 4.

FIGS. 10 and 16 are especially noteworthy. The mandrels 26 (12 or more at a time, as shown in FIG. 8) carrying blanks B are turned positively as they move through about 150° in a semicircle in the direction of the arrow A (16) around an arcuate stationary track 30 so that the evenly spaced parallel annular ribs 31 on the mandrels disposed inside the blanks can cooperate with one after another of the concentric ribs 32 provided in evenly spaced parallel relation on the track to roll form the annular grooves 22 in the walls of the blanks progressively outwardly toward the mouthpiece 18, due to the offsetting of the ends of ribs 32 at both ends as seen at 33 in FIGS. 9 and 10, the first rib 32 at the right in FIG. 16 having substantially completed the first groove 22 in a blank when the next rib is starting to form the second groove, and so on until all of the grooves are produced. With this method I draw upon the wall material of the body of the blank to the left of each rib 32 provided over the roll-forming operation described, are easily enough flexible laterally to the small extent necessary to allow stripping the formed blanks B off the mandrels 26 as required for their
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later reception of mandrels 27 (FIG. 15) used in subjecting the formed blanks to endwise compression to the final form in which they are packaged for shipment and sale.

Referring next to FIGS. 7 to 16, 35 indicates a hopper from which the formed blanks 27 are fed by one by one, into notches 36 provided in the periphery of a rotary drum 37 that has a plate 38 on one end closing that end of the notches 36, the other end of the notches being open and registering with a series of mandrels 26, previously mentioned, supported in registering holes in a pair of spaced disks 39 and 40 that have an intermediate connecting hub 41. The mandrels 26, of which only two diametrically opposed ones are shown, are illustrated in FIGS. 7 to 10 to facilitate and make clear the illustration, each has a pinion 42 on one end meshing with a gear 43 to transmit rotation to the mandrels and the straw blanks B carried thereby as they revolve around the stationary arcuate track 30 and have the grooves formed therein next to the mouthpiece end 18. Each straw blank B promptly after entry in a notch 36 in the drum 37 is fed by a compressible rubber or plastic friction roller 44, as seen in FIG. 12, outwardly into telescoping relationship with its associated mandrel 26 until the mouthpiece end 18 strikes a stop 45 formed by a roller bearing part, this occurring in the space marked “Apply” in FIG. 8. Then, in further turning of the drum 37 in a clockwise direction relative to track 30, as illustrated in FIG. 8, “130° of Grooving,” with the set arrangement of the ribs 32 on track 30, shown in FIGS. 9 and 16, the first annular groove is formed in the straw blank B before the start of the second annular groove and so on until the last annular groove is produced, and it is this progressive forming of the grooves in which the necessary material for each successive groove is derived from the mouthpiece end 18 that insures having enough material for all of the corrugations so that all of these are exactly alike with no even a slight variation, thereby insuring uniformly good operation of all of the drinking straws produced with this machine. Not only that but the production is speeded up to a point where at least 600 per minute is possible so that the straws can be made available to the public at a much lower cost for a higher quality product.

Referring to FIG. 14, the straw blanks B in their grooved form are stripped off the mandrels 26 by another soft roller 46 in the space marked “strip” in FIG. 8, and promptly thereafter when the notch 36 carrying the stripped blank registers with a notch 47 in another smaller diameter drum 48 below drum 37 the blank is transferred thereto by gravity: Drum 48 turns in a counterclockwise direction, as seen in FIG. 8. The soft rubber or plastic friction roller 46 turns in the opposite direction with respect to roller 44 and serves to strip the straws off the mandrels 26 and slide them inwardly into abutment with the end plate 38. An end plate 49 is provided on drum 48 in alignment with end plate 38 on drum 37 and prevents endwise displacement of the straws relative to drum 48. A curved housing 50 keeps the grooved straw blanks B confined in their notches 46 until each of the notches 46 registers with a notch 51 provided in the periphery of a third drum 52 disposed below the drum 47 as seen in FIG. 8. At that point the grooved blanks B are transferred by gravity one by one from notches 46 to notches 51 and here again an end plate 53 on one end of drum 52 has abutment with the inner end of each blank B to prevent their displacement from that end of the drum. In this case plate 53 serves as a supporting abutment for the inner end of each straw blank B while the mandrel 27 entered in the mouthpiece end 18 subjects the straw to endwise compression by means of its annular shoulder 29 to close all of the corrugations and define the recess resulting from abutments of end plates 38 and 53 shown in FIG. 4, only two diametrically opposed ones of the mandrels and their connections being illustrated at their opposite extreme positions for simplicity as well as clarity. The secondary swash plate 58 has a universal joint connection indicated at 69 with the shaft 61 to which is fixed a drive yoke 62, the horizontal arm 63 of which transmits drive to the secondary swash plate 58 as indicated at 64 in FIGS. 10 and 18. A mandrel 27 is carried by either of the spaced concentric disks 66 and 67, and it should be clear from FIGS. 7, 8 and 10, that immediately upon transfer by gravity of the grooved straw blank B from a notch 47 in drum 49 to a notch 51 in drum 52, the pointed end of a mandrel 27 registering with the notch 51 is started on its way into the mouthpiece end 18 of the straw so that in the first 180° travel in a clockwise direction with the blank 27, in the notches 51 by the substantially semicircular housing plate 68 (FIG. 8), the straws are all compressed fully to the extent shown in FIGS. 1, 4 and 15, and thereafter in the next substantially 90° travel or less the mandrels 27 are withdrawn enough to permit the finished straws to drop off the drum 52 or be brushed off, if necessary, to fall onto the horizontal conveyor belt indicated at 69 in FIG. 7 to be conveyed to a packaging machine.

The drive train is as follows: an electric motor 70 drives the input shaft of a speed reducer 71 to drive the shaft 61 at a predetermined speed in relation to the motor speed, and in a clockwise direction, as seen in FIG. 8. Disk 67 on shaft 61 is a gear which, as seen in FIGS. 7 and 10, meshes with a pinion 72 on the intermediate shaft 73 to transmit drive through pinion 74 to the gear 40 to drive the drum 41 in a counterclockwise direction, the same as drum 37 is driven through another pinion 75 meshing with another gear 76 to drive the upper shaft 77, to which the drum 37 is fixed. The arcuate ribbed track or plate 30 is fixed to a stationary shaft 78 fixed to frame member 79, the drum 37 turning relative to the coaxial inner end of the fixed shaft 78, which, as by means of a reduced pilot end portion on the fixed shaft (not shown) is received in a bearing recess provided in the inner end of shaft 77. Gear 80 turning with shaft 77 transmits drive to gear 81 to which the small intermediate drum 48 is fixed, whereby to drive said drum in a counterclockwise direction, as seen in FIG. 8, at the same peripheral speed as the drums 37 and 52, the drum 48 turning freely relative to shaft 73. A worm gear 82 in FIG. 8, is fixed to the shaft 73 and transmits drive to a worm 83 fixed to a cross-shaft 84 to provide a power takeoff for driving the previously mentioned soft rubber or plastic rollers 44 and 46, the first of which serves to apply the straw blanks to the mandrels 26 and the other serving to strip the straw blanks from the mandrels 26 after the grooving operation. In the power takeoff, a belt 85 driven by the lower pulley 86 transmits drive to the upper pulley 87 on the cross-shaft to which roller 46 is attached. Then, through meshing beveled gears 89 and 90, drive is transmitted to a vertical shaft 91, which carries a bevel gear 92 on its upper end transmitting drive to another beveled gear 93 carried on the upper cross-shaft 94 to which the upper roller 44 is fixed. The directions of rotation are indicated by arrows in FIG. 8, the roller 44 serving to slide the straw blanks outwardly with respect to drum 37, and the other roller 46 stripping the freshly grooved straws off the mandrels 26 back onto the drum 37 just prior to transfer to these straws onto drum 48.

A sprocket 95 fixed to shaft 73 transmits drive through a chain 96 to a sprocket 97 fixed to a hub 98 turning on the stationary shaft 78 carrying the gear 43 that transmits drive to the pinions 42, turning the mandrels 26 as they are carried around in a circle with the drum 41 in registering relationship to the straws carried on the drum 37. The speed of rotation of the straw blanks with the mandrels 26 is fast enough in relation to their orbital movement to easily accomplish the completion of the first groove by cooperation of ribs 31 on the mandrel 26 with the first of the ribs 32 on the curved track or plate 30 before forming of the second groove commences, and so on for all of the grooves.

The machine is portable and as shown in FIG. 7 is carried on a table 99 having supporting legs 100 at its opposite ends.
The operation is believed to be clear from the foregoing description. The straw blanks B are fed from a hopper 35 into notches or holders 36 in drum 37 and promptly thereafter are applied by friction rollers 40 on the mandrels 26, as indicated by the caption "Apply" in FIG. 8. Then the straw blanks are grooved as they rotate with the mandrels 26 and move in an arc relative to the arcuate track or plate 30 by contact with successive ribs 32 on this plate cooperating with ribs 31 on the mandrel, the material required to form each groove being derived from the mouthpiece end of the straw, accordingly incurring the walls of all of the grooves being alike. This is done in 150° of travel of the mandrel 26 relative to plate 30, as shown by the caption in FIG. 8, and promptly thereafter the roller 46 strips the grooved straws off the mandrels 26 as indicated by the caption "Strip" in FIG. 8, just before each holder or notch 36 in drum 37 registers with a holder or notch 47 in drum 48 for transfer thereto, gravity alone being considered sufficient for the transfer of the straws from drum 37 to drum 48, although, if necessary, fingers 101 working in annular grooves in the drum 37 at opposite ends, or near opposite ends, serving to insure the desired transfer, the fingers 101 being indicated as integral extensions of the curved housing 36. In like manner, fingers 102 indicated in dotted lines in FIG. 8 as extensions of the curved housing 68, will serve to insure transfer of straws from the holders or notches 47 in drum 48 into holders or notches 51 in drum 52, the fingers 102 being extensions of housing 66 and received in annular grooves provided therefor in drum 48. In 180° travel of the grooved straws on drum 52, these straws are subjected to endwise compression by entry and reciprocation therein of smooth ended mandrels 27, as shown in FIG. 15. The mandrels 27 withdraw from the straws sufficiently within the next 90° or more of travel of the straws with the drum 52 so that a brush or brushes or a stripper finger or fingers 103 working in an annular groove or grooves in a drum 52 will serve to positively eject whatever straws have not already fallen off the drum by gravity onto the conveyor 69, the latter carrying the finished straws to a packaging machine.

It is believed the foregoing description conveys a good understanding of the objects and advantages of my invention. While a preferred embodiment of the invention has been illustrated and described, this is only for the purpose of illustration, and it is to be understood that various modifications in structure will occur to a person skilled in this art.

1. A machine for the production of drinking straws each having a flexible portion intermediate the ends defined by circumferential grooves formed therein, a first support means on which the straws are conveyed and held in spaced parallel relationship, a second support means on which forming mandrels are conveyed in spaced parallel relationship to one another registering with said straws, means for feeding the straws endwise from the first support means onto said mandrels for the forming operation, the mandrels having axially spaced annular ribs thereon, means for turning said mandrels with the straws telescoped thereon, a fixed plate along which said mandrels are movably transversely having spaced parallel ribs thereon in a predetermined spaced relation to the annular ribs on said mandrels, whereby to roll form annular grooves in said straws in the relative movement, means for stripping the grooved straws off said mandrels, a third support means on which the grooved straws are conveyed in spaced parallel relationship to one another, a fourth support means on which second annular shoulders are provided, the straws telescoped thereon, a second fixed plate along which said second annular shoulders are entered in the other end of said straws for the annular shoulders to subject the straws to endwise compression to collapse the grooved portions thereof, and means for reciprocating said second mandrels relative to said straws for this operation.

2. A machine as set forth in claim 1, wherein the ribs on said plate are in longitudinally offset relationship to one another for forming the grooves in said straws progressively from one end of the grooved portion of the straws toward one end of the straws, so that the material required in the rolling of each groove is derived from one end portion of each straw, thereby insuring uniformity of wall thickness throughout the entire grooved length of said straws.

3. A machine as set forth in claim 2, wherein the ribs on the first-named mandrels are so spaced and arranged relative to those on the plate that the circumferential grooves formed in the straws have sides of unequal length.

4. A machine as set forth in claim 2, wherein the ribs on the first-named mandrels are laterally flexible to facilitate stripping off the grooved straws.

5. In combination, an apparatus for production of drinking straws having a flexible portion intermediate the ends defined by circumferential grooves formed therein, a first mandrel over which an end portion of the straw is slipped endwise having spaced annular ribs to cooperate with an elongated plate having spaced parallel elongated ribs that are disposed between said annular ribs to roll form the circumferential grooves in the straw by rotation of said mandrel while there is relative movement lengthwise of said plate, and a second mandrel having a smooth end portion to fit freely in the grooved end portion of the straw after it is stripped off the first mandrel, said second mandrel having an annular shoulder thereon which by engagement with the end of the second mandrel and movement endwise thereof while the other end is supported serves to compress the grooved portion to collapsed form.

6. The combination set forth in claim 5, wherein the ribs on said plate are in longitudinally offset relationship to one another for forming the grooves in said straws progressively from one end of the grooved portion of the straws toward one end of the straws, so that the material required in the rolling of each groove is derived from one end portion of each straw, thereby insuring uniformity of wall thickness throughout the entire grooved length of said straws.

7. The combination set forth in claim 5, wherein the ribs on the first mandrel are so spaced and arranged relative to those on the plate that the circumferential grooves formed in the straws have sides of unequal length.

8. The combination as set forth in claim 5 wherein the annular ribs on said first named mandrel are laterally flexible to facilitate stripping off the grooved straws.

9. In a machine for the production of drinking straws having a flexible portion intermediate the ends defined by circumferential grooves formed therein, means for feeding the straws to the machine, a rotary drum having circumferentially spaced holders on the periphery to receive the straws one by one and convey them through an arc, a plurality of mandrels mounted in circumferentially spaced relation on a rotary carrier turning in concentric relation to said drum with the mandrels in register with the holders and adapted to have end portions of the straws telescoped on the end portions thereof, means cooperating with said drum and straws to feed the straws endwise onto said mandrels for the grooving operation, means for turning said mandrels with the straws telescoped thereon, said mandrels having spaced annular ribs thereon, an accurate plate having spaced parallel ribs provided on the periphery thereof in a predetermined spaced relation to the annular ribs provided on said mandrels for roll-forming circumferential grooves in said straws, said plate being stationarily mounted between said drum and said mandrel carrier in concentric relation to said drum and carrier, means cooperating with said drum and straws to style in register relationship to said grooved straws, means serving as a supporting abutment for one end of said grooved straws while said second mandrels are entered in the other end of said straws for the annular shoulders to subject the straws to endwise compression to collapse the grooved portions thereof, and means for reciprocating said second mandrels in register with the holders and grooved straws therein, and means for reciprocating said last-mentioned mandrels so
as to enter the free ends of said mandrels in said grooved straws and have the annular shoulders subject said grooved straws to endwise compression by the engagement of the annular shoulder on each of said mandrels with one end of each straw while the other end of the straw is held against endwise displacement by the collapsing of the grooved portion.

10. A machine as set forth in claim 9, wherein the annular ribs on the first mandrels are laterally flexible to permit more easily stripping the grooved straws off said mandrels.

11. A machine as set forth in claim 9, wherein the means for feeding the straws onto the first-mentioned mandrels comprises a soft friction roller disposed in substantially tangential relation to said first drum and turning in a direction to frictionally slide the straws relative to the holders off said first-mentioned mandrels.

12. A machine as set forth in claim 9, wherein the means for stripping the grooved straws off the first-mentioned mandrels comprises a soft friction roller disposed in substantially tangential relation to said first drum and turning in a direction to frictionally slide the straws relative to the holders off said first-mentioned mandrels.

13. A machine as set forth in claim 9, wherein the means for transferring the grooved straws from the holders on the drum to the holders on the second drum comprises a third drum between the first and second drums turning at the same peripheral speed but in an opposite direction and having holders on the periphery thereof registering with the holders on the first and second drums into which the grooved straws are first transferred from the first drum to the third drum and thereafter from the third drum to the second drum.

14. A machine as set forth in claim 13, including means for positively stripping the straws from the holders on the third drum and entering the same into holders on the second drum.

15. A machine as set forth in claim 13, including means for substantially positively stripping the straws from the holders on the third drum and entering the same in holders on the second drum.

16. A machine as set forth in claim 9, including an arcuate retainer in radially outwardly spaced concentric relation to the curved plate serving to retain the straws in the holders on the first drum while they are being subjected to the grooving operation.

17. A machine as set forth in claim 9, including an arcuate retainer in radially outwardly spaced concentric relation to the curved plate serving to retain the straws in the holders on the first drum while they are being subjected to the grooving operation and continuing to retain said straws in said holders thereafter until they are being stripped off the first-mentioned mandrels.

18. A machine as set forth in claim 13, including an arcuate retainer in radially outwardly spaced concentric relation to the third drum to retain the grooved straws in the holders on the third drum between their transfer from the holders on the first drum to the point of transfer to the holders on the second drum.

19. A machine as set forth in claim 13, including an arcuate retainer in radially outwardly spaced concentric relation to the third drum to retain the grooved straws in the holders on the third drum between their transfer from the holders on the first drum to the point of transfer to the holders on the second drum, said retainer including stripper means cooperating with the first drum to transfer the grooved straws from the holders on the first drum to the holders on the third drum.

20. A machine as set forth in claim 13, including an arcuate retainer in radially outwardly spaced concentric relation to the second drum to retain the grooved straws in the holders on the second drum during their endwise compression by the last-mentioned mandrels.

21. A machine as set forth in claim 9, wherein the last-mentioned means comprises a swash plate in concentric relation to the rotary carrier for the last-mentioned mandrels, the latter having follower means cooperating with the swash plate and connected with the outer end portions of said mandrels in the rotation of the mandrel carrier relative to the swash plate, whereby reciprocatory motion is given said mandrels.

22. A machine as set forth in claim 9, wherein the last-mentioned means comprises a swash plate in concentric relation to the rotary carrier for the last-mentioned mandrels, the latter having follower means cooperating with the swash plate and connected with the outer end portions of said mandrels in the rotation of the mandrel carrier relative to the swash plate, whereby reciprocatory motion is given said mandrels, the follower means comprising a secondary swash plate that is parallel to and rotatable relative to the first-mentioned swash plate on a universal joint and having follower means cooperating with the swash plate in circumferentially spaced relation on the periphery thereof with the last-mentioned mandrels.

23. A machine as set forth in claim 9, wherein the ribs on said arcuate plate are in longitudinally offset relationship to one another for forming the grooves in said straws progressively from one end of the grooved portion of the straws toward the other end so that the material required in the rolling of each groove is derived from one end of each straw, thereby insuring uniformity of wall thickness throughout the entire grooved length of said straws.

24. A machine as set forth in claim 9, wherein the ribs on the first-mentioned mandrels are so spaced and arranged relative to those on the arcuate plate that the circumferential grooves in the straws are spaced but unequal length and having holders on the periphery thereof registering with the holders on the first and second drums into which the grooved straws are first transferred from the first drum to the third drum and thereafter from the third drum to the second drum.

25. A machine as set forth in claim 9, including an arcuate retainer in radially outwardly spaced concentric relation to the second drum to retain the grooved straws in the holders on the second drum during their endwise compression by the last-mentioned mandrels, said retainer including stripper means cooperating with the third drum to transfer the grooved straws from the holders on the third drum to the holders on the second drum.

26. A machine as set forth in claim 9 including means cooperating with the second drum for removal of finished straws when the second mandrels are sufficiently clear of the straws following the endwise compression of said straws.

27. A machine as set forth in claim 9 including stripper means to strip grooved straws off holders on said first drum following return to said holders, said means operating in timed relation to the means for transferring the grooved straws from said first drum to the holders on said second drum.

28. A machine as set forth in claim 13 including a first stripper means for stripping grooved straws off holders on the first drum at the point of transfer to holders on the third drum, a second stripper means for stripping grooved straws off holders on the third drum at the point of transfer to holders on the second drum, and a third stripper means for stripping the grooved and longitudinally compressed straws off holders on the second drum.

29. The method of making a flexible drinking straw comprising the steps of first mounting the straw on a mandrel having a plurality of axially spaced annular ribs thereon between which to define in the straw a plurality of circumferential grooves intermediate the ends of the straw, and then rolling the straw by relative transverse movement between the mandrel and a plate having elongated parallel ribs all at right angles to the mandrel and spaced similarly as the annular ones but disposed therewith and offset endwise relative to one another sufficiently for individual forming of the grooves so that when the first of the circumferential grooves is substantially completely formed the straw is located against endwise movement relative to the mandrel to the point of forming the groove progressively grooved from the first groove toward one end of the straw, the material required to form each of the grooves being derived from the outer end portion of the straw to insure uniformity of wall thickness throughout the entire grooved length of said straw.

30. The method of making a flexible drinking straw comprising the steps of first mounting the straw on a mandrel having a plurality of axially spaced annular ribs between which to define in the straw a plurality of circumferential grooves hav-
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34. The method as set forth in claim 30, including the additional initial step of confining the two ends of the straw against endwise displacement with respect to the mandrel prior to the transverse movement between the mandrel and the plate so as to insure correct location of the grooves in the straw in relation to the opposite ends by insuring correct location of the first groove.

35. In a machine for the production of drinking straws, each having a flexible portion intermediate the ends defined by circumferential grooves formed therein, a first support means on which the straws are conveyed and held in spaced parallel relationship, a second support means on which forming mandrels are conveyed in spaced parallel relationship to one another registering with said straws, means for feeding the straws endwise from the first support means onto said mandrels for the forming operation, the mandrels having axially spaced annular ribs thereon, means for turning said mandrels with the straws telescopied thereon, and a fixed plate along which said mandrels are movable transversely having spaced parallel ribs thereon in a predetermined spaced relation to the annular ribs on said mandrels, whereby to roll form annular grooves in said straws in the relative movement, the parallel ribs being offset endwise relative to one another enough to form the grooves individually, from the first groove to the last, the material required for each of the grooves being derived from one end portion of the straw to insure uniformity of wall thickness in all of the grooves.

36. A machine as set forth in claim 35, wherein the ribs on the first-named mandrels are so spaced and arranged relative to those on the plate that the circumferential grooves formed in the straws have sides of unequal length.

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