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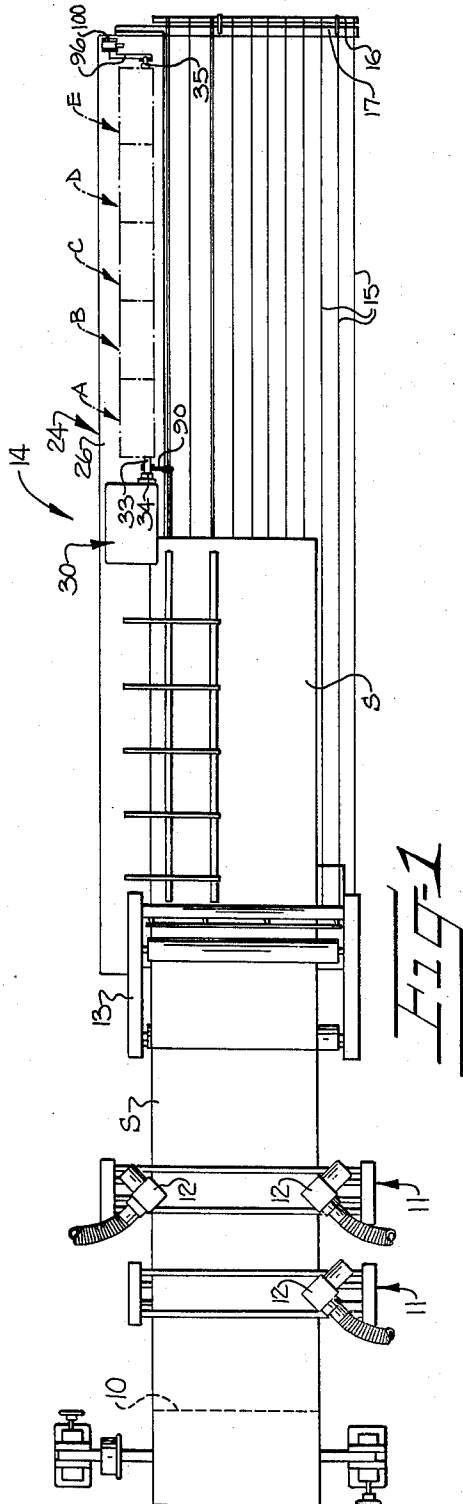
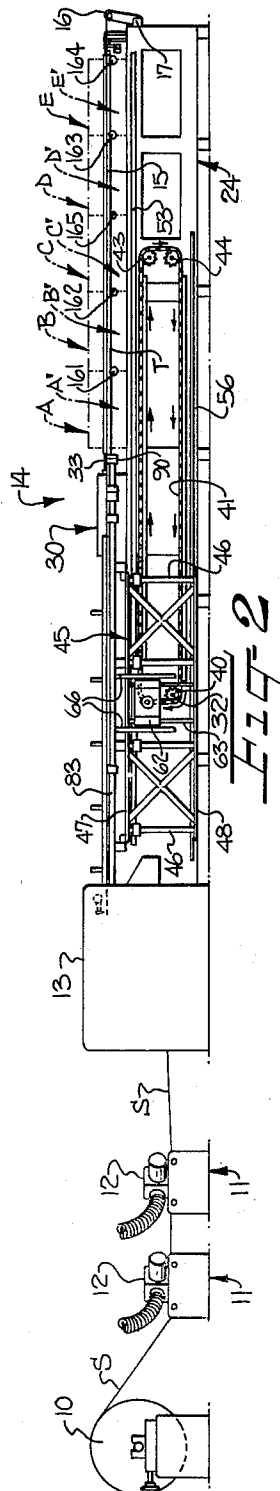
C. L. ROEDIGER ET AL

3,073,218

APPARATUS FOR MAKING CONVOLUTE PAPER TUBES AND METHOD

Filed May 15, 1962

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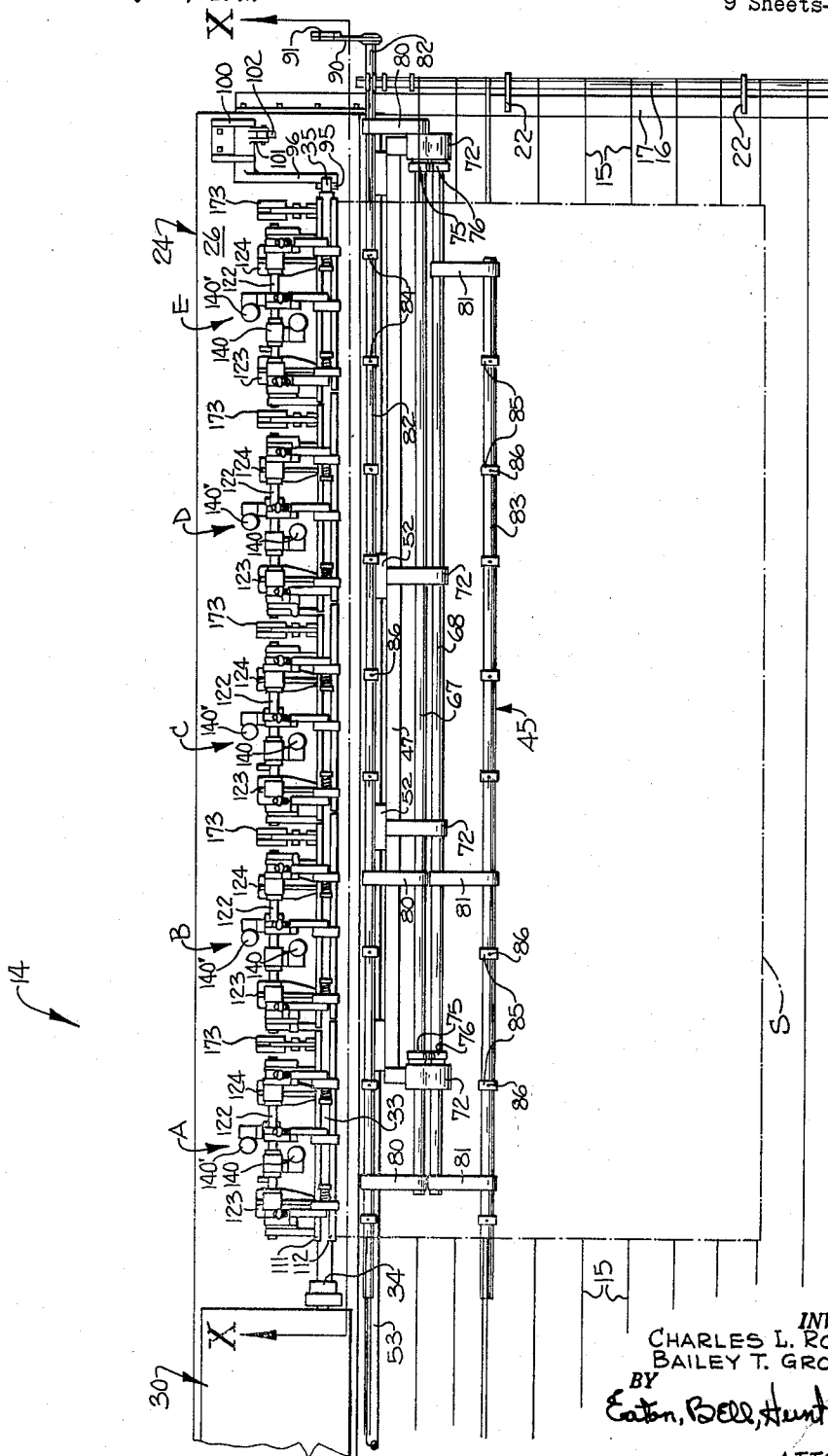


FIG. 3

INVENTORS:
CHARLES L. ROEDIGER and
BAILEY T. GROOME
BY
Eaton, Bell, Hunt & Deitzler
ATTORNEYS

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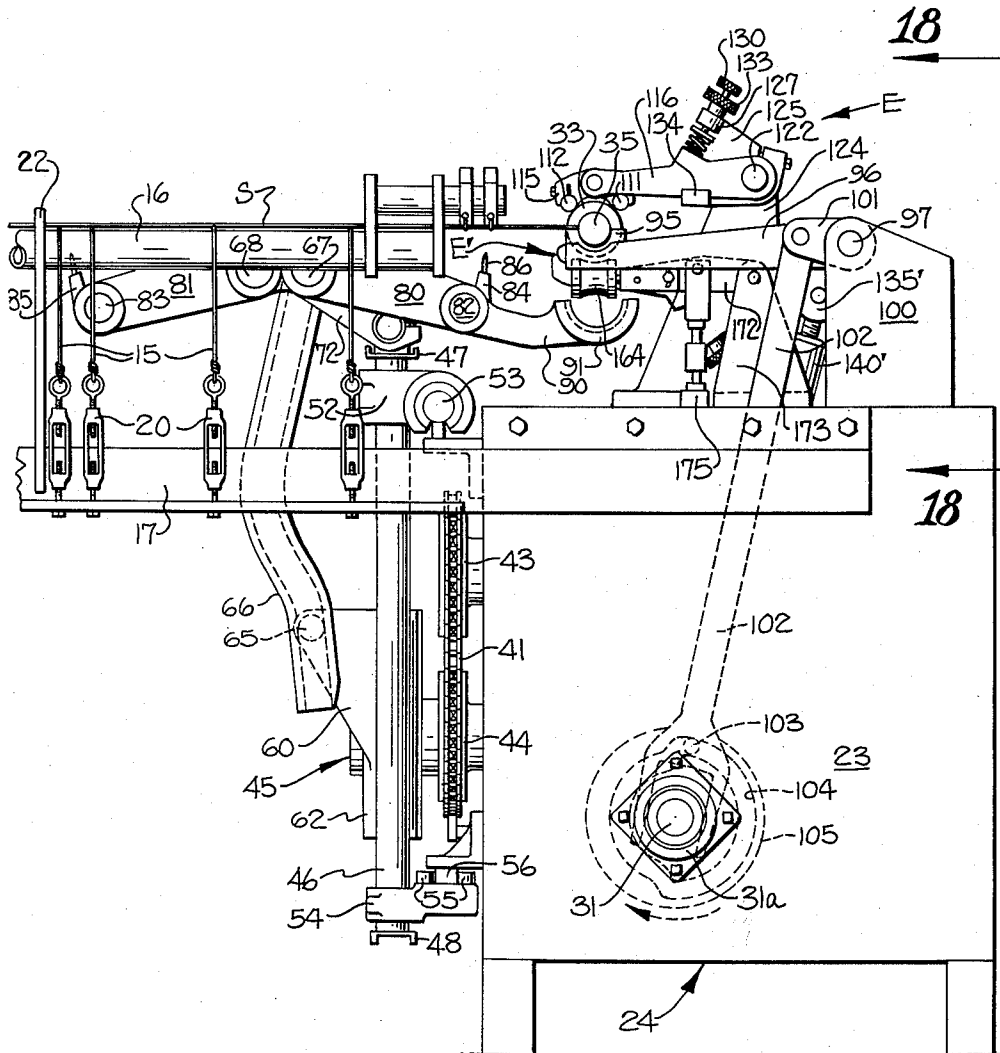


Fig. 4

INVENTORS:
CHARLES L. ROEDIGER and
BAILEY T. GROOME

BY

Eaton, Bell, Hunt & Delaney
ATTORNEYS

Jan. 15, 1963

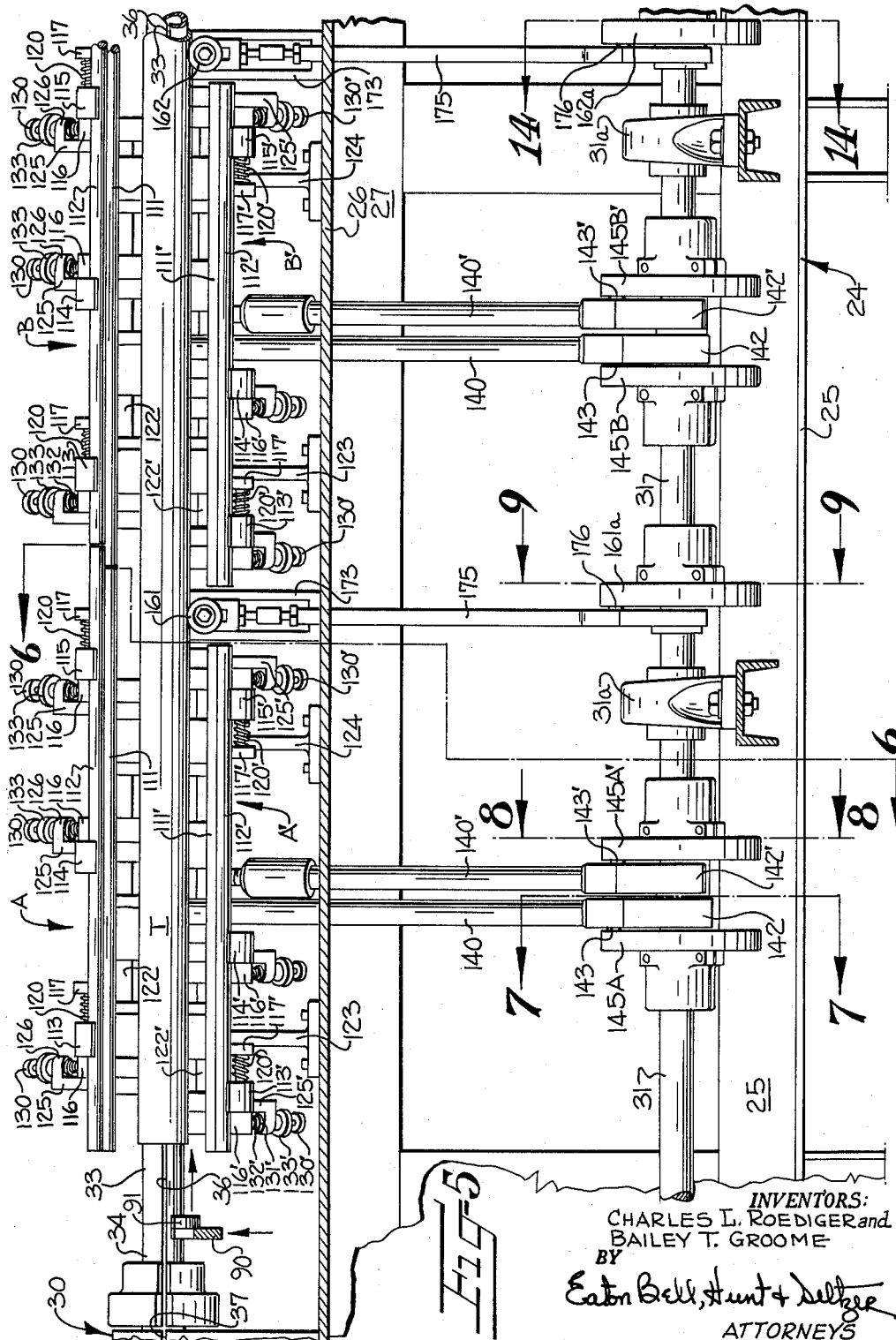
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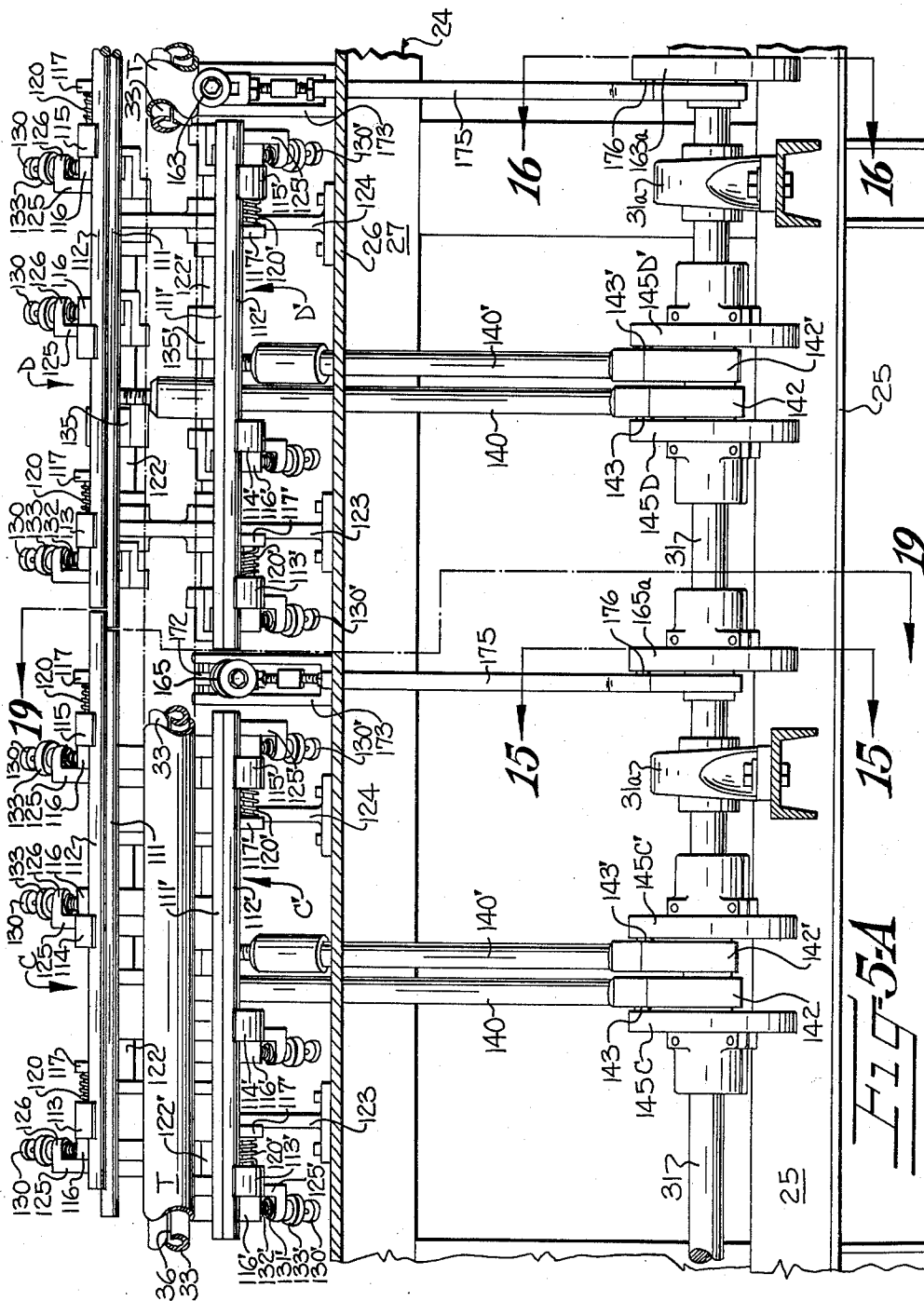
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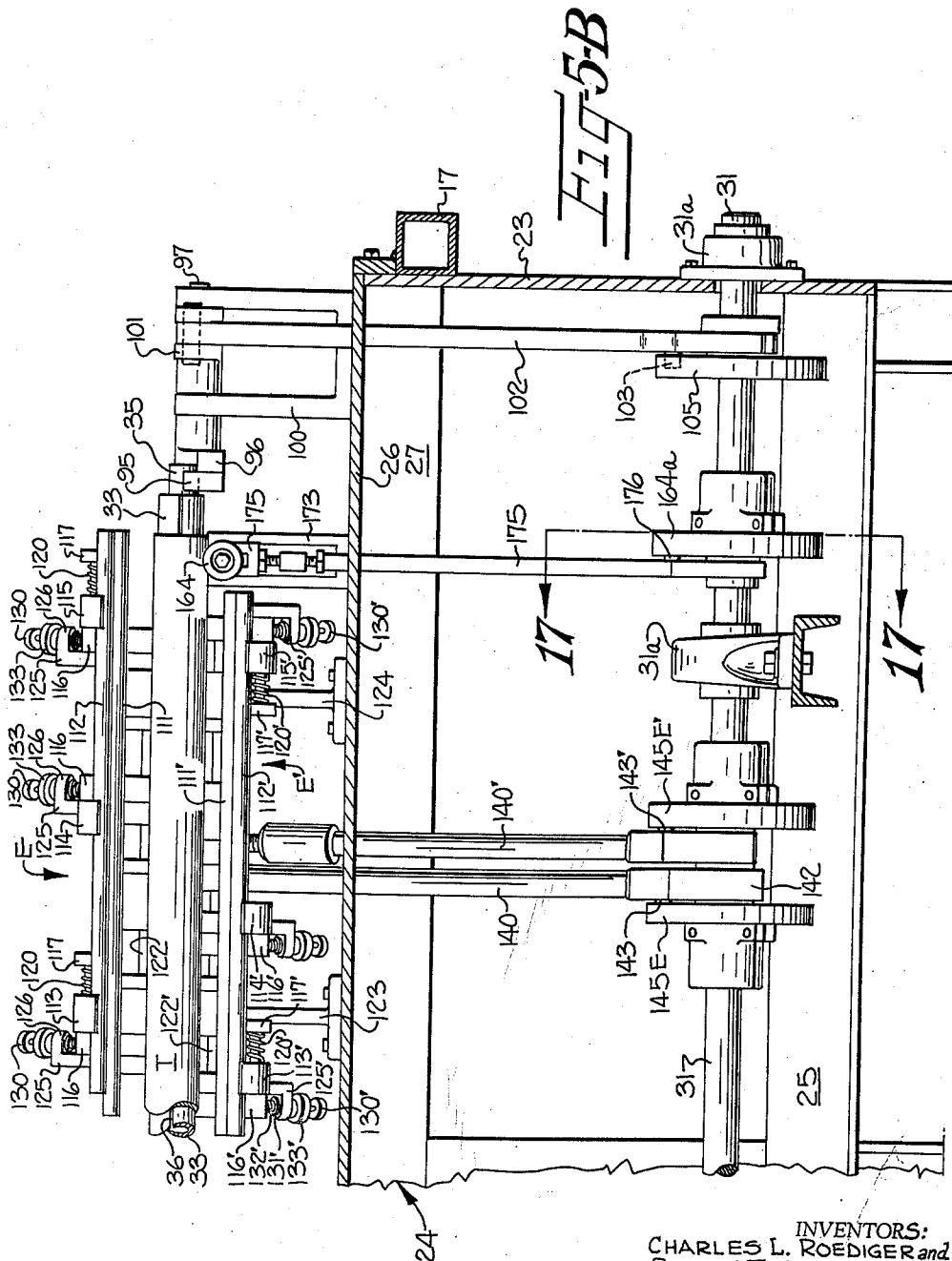
C. L. ROEDIGER ETAL

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INVENTORS:
CHARLES L. ROEDIGER and
BAILEY T. GROOME

Eaton, Bell, Hunt & Deitzner
ATTORNEYS

Jan. 15, 1963

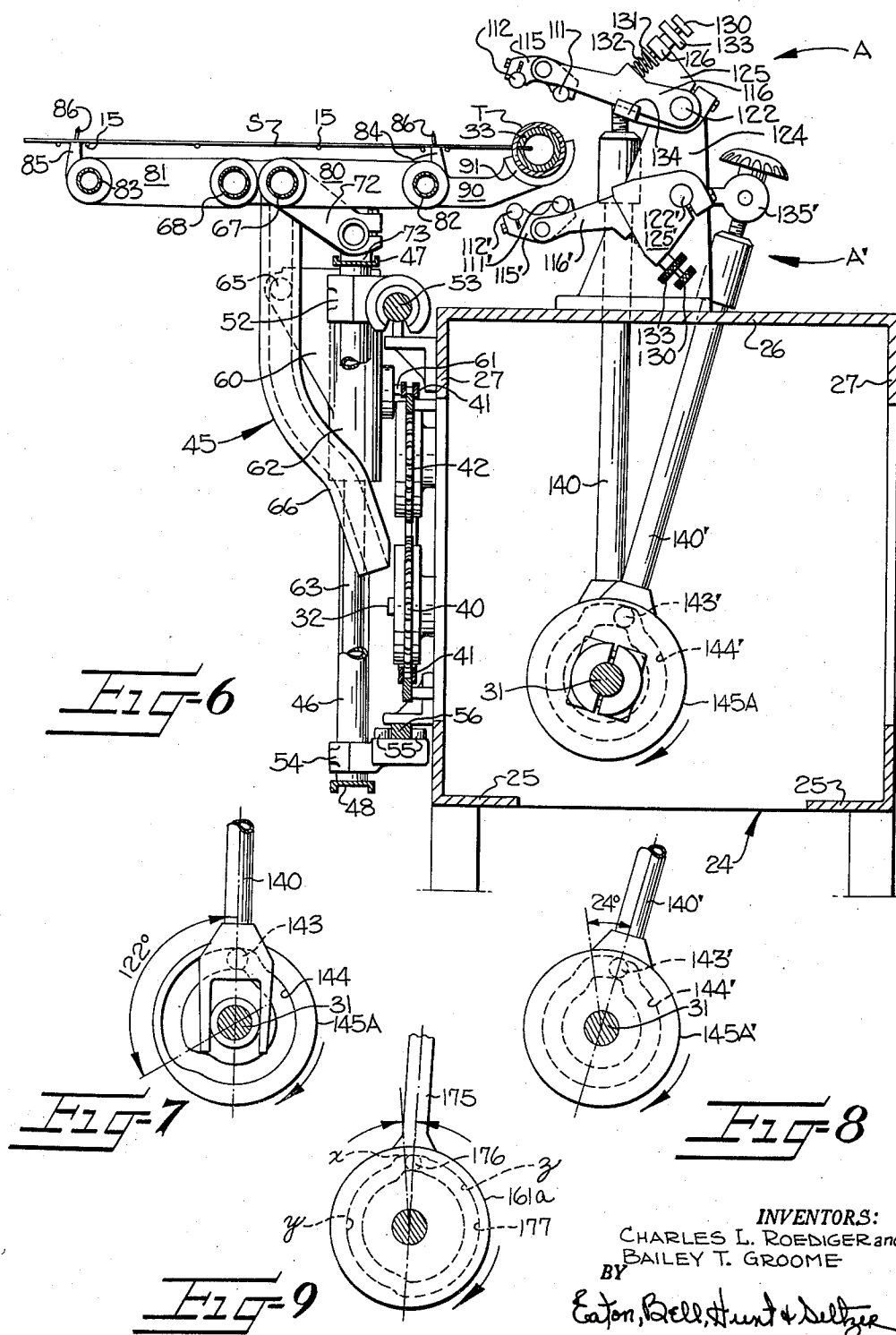
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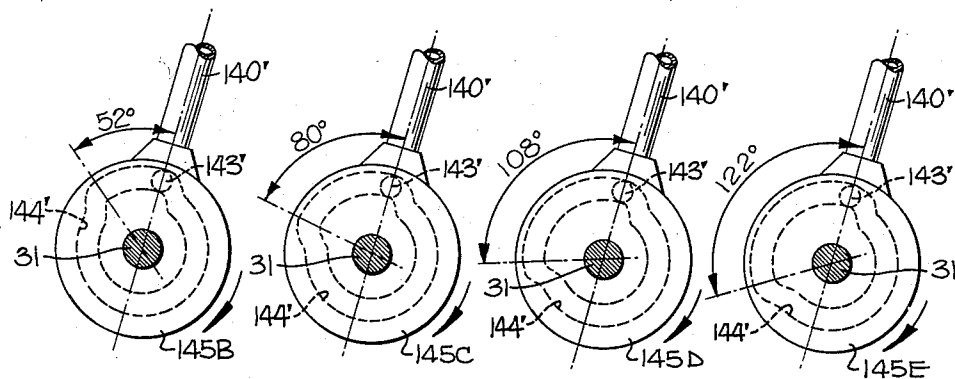


Fig-10 Fig-11 Fig-12 Fig-13

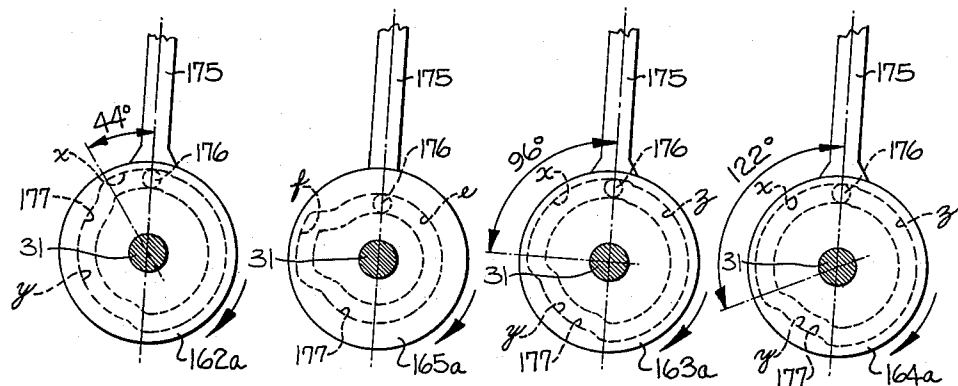
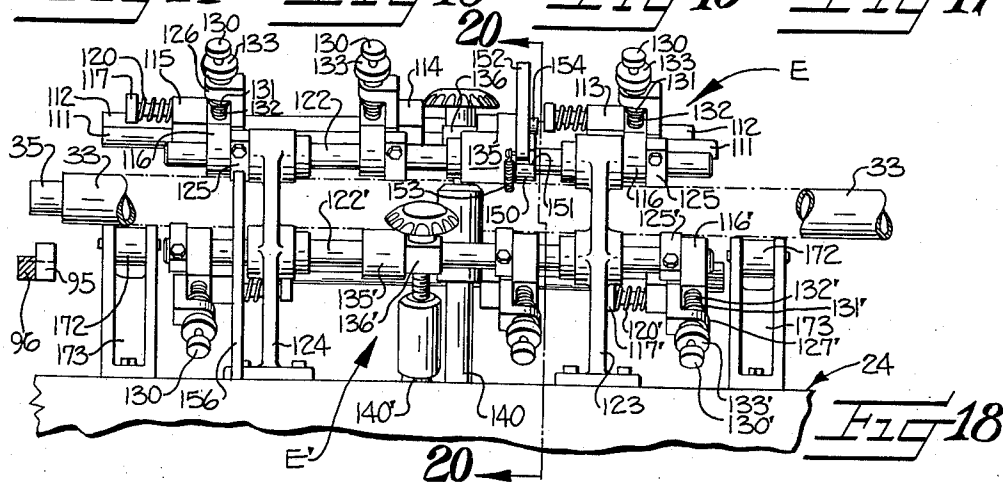


Fig-14 Fig-15 Fig-16 Fig-17



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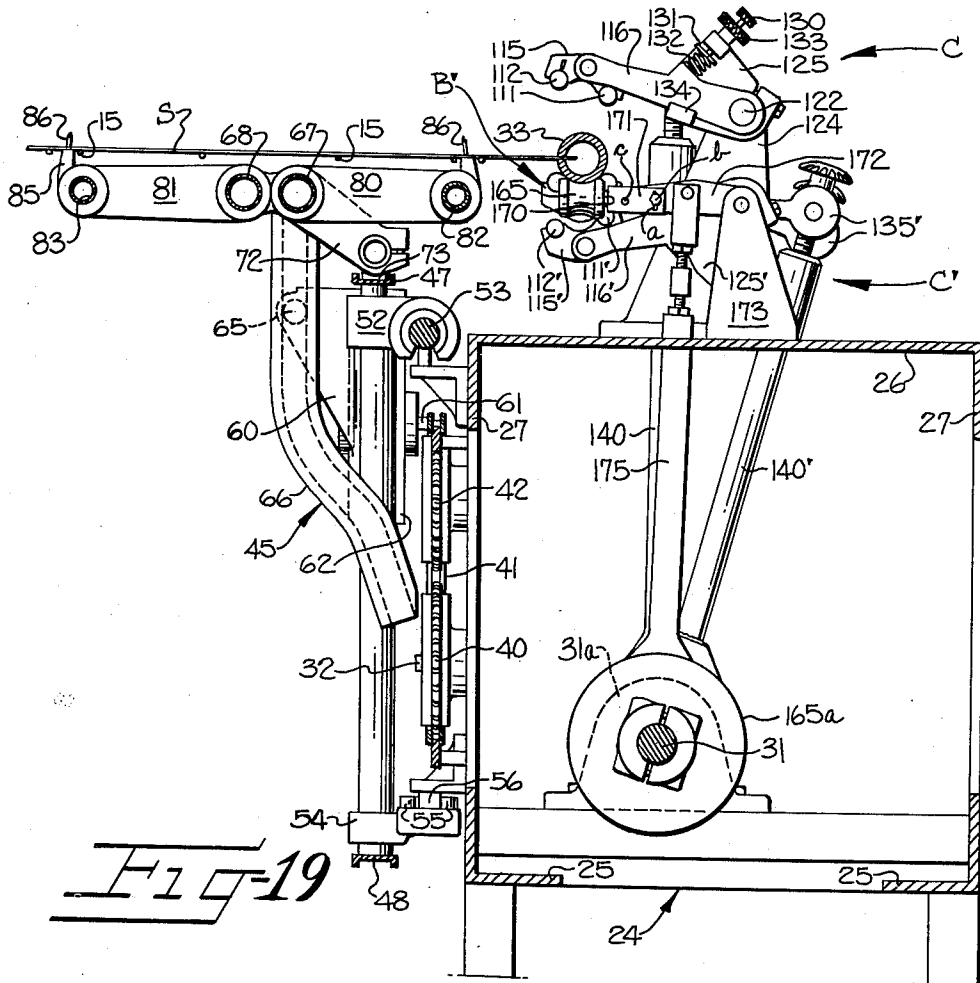


FIG-19

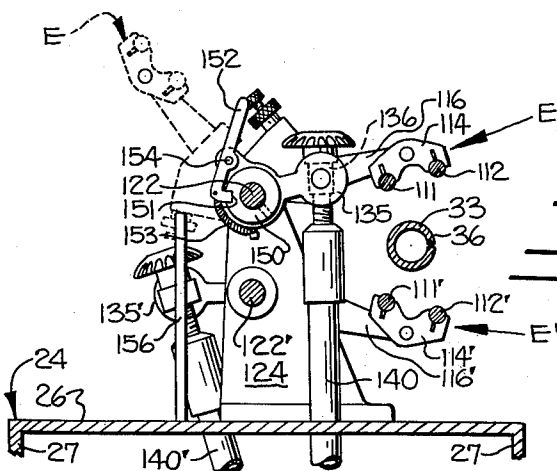


FIG-20

INVENTORS:
CHARLES L. ROEDIGER and
BAILEY T. GROOME

BY
Eaton, Bell, Hunt & Seltzer
ATTORNEYS

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3,073,218

APPARATUS FOR MAKING CONVOLUTE PAPER
TUBES AND METHOD

Charles L. Roediger, Rock Hill, S.C., and Bailey T. Groome, Atlanta, Ga., assignors to Star Paper Tube, Inc., Rock Hill, S.C., a corporation of South Carolina
Filed May 15, 1962, Ser. No. 194,763
33 Claims. (Cl. 93-81)

This invention generally relates to the art of making elongate tubes from thin web material such as paper, plastic and other sheet materials, and is particularly concerned with an improved apparatus and method for automatically making convolute tubes of much greater length than has been practicable on any prior apparatus of which we are aware.

Prior art apparatuses for making convolute paper tubes generally include means for drawing paper from a roll, then applying an adhesive to the paper and cutting the same into the desired length of the tube to be formed therefrom. The paper is then moved longitudinally into engagement with a longitudinally extending groove in one side of an elongate mandrel of a length greater than the cut paper, whereupon the mandrel is rotated to wind the paper thereon in convolute form. So-called slicker plates apply pressure against the paper as it is being wound on the mandrel to insure that tight adhesively interconnected convolutions are formed. Thereafter, the slicker plates are withdrawn from the tube and the tube is then stripped off the mandrel.

Such prior art apparatuses or machines have served quite well in many respects but have had inherent limitations with regard to the maximum length of convolute tube which could be wound thereon and, also, the longer a convolute tube, the more aggravated has been the problem of avoiding or compensating for relatively thick and thin areas in the paper and the resultant wall thickness of the tube being formed. Heretofore, it has been impracticable to produce convolute paper tubes of a length exceeding 90 inches, for example, primarily because mandrels of the required relatively small diameter of as little as one and one-half inches could not be supported adequately, especially during the recharging of the mandrel with a new sheet of paper and the simultaneous stripping of the previously wound tube from the mandrel, as will be further explained hereinafter.

Longer convolute tubes have been wound by more expensive hand methods heretofore. However, the demand for convolute tubes of lengths up to and exceeding 200 inches has currently increased due to the longer carpets and other types of floor coverings and fabrics currently being manufactured. It is also contemplated that asphalt-impregnated convolute tubes of such long lengths will also become much in demand for use as underground sewer and waste water lines. Thus, it is highly desirable to manufacture such long tubes by relatively high speed production machinery.

It has long been customary to make tubes of considerable length by winding them in spiral form. Although spiral paper tubes have many uses, they are not satisfactory for supporting carpeting and other pliable web materials which are formed into rolls of considerable length, because although a spiral tube has a greater crush resistance or crush strength than a convolute tube, it does not have the "beam" strength of a convolute tube having the same length and wall thickness as the spiral tube. In other words, the convolute tube may be bent to a considerable extent without breakage, because the grain of the paper extends lengthwise of the tube. On the other hand, a spiral tube can only be bent a relatively small amount before it will fracture or break, because the grain of the paper extends diagonally of the tube.

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Thus, in order for a spirally wound paper tube to adequately support a roll of carpeting of the maximum length and weight which could be adequately supported by a comparable convolute tube, a spiral tube would have to be of substantially greater wall thickness and/or of larger inside diameter than a comparable convolute tube, thus resulting in (a) higher cost in the manufacture thereof, (b) more paper being required per given length thereof, (c) more shipping weight, (d) more difficulty in handling, and (e) the breakage problem would still not be completely nullified to the extent that it is with a comparable convolute tube.

The most critical period in the stripping of a convolute paper tube off a mandrel is that instant at which the stripper leaves the front free end of the mandrel. During the stripping operation, the stripper advances along, beneath and in engagement with the mandrel, and as the stripper approaches the free end of the mandrel, the prior art machines did not have the mandrel adequately supported adjacent its free end or at a medial portion thereof. Because of the length of the mandrel compared to its diameter there would be some deflection or downward inclination of the unsupported free end of the mandrel as the tube was being stripped therefrom.

Thus, as the stripper approached the free end of the mandrel, it would raise the mandrel momentarily until it would move beyond the free end thereof. Thereupon, the mandrel would suddenly be relieved of the support effected by the stripper and would drop to some extent, depending upon its own strength and rigidity, and this would vibrate the mandrel throughout its length or at least near its free end. This would cause the carriage, having the pins therein which advance the new sheet of paper, to also vibrate and would cause the paper to be vibrated, thus increasing the size of the holes in the paper which were formed by the advancing pins and also causing the paper to become wrinkled, distorted and/or misaligned with respect to the mandrel. In some instances, even a portion of the paper would be entirely withdrawn from the longitudinal groove in the mandrel.

It is apparent that, the longer the mandrel, the more pronounced would be the deflection and vibration of the free end thereof each time it is released. Thus, it can be seen that the problems pointed out above become much more critical when a 200-inch or longer mandrel is to be used as compared to the prior art mandrels which could not exceed 96 inches, to our knowledge, unless they were materially increased in diameter.

It should also be pointed out that, without adequate support, the mandrel will bow or sag and impede or prevent the movement of the tube longitudinally thereof. This will further impede the movement of the paper longitudinally along said groove, and it will cause the paper to be taken up unevenly by the mandrel. If the movement of the paper along the groove in the mandrel becomes obstructed, this may tear or wrinkle the paper to such extent that the corresponding cycle in the operation of the machine would be interrupted, thus requiring that the machine be stopped, the unused sheet of paper be removed from the machine and the partially stripped tube be manually removed from the machine. Since the paper is necessarily coated with a wet glue and the previously formed tube also has a glue coated surface engaging the mandrel, any undue delay in the cycling of the machine will cause the tube to adhere so tightly to the mandrel that it cannot be removed without cutting the same into small fragments, after which the mandrel has to be thoroughly washed to remove residue paper and glue from the mandrel.

Also, if the opposed front and rear end edges of the paper are not positioned in perpendicular relationship to the longitudinal axis of the mandrel at the start of

each winding operation, the ends of successive layers or convolutions of the paper being wound will not be properly aligned and will result in one end of the tube being externally tapered and the other end of the tube being internally tapered. Not only would this require that the ends of the tubes be cut away following the stripping operation, but if the externally tapered end of the tube happens to be at the rear end thereof, the stripper would then merely ride over the tube without pushing the same off the mandrel. Thus, the succeeding sheet of paper being advanced in fixed spaced relation to the movement of the stripper would then be pulled into engagement with the end of the previously formed tube and would become badly torn and wrinkled, thus completely jamming the machine and requiring that the machine be cleaned and reconditioned in the manner set forth above.

It is therefore an object of this invention to provide an improved method and apparatus for supporting the mandrel of a convolute tube winding machine of the character described, particularly during insertion of one edge of each successive sheet of paper or other sheet material in the longitudinal groove in one side of the mandrel and during the simultaneous stripping of each successive tube forwardly off the free end of the mandrel, and wherein a stripper engages and applies an uninterrupted force against the rear end of the tube and longitudinally of the mandrel while the tube and mandrel are positively supported at a medial portion thereof or at a plurality of points spaced longitudinally of the mandrel. The tube is successively released as its rear end approaches each such point of support, and a medial portion of the mandrel is positively supported immediately following movement of the rear end of the corresponding tube and the stripper therebeyond, thus maintaining the mandrel substantially straight throughout its length so that the convolute tube is readily stripped off the same regardless of the length of the mandrel or the tube previously wound thereon.

It is another object of this invention to provide apparatus, operating in conjunction with a sheet advancing and tube stripping means, to adequately support the mandrel not only during the winding of the sheet material thereon, but during uninterrupted movement of the stripper means from adjacent the permanently journaled end of the mandrel to the other or free end thereof to prevent distortion and vibration of the mandrel and thereby insure that the succeeding tube will be properly wound.

It is another object of this invention to provide an improved mandrel supporting means of the character described which includes a plurality of longitudinally spaced supports in the form of rollers which are normally spaced below the mandrel along the length thereof, the majority of such rollers being so operated that they move into a position in predetermined spaced relation to the mandrel following the winding of the convolute tube thereon so that they engage and support the tube then on the mandrel and, as the stripper element moves from adjacent the permanently journaled end of the mandrel toward the free end thereof, the said majority of the rollers progressively withdraw from engagement with the tube as the stripper approaches the same so that the stripper may move thereby. As the stripper moves a predetermined distance along the mandrel in the stripping operation, at least one of the rollers moves upwardly subsequent to the movement of the stripper thereby and engages a medial portion of the mandrel to thus support the same as the tube is stripped off the remaining portion of the mandrel and a succeeding length of sheet material is moved into winding position.

It can thus be seen that the support rollers, both those which support the tube during the ejection or stripping thereof, and that roller which supports the mandrel at the time of the withdrawing of the first-mentioned tube,

keep the mandrel straight throughout its length and thereby prevent undue vibration of the mandrel at the critical time that the stripper passes beyond the free front end thereof.

To assist in supporting the paper tube and the mandrel during the stripping of the paper tube from the mandrel, and to also insure that the convolutions of paper are tightly adhesively interconnected and that the paper tube is of uniform thickness throughout the periphery thereof, it is another object of this invention to provide improved slicker bars, there being a plurality of sets or pairs of upper slicker bars arranged in series above the mandrel and a plurality of lower sets or pairs of slicker bars arranged in series beneath the mandrel. Each set of slicker bars includes two elongate rods or bars mounted on a pivoted cradle so they will seek their own positions when moved into engagement with the periphery of the mandrel and when engaged by the material being wound. Also, the slicker bars are staggered at the junctures thereof, so that adjacent slicker bars are disposed in overlapping relationship, thus obviating the occurrence of uneven places in the paper being wound in the forming of the tube. Means are provided for moving all the sets of slicker bars out of engagement with the tube then on the mandrel preceding the stripping of the tube off the mandrel and, as the stripper moves in the tube stripping operation, the lower sets of slicker bars successively yieldably engage the mandrel to assist in supporting the same as the stripper bar moves therebeyond.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds, when taken in connection with the accompanying drawings, in which:

FIGURE 1 is a somewhat schematic top plan view of the convolute tube winding machine with the stripper in its rearmost, retracted, position and wherein apparatus of the present invention is shown schematically in association with the mandrel;

FIGURE 2 is a side elevation of the machine looking up at the lower side of FIGURE 1;

FIGURE 3 is an enlarged top plan view similar to the right-hand portion of FIGURE 1, but showing the various parts more in detail with the wiper or stripper in fully ejected or extended position;

FIGURE 4 is an enlarged front end or discharge end view of the machine looking at the right-hand side of FIGURE 3 with the various movable parts of the machine shown in the position occupied thereby during the winding operation;

FIGURES 5, 5-A and 5-B are, collectively, a longitudinal vertical sectional view taken substantially along line X—X adjacent the mandrel, in FIGURE 3, showing the arrangement of the cams for controlling the operation of the slicker bars and the corresponding tube and mandrel support rollers of the present invention, but wherein the slicker bars, supporting rollers and stripper occupy the positions at which the stripping operation commences and following the tube winding operation;

FIGURE 6 is a fragmentary vertical sectional view taken substantially along line 6—6 in FIGURE 5 showing the relative positions occupied by the corresponding upper and lower sets of slicker bars and the stripper or wiper element during the stripping of the completed tube from the mandrel;

FIGURE 7 is a fragmentary vertical sectional view taken substantially along line 7—7 in FIGURE 5 showing one of the cams for controlling the slicker bars of the upper pressure applying units, all of the upper sets of slicker bars being controlled by identical cams and being operable in unison;

FIGURE 8 is a fragmentary vertical sectional view taken substantially along line 8—8 in FIGURE 5 and showing the cam for controlling the first lower pressure applying unit or set of lower slicker bars;

FIGURE 9 is a fragmentary vertical sectional view

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taken substantially along line 9—9 in FIGURE 5 showing the cam for controlling the operation of the first of the tube mandrel support rollers;

FIGURES 10, 11, 12 and 13 are views similar to FIGURE 8 showing the cams for controlling the second, third, fourth and fifth sets of lower slicker bars in the series;

FIGURES 14, 15, 16 and 17 are fragmentary vertical sectional views similar to FIGURE 9, but being taken substantially along lines 14—14, 15—15, 16—16 and 17—17 in FIGURES 5, 5-A and 5-B, and illustrating the cams for sequentially operating the remaining four tube and mandrel support rollers in the series;

FIGURE 18 is a fragmentary elevation of parts adjacent the front portion of the mandrel and being taken substantially along line 18—18 in FIGURE 4;

FIGURE 19 is an enlarged transverse vertical sectional view taken substantially along line 19—19 in FIGURE 5-A showing the carriage for the paper feeding mechanism, and corresponding upper and lower sets of slicker bars and, more importantly, showing the support roller which engages a medial portion of the mandrel upon the convolute tube and stripper moving beyond the support roller in the course of the stripping operation;

FIGURE 20 is a fragmentary vertical sectional view taken substantially along line 20—20 in FIGURE 18, with the convolute tube removed from the mandrel and showing how the corresponding upper set of slicker bars may be swung away from above the mandrel to facilitate repairing, adjusting and/or cleaning the mandrel and adjacent parts of the machine.

Referring more specifically to the drawings and to FIGURES 1 and 2, in particular, it will be observed that the paper or other sheet material S is drawn from a roll 19 or other suitable source of supply and then is generally passed through a suitable skiving mechanism generally designated at 11. The skiving mechanism generally includes two or more skiving heads 12 which operate in a conventional manner to taper or bevel opposed edges of the paper S.

The sheet material S is then drawn through a suitable gluing and cutting station generally designated at 13 which functions in a well-known manner to apply a suitable adhesive material to the upper surface of the paper S and to sever the same upon the paper being advanced through the gluing station a predetermined distance by usual means, not shown, associated with the gluing and cutting station 13. Thereafter, the cut sheets S are advanced, by means of paper advancing pins, to the mandrel of a convolute tube winding machine broadly designated at 14. The method and apparatus of the present invention will be described in their preferred embodiments in conjunction with a convolute tube winding machine which, with the exception of the novel features of the present invention, is constructed and operated in a manner generally known to those familiar with the art. Therefore, only so much of the machine 14 will be described as is deemed necessary to a clear understanding of the present invention.

As heretofore stated, the gluing and cutting station 13 has means for advancing predetermined lengths of paper S and cutting the paper into such lengths in accordance with the length of the tube to be formed therefrom. As the paper is advanced by the gluing and cutting station 13, it is then coated with wet glue and passes onto a platform formed from a plurality of longitudinally extending and laterally spaced wires 15, whose rear ends are suitably connected to the frame of the gluing and cutting station 13 and whose front portions extend over a transverse bar 16 (FIGURES 3 and 4) and then extend downwardly and are connected to a transverse frame member 17 by means of suitable turnbuckles 20.

The transverse bar 16 is suitably supported by upright bridging members 22 (FIGURES 3 and 4) carried by frame member 17. Member 17 is a form of cantilever,

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having its right-hand end in FIGURE 4 suitably secured to a relatively narrow upright end frame member 23 which is a part of a frame broadly designated at 24. Frame 24 includes longitudinally extending, laterally spaced, lower frame members 25 and an upper main platform 26 having flanges 27 on opposite sides thereof (FIGURE 6). It will be observed in FIGURE 5-B that the front ends of frame members 25, 26 are suitably secured to front frame member 23. The rear portions of members 25, 26 are carried by the frame of the gluing and cutting station 13 (FIGURES 1 and 2).

Medial portions of the frame members 25 and main platform 26 are also connected to a housing of a driving mechanism broadly designated at 30 which has conventional means therein, not shown, for imparting continuous rotation to a longitudinally extending cam shaft 31 (FIGURES 4-17) and a feed carriage drive shaft 32 (FIGURES 2, 6 and 19). Cam shaft 31 is journaled in bearings 31a carried by frame 24 and spaced beneath platform 26.

The driving mechanism 30 also imparts intermittent rotation to a longitudinally extending mandrel 33 spaced above platform 26 and having its axis on substantially the same level as the paper supporting wires 15. The mandrel 33 has a permanently supported or journaled rear end 34 and an intermittently supported or periodically supported front or free end 35. The drive mechanism 30 is so constructed as to periodically or intermittently impart a predetermined number of revolutions to mandrel 33, say twelve revolutions, at the termination of which a longitudinally extending slot or groove 36 formed in one side of the mandrel 33 (FIGURES 5, 6 and 19) is alined with a corresponding slot 37 in one wall of the housing of driving mechanism 30 (FIGURE 5). The slots 36, 37 are then alined with and face inwardly toward the path of travel of the paper or sheet material S as it is advanced by means to be presently described to thereby insure that the paper is wound up by the subsequently rotated mandrel 33.

As best shown in FIGURE 2, the carriage drive shaft 32 has a sprocket wheel 40 fixed thereon which is engaged by an endless sprocket chain 41. Sprocket chain 41 also engages and passes outwardly of a sprocket wheel 42 (FIGURE 6) spaced above sprocket wheel 40 and a pair of sprocket wheels 43, 44 (FIGURES 2 and 4) which are spaced a substantial distance forwardly of sprocket wheels 40, 42 and are disposed on substantially the same level as sprocket wheels 40, 42, respectively. The sprocket wheels 42, 43, 44 are suitably journaled on the left-hand side of frame 24 in FIGURES 4, 6 and 19.

Endless sprocket chain 41 imparts longitudinal, reciprocatory movement to the elongate substantially rectangular carriage broadly designated at 45 (FIGURES 2, 4, 6 and 19) which is conventional and includes a plurality of longitudinally spaced upright frame members 46 whose upper and lower ends are suitably interconnected by respective longitudinal frame members 47, 48. The upright frame members 46 each has a guide block 52 fixed thereto which engages and is suspended on a longitudinally extending track or bar 53 suitably supported by the frame 24 and spaced above the upper run of the endless sprocket chain 41. The lower portion of each upright frame member 46 of carriage 45 also has a guide block 54 extending inwardly therefrom and provided with a pair of rollers 55 on the upper surface thereof which straddle a track or bar 56 suitably secured to the frame 24 and extending parallel to the upper track 53. The lower track 56 is disposed below the level of the lower run of sprocket chain 41.

In order to transmit longitudinal reciprocatory movement to the carriage 45 from the endless sprocket chain 41, one of the links of sprocket chain 41 has an auxiliary carriage or follower carrier 60 pivotally connected thereto, as at 61 (FIGURE 19). Opposed front and rear portions of follower carrier 60 have upright bosses

62 thereon which are mounted for vertical sliding movement on upright shafts or guide rods 63 extending between and suitably secured to the upper and lower frame members 47, 48 of main carriage 45.

It is thus seen that, assuming that the sprocket chain 41 moves in a clockwise direction in FIGURE 2, the carriage 45 moves forwardly with the upper run of sprocket chain 41 and moves rearwardly with the lower run of sprocket chain and, at the ends of the forward and rearward strokes of the carriage 45, the upright portions of sprocket chain 41 between the respective pairs of sprocket wheels 43, 44 and 40, 42 impart downward and upward movement, respectively, to the follower carrier 60.

The flanged front and rear portions of follower carrier 60 each has a follower or roller 65 thereon which engages an irregularly shaped rockable cam or track 66 which extends upwardly and is fixed to a rocker shaft 67 extending longitudinally of the machine 14 and adjacent which a similar rocker shaft 68 is positioned. The rocker shafts 67, 68 are parts of the sheet advancing means and are movable with carriage 45. The rocker shafts 67, 68 are journaled in bearing brackets 72 which extend downwardly and inwardly at an angle and are each adjustably secured on a block 73 fixed to the upper longitudinally extending frame member 47 of carriage 45. It will be observed in FIGURE 3 that four of the bearing brackets 72 are provided for supporting the rocker shafts 67, 68.

It is apparent, by referring to FIGURES 4 and 6, that the cam tracks 66 are so formed as to rock or oscillate the shaft 67 about its axis with vertical movement of the followers 65 and follower carrier 60 in the manner heretofore described. Accordingly, in order that rocker shaft 68 oscillates with, but in the opposite direction from, shaft 67, the shafts 67, 68 have intermeshing gears 75, 76 fixed on the front and rear portions thereof adjacent the foremost and rearmost bearing brackets 72 (FIGURE 3).

The rocker shafts 67, 68 have respective groups of longitudinally spaced crank arms 80, 81 fixed thereon which also are parts of the paper or sheet advancing, feeding or conveying means, and which have respective longitudinally extending shafts 82, 83 fixed in the distal ends thereof. It will be observed in FIGURES 4, 6 and 19 that the crank arms 80 extend in the opposite direction from crank arms 81 and the shafts 82, 83 have respective coils 84, 85 fixed thereon upwardly from which pins or paper piercing elements 86 project.

It will also be observed in FIGURES 4 and 6, for example, that the cam track 66 is so formed that, when the cam followers 65 occupy lowermost position, the crank arms 80, 81 extend downwardly at an angle from the respective shafts 67, 68 so that the pins 86 carried thereby are spaced substantially below the level of the upper surfaces of the wires 15. Conversely, when follower carrier 60 moves upwardly from the position of FIGURE 4 to that of FIGURE 6, the followers 25 rock the cam tracks 66 inwardly or in a counterclockwise direction to move the free ends of the crank arms 80, 81 upwardly to thus move the corresponding pins 86 upwardly so that they project above the level of the wires 15. Of course, if paper or other sheet material S is then resting upon the wires, the pins will penetrate the paper.

By referring to FIGURE 2, it is apparent that the follower carrier 60 only moves upwardly when the carriage 45 occupies rearmost position, and it follows, therefore, that the paper is penetrated by the pins 86 and is then advanced as the carriage 45 moves forwardly with the upper run of chain 41. In so doing, one side edge portion of the paper is alined with and moved along the slot 36 in the then stationary mandrel 33.

At the same time that the paper or sheet material S is advanced from the position of FIGURE 2 to that of FIGURE 3, for example, the previously wound tube on

the mandrel 33 is stripped therefrom by a stripper means embodied in a wiper or stripper 90 which is in the form of an arm fixed to the foremost portion of the shaft 82 carried by the crank arms 80 heretofore described. In this connection, it will be observed in FIGURE 3 that shaft 82 extends forwardly a substantial distance beyond shaft 83 and a substantial distance beyond the foremost pins 86 and the leading edge of the sheet of paper S. This insures that the stripping of a completed tube from the mandrel 33 does not interfere with the positioning of a succeeding sheet in alinement with the mandrel 33 preparatory to the winding of a succeeding tube on the mandrel.

The wiper or stripper 90 has an arcuate, substantially semi-circular, concave, tube-engaging portion 91 on the free end thereof which is spaced substantially below the level of the mandrel 33 during rearward movement of carriage 45 (see FIGURE 4), but which is moved upwardly at the end of each rearward stroke of the carriage 45 and into close proximity to or against the mandrel 33 adjacent the permanently journaled end 34 thereof, as shown in FIGURE 5. Thus, with the next succeeding forward stroke of carriage 45, the free end 91 of wiper or stripper 90 engages the rear end of the tube T then completely wound on the mandrel 33 and pushes the tube off the free end of the mandrel 33. The movement of stripper 90 is uninterrupted throughout the stripping operation. Portion 91 of stripper 90 is preferably formed of or coated with plastic material, such as nylon.

As is conventional, the end 35 of mandrel 33 is suitably supported for rotation during the winding of the paper S around the mandrel 33, as by a bearing block 95 (FIGURE 4). Bearing block 95 is open at its upper portion so that it may move downwardly away from the then free end 35 of mandrel 33 so as to be positioned out of the path of the tube when the same is being stripped from the mandrel 33 in the manner heretofore described.

In this instance, the bearing block 95 for the free end of mandrel 33 is fixed on a crank 96 which extends outwardly, away from the wires 15, and is fixed on a shaft 97 journaled in a standard 100. Standard 100 is fixed to the platform 26 of frame 24. Shaft 97 has a crank 101 fixed thereon to which the upper end of a connecting rod 102 is pivotally connected.

The lower end of connecting rod 102 has a forked portion thereon which straddles crank shaft 31 and has a cam follower 103 thereon. Cam follower 103 engages an irregularly shaped groove 104 in one face of a cam wheel 105 fixed on cam shaft 31 (FIGURES 4 and 5-B).

From the foregoing, it is apparent that the free end 35 of mandrel 33 is not supported during the tube stripping operation. It is not important that a similar mandrel is supported along any portion of its length on conventional machines, because of the fact that the tubes and mandrel are relatively short. However, in order to form tubes of the length contemplated, which length may be twice or more than twice the length of tubes which have been formed on prior art convolute tube winding machines, it is necessary that means are provided, as embodied in the present invention, for supporting the tube and the mandrel during the stripping of the tube therefrom so the tube and the mandrel, and the groove 36 therein, are maintained sufficiently straight to insure that the paper is readily guided along and maintained partially within said groove and so that the mandrel does not impede the movement of the tube therealong for reasons heretofore described. Also, even though opposed ends of the mandrel are satisfactorily supported during each winding operation, it is desirable that the mandrel is further supported, to some extent, while the paper is being wound on the mandrel, so that the medial portion of the mandrel does not sag or bow to such extent as to cause the paper to be wound more tightly about the

medial portion of the mandrel than at opposed end portions thereof. The novel slicker bar construction of the present invention will now be described, since it, in part, yieldably supports the mandrel and the tube, during both the winding and stripping operations, and operates in conjunction with the novel more rigid tube and mandrel supporting means to be later described.

Upper Pressure Applying Units for Tube and Mandrel

Heretofore, conventional convolute tube winding machines have been equipped with so-called flat slicker plates, there having been one upper slicker plate or bar and one lower slicker plate or bar, which moved from positions spaced from the mandrel to positions such as to apply pressure along a substantially straight line at each of the upper and lower portions of the tube during the winding of the same. Here again, such plates might operate satisfactorily in the formation of relatively short paper tubes. However, when slicker plates of this type are used in the manufacture of relatively long tubes, it has been found that pressure has not been applied uniformly throughout their lengths and air bubbles are created between the successive convolutions of tubular or sheet material to such extent as to result in loose portions of the paper along the length of the tube being formed, thus resulting in an inferior product.

In lieu of the prior art type of slicker plates, there is provided in the present invention improved pressure applying means for applying pressure to the paper toward the mandrel during the winding operation which is embodied in a plurality of longitudinally disposed pairs or sets of laterally spaced slicker bars. Each pair or set of upper and lower slicker bars is mounted on an individual cradle so that they will seek their position to apply uniform pressure to the tube and mandrel at spaced points along its periphery and throughout its length during the winding operation, each of these spaced points being very narrow and thereby concentrating the pressure applied by the slicker bars.

In its preferred embodiment, as shown herein, each pressure applying unit includes two slicker bars and there are five sets of upper slicker bars and five sets of lower slicker bars. With the exception of the cam wheels which control the positions of the slicker bars, all the lower pressure applying units are identical to each other or substantially the same and all of the upper pressure applying units or sets of slicker bars are substantially the same.

Accordingly, the upper pressure applying units are generally designated at A, B, C, D, E, and the lower pressure applying units are designated at A'-E' reading from the rearmost to the foremost units, respectively (FIGURES 5, 5-A and 5-B). Since all of the upper pressure applying units may be identical, only the front upper pressure applying unit E will be described in detail and like parts associated with the other pressure applying units A-D will bear the same reference characters with the exception of the cams which operate the slicker bars. However, all the cams associated with the upper pressure applying units A-E will bear the same reference characters with the letter A, B, C, D or E applied thereto to correspond with the corresponding upper pressure slicker bars. The lower pressure applying units or sets of slicker bars shall also be described in a like manner in order to avoid repetitive description.

Each upper pressure applying unit includes two substantially parallel, laterally spaced slicker bars 111, 112 which are in the form of round rods suitably secured to and projecting downwardly from a plurality of cradle blocks, there being three such cradle blocks 113, 114, 115 provided for each pair of upper slicker bars 111, 112 (FIGURES 5, 5-A, 5-B and 18). Each of the cradle blocks 113, 114, 115, at a point approximately midway between and above the corresponding slicker bars 111, 112, is pivotally connected to the inner end of a corresponding crank arm 116.

In this instance, the two outside crank arms 116 of each pressure applying means A-E have the corresponding cradle blocks pivotally connected thereto by means of studs or shafts 117, each of which is fixed to the corresponding arm 116 and loosely penetrates the corresponding block 113 or 115, as the case may be. The enlarged head of each stud 117 has one end of a torsion spring 120 connected thereto. The torsion spring 120 is coiled about the corresponding stud 117 and its other end is connected to the corresponding cradle block 113 or 115 so as to normally urge the corresponding slicker bars 111, 112 and cradle blocks 113, 114, 115 in a counterclockwise direction in FIGURES 6 and 19. This counterclockwise movement is limited by engagement of the outermost slicker bar 111 with the lower surfaces of the corresponding crank arms 116.

The outer portions of the crank arms 116 associated with each upper pressure applying unit are pivotally mounted on a shaft 122 journaled in a corresponding pair of bearing stands or standards 123, 124 (FIGURES 5, 5-A, 5-B, 6, 18, 19 and 20). In order that the slicker bars 111, 112 of each set may yieldably engage the mandrel and the tube during the winding thereof about the mandrel 33, the shaft 122 of each pressure applying unit has a plurality of pressure brackets 125 adjustably secured thereon, there being one of the brackets 125 adjacent each crank arm 116.

In FIGURES 6, 18 and 19, each pressure bracket 125 has a portion 126 which overlies the corresponding crank arm 115 and is threadedly penetrated by an adjustment screw 130 having a spring seat 131 on its lower end which engages the upper end of a compression spring 132. The lower end of each compression spring bears against the corresponding crank arm 116. Each set screw 130 is locked in the desired adjusted position by a lock nut 133. Each pressure bracket 125 also has an abutment 134 thereon (FIGURES 6 and 19) against which crank arms 116 are normally urged by springs 132. Abutments 134 may move downwardly away from crank arms 116 when slicker bars 111, 112 are lowered to engage mandrel 33.

In addition to the three crank arms 113, 114, 115, each shaft 122 also has a relatively short crank arm 135 (FIGURES 18 and 20) loosely mounted thereon. It will be observed in FIGURE 20 that the end of crank arm 135 opposite from shaft 122 has a cuff member 136 journaled thereon which is loosely penetrated by the upper end of an extensibly adjustable link or connecting rod 140.

The connecting rods 140 extend downwardly, and loosely penetrate the platform 26, and each has a yoke member 142 on the lower end thereof which straddles the cam shaft 31 as shown in FIGURES 5, 5-A, 5-B and 7. Each yoke member 142 has a cam follower 143 on one side thereof which engages in an irregularly shaped cam groove 144 (FIGURE 7) formed in one face of a corresponding cam wheel, there being five such cam wheels and each of them bearing the reference character 145 with the corresponding letter A, B, C, D or E added in accordance with the particular pressure applying unit A-E operated thereby, as heretofore explained. In other words, the cam wheel in FIGURE 7 bears the reference numeral 145A. All of the cam wheels 145A, 145B, 145C, 145D, 145E (FIGURES 5, 5-A, 5-B) may be identical, because all of the upper pressure applying units A-E operate in unison both as to inward or downward and outward movement thereof. Accordingly, only the cam wheel 145A is shown in detail in FIGURE 7.

As heretofore stated, the crank arm 135 (FIGURES 18 and 20), to which the upper end of each corresponding connecting rod 140 is pivotally connected, is loosely mounted on the corresponding shaft 122. Thus, a latching mechanism is provided for latching or locking each crank arm 135 with respect to its respective shaft 122. Although each crank arm 135 may be tightly secured on the corresponding shaft 122, it is desirable that it is

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releasably connected thereto, in a manner to be presently described, in order that the corresponding sets of slicker bars 111, 112, may be swung outwardly to the broken line position of FIGURE 20, for example, so that the mandrel 33 may be readily accessible for the purpose of cleaning and repairing the same.

It will be observed, therefore, that the shaft 122 shown in FIGURES 18 and 20 has a collar 150 thereon provided with a notch 151 in its periphery which is adapted to be engaged by a free hooked end of a latch member 152. Latch member 152 is normally urged into engagement with collar 150 by a suitable spring 153, which is shown in FIGURE 20 in the form of a tension spring, one end of which is connected to latch member 152 and the other end of which is connected to the hub of the corresponding crank arm 135. The hub of crank arm 135 also has the medial portion of latch 152 pivotally connected thereto, as at 154 (FIGURE 20).

It is apparent that each shaft 122 moves with the corresponding link 140 and crank 135 whenever the latch 152 occupies the locked position shown in FIGURE 20 and, in so doing, the shaft 122 raises and lowers the corresponding crank arms 116 and slicker bars 111, 112 through the medium of the corresponding brackets 125 and springs 132. A post 156 may be fixed to platform 26 and positioned outwardly of each shaft 122 so as to support one of the corresponding brackets 125 and crank arms 116 when they are moved to the inoperative position shown in broken lines in FIGURE 20. It is apparent that only a single post 156 is required in order to support each upper pressure applying unit in the remote inoperative position shown in broken lines in FIGURE 20.

Lower Pressure Applying Units For Tube and Mandrel

It may be readily observed in FIGURES 5, 5-A, 5-B, 6, 18, 19 and 20 that the lower pressure applying units A'-E' include substantially the same elements as the upper pressure applying units A-E with the exception that they operate in a manner opposite from the upper pressure applying units, since the slicker bars thereof are positioned beneath the mandrel 33 instead of above the mandrel 33. The sequence of operation of the lower pressure applying units A'-E' differs from that of the upper pressure applying units A-E, as will be later described. However, since the lower pressure applying units A'-E' include substantially the same parts as the upper pressure applying units A-E, those parts of the lower units which correspond to parts of the upper units will bear the same reference characters with the prime notation added, in order to avoid repetitive description. The differences between the lower and upper units will be pointed out hereinafter.

In comparing the upper and lower pressure applying units A-E, A'-E', it will be observed that each shaft 122' is mounted in the same pair of bearing stands 123, 124 as the corresponding shaft 122 thereabove, and each crank arm 135' is fixed directly to the corresponding shaft 122' and extends outwardly therefrom in the opposite direction from the crank arms 116'. A latch mechanism, such as that shown in the upper central portions of FIGURES 18 and 20, is not required for the lower pressure applying units A'-E'.

It is particularly important to note that each of the cams 145A' through 145E' shown in FIGURES 8 and 10 to 13 has a somewhat different cam groove 144' therein from the others of these cams. These cam grooves 144' are so formed that all the lower slicker bars 111', 112' move downwardly in unison simultaneously with the upward movement of all of the upper slicker bars 111, 112. However, all of the upper slicker bars 111, 112 will remain in raised position throughout the stripping operation while, on the other hand, the slicker bars 111', 112' of the lower pressure applying units A'-E' move upwardly against the mandrel 33, in succession, following

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the movement of the stripper 90 thereby to thus assist in supporting the mandrel 33 during the stripping of the corresponding tube T off the mandrel 33.

Since the slicker bars 111, 112, 111', 112' must engage the tube being wound on the mandrel 33 under yieldable pressure, due to the gradually increasing diameter thereof, the lower slicker bars 111', 112' must necessarily engage the mandrel 33 under yieldable pressure as the slicker bars 111', 112' move upwardly following the movement of the stripper 90 thereby. Accordingly, since the mandrel is necessarily of small diameter, and quite heavy, the yieldability of the lower slicker bars 111', 112' renders them of insufficient strength to adequately support the mandrel so as to maintain the mandrel straight, of themselves, during the stripping operation. However, when both ends of mandrel 33 are rigidly supported (during rotation of mandrel 33), the lower slicker bars 111', 112' impart sufficient upward pressure against the mandrel and the tube being wound thereon to prevent any noticeable sagging of the medial portion of the mandrel. Since the lower slicker bars 111', 112' cannot adequately support mandrel 33 during the stripping and paper recharging operations, there are provided novel method and means for supporting and maintaining the mandrel straight throughout the recharging and stripping operations, which method and means will now be described.

Mandrel Supporting Structure

The tube and mandrel supporting structure is best shown in FIGURES 5, 5-A, 5-B and includes a plurality of longitudinally spaced vertically movable supports 161-165, each of which is in the form of a peripherally grooved or concave roller preferably made from a material having a relatively low coefficient friction, such as nylon or other suitable plastic material. Rollers 161, 162, 163, 164 serve as combination tube and mandrel supports while roller 165, which is spaced between the rollers 162, 163, serves only as a mandrel support, and functions in a manner somewhat different, with regard to the sequence of operation thereof, from the tube support rollers 161-164. It will be apparent, however, that mandrel support roller 165 may support the tube during the stripping operation and may subsequently support the mandrel after the tube passes thereby, without departing from the spirit of the invention. In fact, only a single combination tube and mandrel support roller, such as roller 163 or 164, for example, will suffice to prevent sagging of the front end of the mandrel 33, when operated in conjunction with roller 165, so the introduction of a new sheet of paper in groove 36 and the stripping of a tube off the mandrel 33 may be favorably effected.

It will be observed in FIGURES 5, 5-A and 5-B that the proximal ends of the lower slicker bars 111', 112' of the pressure applying units A'-E' are spaced apart from each other to accommodate the rollers 161, 162, 163 and 165. Also, the front ends of the slicker bars 111', 112' of lower pressure applying unit E' terminate short of the vertical plane of the corresponding pair of upper slicker bars 111, 112 to accommodate the tube support roller 164.

In order to insure that pressure is applied to the paper or other sheet material being wound on the mandrel 33 throughout the length thereof and, particularly at the areas corresponding to rollers 161-165, it will be noted that the proximal ends of adjacent upper slicker bars 111, 112 are staggered, not only with respect to each other, but also with respect to the ends of the lower slicker bars 111', 112' adjacent the rollers 161-164. Also, uninterrupted portions of the upper slicker bars 111, 112 overlie and extend beyond the gaps defined between the proximal ends of corresponding lower slicker bars 111, 112 adjacent the support rollers 161, 162, 163 and 165. It is apparent, in FIGURE 5-B, that the front ends of the slicker bars 111, 112 of upper pressure applying unit E extend beyond the front ends of the slicker bars 111', 112' of the corre-

sponding lower pressure applying unit E' to insure that the front end portion of the tube T which is to be subsequently engaged by roller 164, is tightly wound at the area corresponding to the roller 164.

The tube support rollers 161-164 and the mandrel support roller 165 are controlled by respective cams 161a-165a fixed on the cam shaft 31 (FIGURES 9 and 14-17). With the exception of the cam wheels 161a-165a, all the support rollers 161-165 are supported and operated in substantially the same manner, except for their sequence of operation. Accordingly, the intervening parts between the cams and the rollers will all bear the same reference characters and only one of them will be described in detail.

The parts associated with mandrel support roller 165 are shown more in detail (FIGURE 19) than the parts associated with the tube support rollers 161-164 and, therefore, the parts associated with mandrel support roller 165 will now be described in detail.

It will now be observed in FIGURE 19 that roller 165 is journaled on a stub shaft 170 secured to and projecting from a bracket 171. Bracket 171 is bifurcated and the two legs thereof straddle the inner portion of a lever 172 pivotally mounted, at its outer portion, on a bearing stand 173.

One of the arms of the bifurcated bracket 171 has a slot *a* therein which is penetrated by a screw *b* for adjustably securing the corresponding block and roller 165 on the lever 172 in the desired angularly adjusted position, it being noted that the inner portion of bracket 171 is pivotally connected, as at *c*, to the inner portion of lever 172 (FIGURE 19).

It is apparent that roller 165 is adjusted in the aforementioned manner so that, when the inner portion of lever 172 occupies its uppermost position, roller 165 may engage and rigidly support the mandrel 33 as shown in FIGURE 19. It is apparent that the remaining support rollers 161-164 are adjustable in the manner described with respect to support roller 165 so that they may be adjusted to accommodate the thickness of the wall of a completed tube when they are raised each time a tube T is wound on the mandrel 33.

A medial portion of lever 172 has the upper end of an extensibly adjustable connecting rod or link 175 pivotally connected thereto. Each link 175 extends downwardly and loosely penetrates the platform 26 and the lower bifurcate end thereof straddles the cam shaft 31. One side of the lower portion of each connecting rod 175 has a cam follower 176 thereon and the followers 176 associated with the respective support rollers 161-165 engage in irregularly shaped grooves 177 in the respective cam wheels 161a-165a (FIGURES 9 and 14-17).

It will be noted that the grooves 177 of the cam wheels 161a-164a each include high, low and medium surfaces *x*, *y* and *z* and the groove 177 in cam wheel 165a (FIGURE 15) includes a low surface *e* and a high surface *f*. All of the surfaces *z* of the grooves 177 are of the same length; i.e., they each extend through an arc of approximately 170°, during which all of the tube support rollers 161-164 occupy a partially raised or intermediate position in close proximity to the mandrel 33 but being spaced a greater distance therefrom than the thickness of the wall of the tube to be wound or being wound thereon. It should be noted that the tube support rollers 161-164 occupy the intermediate position throughout each return or rearward stroke of the stripper 90 so that they do not obstruct the path of movement of the stripper 90 therebeneath during each inactive rearward stroke thereof as shown in FIGURE 4.

Method of Operation

By comparing the cam grooves 177 of FIGURES 14-17 with those of FIGURES 10-13 thereabove, it will be noted that all of the cam followers 143 (FIGURE 7)

and 143' (FIGURES 8 and 10-13) would be in engagement with the low portions or surfaces of the corresponding cam grooves 144, 144' while the cam followers 176 are in engagement with the intermediate surfaces *z* in the cam grooves 177 of cam wheels 161a-164a. Thus, the lower slicker bars 111', 112' of all the lower pressure applying units A'-E' would also occupy raised position, in engagement with the mandrel and/or the tube being found thereon, during each rearward stroke of the stripper 90, and the slicker bars 111, 112 associated with all the upper pressure applying units A-E would also occupy fully lowered position in engagement with the periphery of the mandrel 33 and/or the paper or sheet material being wound thereon in the formation of the tube T.

It is apparent that the mandrel 33 is also rotating during each return stroke of the stripper 90 so that a new tube T is formed by the time stripper 90 reaches the end of each return or rearward stroke. The follower 103 (FIGURE 4) would also be in engagement with the high portion of the cam groove 104 in cam wheel 105 and bearing 95 would then be in engagement with the free end portion 35 of mandrel 33 during the return, rearward or inactive stroke of stripper 90.

In FIGURES 4 and 6 to 17, all the cam wheels 105, 145a, 145A'-145E' and 161a-165a are shown in the positions occupied thereby as cam carrier 60 (FIGURES 2 and 4) is moved upwardly with the left-hand portion of the endless sprocket chain 41 in FIGURE 2 and as the U-shaped or semi-circular portion 91 of stripper 90 is moved upwardly into active position closely adjacent or against the periphery of mandrel 33 and rearwardly of the rearmost end of the tube T which has just been completed.

At this time, it will be noted that the high surface of the groove 144 of cam wheel 145A is then in engagement with the follower 143 and the high surfaces of the grooves 144' of all the cam wheels 145A'-145E' are in engagement with the followers 143', thus indicating that the upper and lower slicker bars 111, 112, 111', 112' of all the pressure applying units A-E, A'-E' have moved away from the mandrel 33 and the tube T then on the mandrel. Thus, slicker bars 111, 112, 111', 112' would all occupy the positions shown in FIGURES 5, 5-A, 5-B. By referring to FIGURE 6, it will be noted that this permits the stripper 90 to move longitudinally of the mandrel 33 and above the lower slicker bars 111', 112' without either the tube or the stripper being hindered by any of the slicker bars 111, 112, 111', 112'.

All the upper slicker bars 111, 112 remain in raised, inoperative, position throughout each forward movement of stripper 90 in stripping a corresponding tube T from mandrel 33. However, in order to adequately support the mandrel during the stripping of the tube off the mandrel, and during which it is necessary that the bearing 95 of FIGURE 4 occupy a lowered position away from the free forward end 35 of mandrel 33, the slicker bars 111', 112' of the lower pressure applying units A'-E' successively return to raised position against mandrel 33 as the stripper element moves forwardly beyond each successive lower pressure applying unit A'-E'. In addition, the tube support rollers 161-164 move upwardly to fully operative position, in unison, as the followers 176 thereof are engaged by respective high surfaces *x* of the corresponding cam wheels 161a-164a.

This short upward stroke of the tube support rollers 161-164 occurs substantially simultaneously with the downward movement of the slicker bars 111', 112' of the lower pressure applying units A'-E' and with the upward movement of the slicker bars 111, 112 of the upper pressure applying units A-E. Thus, all the parts adjacent mandrel 33 and the corresponding tube T occupy the positions substantially as shown in FIGURES 5, 5-A, 5-B. It should be noted that, at this time, the mandrel support roller 165 (FIGURE 5-A) then occupies a lowered posi-

tion. It follows that, as the stripper 90 pushes the tube T forwardly along mandrel 33, the rollers 161-164 then support both the tube and mandrel 33 and roll in engagement with the tube T during the ejection or stripping thereof from the mandrel 33.

As the stripper 90 moves from left to right or forwardly in FIGURE 5, it passes above the bars 111', 112' of the first lower pressure applying unit A'. Now, it will be noted that the surface x of cam 161a (FIGURE 9) is relatively short, and this causes the first roller 161 to move downwardly as the cam surface y of cam wheel 161a engages the corresponding follower 176 so the stripper 90 may then pass above the first tube support roller 161 without engaging the same.

While the high portion of the groove 144' in cam wheel 145A' (FIGURE 8) is somewhat longer than the surface x of cam wheel 161a, it will be noted that the high portion of groove 144' of cam wheel 145A' is relatively short as compared to the high surfaces of the remaining grooves 144' in the corresponding cam wheels 145B'-145E'. By comparing FIGURES 5 and 8, it is apparent that, shortly after stripper 90 moves forwardly beyond the front ends of the slicker bars 111', 112' of the first lower pressure applying unit A', the low surface of the groove 144' of cam 145A' engages the corresponding follower 143' and moves the slicker bars 111', 112' of the first lower pressure applying unit A' upwardly against the mandrel 33.

It is apparent that, even though the rearmost slicker bars 111', 112' yieldably engage the mandrel 33, they do, nevertheless, provide some support for the mandrel 33 in lieu of the support previously provided by the first roller 161.

The stripper element 90 then continues its forward movement above the slicker bars 111', 112' of the second lower pressure applying unit B', until it moves into close proximity to the second tube support roller 162. Thereupon, since the high surface x of the cam wheel 162a (FIGURE 14) is somewhat longer than the corresponding surface x of cam wheel 161a, it is apparent that roller 162 moves downwardly in the same manner as the roller 161 previously moved downwardly. Also, since the high surface of the groove 144' of cam wheel 145B' is somewhat longer than the corresponding surface in cam wheel 145A', it is apparent that the slicker bars 111', 112' of the second lower pressure applying unit B' then move to fully raised position.

By referring to FIGURES 11, 12 and 13, it is apparent that the cam wheels 145C', 145D' and 145E' also cause the slicker bars 111', 112' of the succeeding pressure applying units C', D' and E' to move upwardly in succession immediately subsequent to the movement of the stripper 90 therebeyond.

Now, by referring to FIGURE 15 and comparing the shape of the cam groove 177 in cam 165a with the cam grooves 177 in the adjacent cam wheels 162a and 145C', it is apparent that mandrel support roller 165 is moved upwardly from a position below the level of the path of travel of stripper 90 to a position in supporting engagement with the mandrel 33 immediately following the movement of the stripper 90 and the rear end of the tube T therebeyond. It will be noted that this upward movement of mandrel support roller 165 also occurs at substantially the same time that the immediately preceding bars 111', 112' of the third lower pressure applying unit C' move upwardly into engagement with the mandrel 33. Since there is no resilient or yieldable connection between mandrel support roller 165 and cam wheel 165a (FIGURE 5-A), it is apparent that the mandrel support roller 165 then provides a solid, unyielding support for the medial portion of mandrel 33 during the remainder of the corresponding stripping operation (see FIGURE 19).

As heretofore stated, during the forward movement of stripper 90 with carriage 45, the pins 86 (FIGURE 6) will have engaged and penetrated a succeeding sheet of paper S and will be advancing the same at the same time

that the stripper 90 is pushing a previously formed tube T off the mandrel 33. It should be noted that the novel mandrel supporting apparatus thus supports and maintains the mandrel 33 straight throughout its length and prevents undue vibration of mandrel so the groove 36 extending longitudinally of the mandrel is also maintained straight and it will not impede the movement of the corresponding edge portion of the sheet of paper S therealong as the stripper is pushing a tube T off the mandrel 33.

Now, by comparing the cam wheels 145A and 145E' of FIGURES 7 and 13, it will be noted that the high surfaces of the grooves 144, 144' of these respective cam wheels are substantially the same. Thus, as the slicker bars 111', 112' of the last or fifth of the lower pressure applying units E' move upwardly into engagement with mandrel 33, all of the bars 111, 112 of the upper pressure applying units A-E then move downwardly into yielding engagement with the mandrel 33.

It will be noted that all the lower pressure applying bars 111', 112' remain in raised position, even though they are raised in succession, until after the upper slicker bars 111, 112 of the upper pressure applying units A-E have moved downwardly and the winding of a succeeding tube T has been completed. At substantially the same time that the upper pressure applying units A-E and the last of the lower pressure applying units E are activated, the high surface of the groove 104 of cam 105 (FIGURE 4) engages follower 103 and returns the bearing 95 into engagement with the free end portion 35 of mandrel 33 substantially at the same time that tube support roller 165 returns to lowered position, whereupon mandrel 33 starts rotating to complete a cycle in the operation of the apparatus.

It is apparent, that during each return or rearward stroke of the carriage 45 with stripper 90, the lower slicker bars 111', 112' of the lower pressure applying units A'-E' occupy raised position, and the tube support roller 165 (FIGURES 5-A and 19) then occupies a sufficiently high position so that the stripper 90, which then occupies the level substantially as shown in FIGURE 4, may readily move rearwardly without being encumbered by any of the pressure applying units or tube support rollers 161-164 or the mandrel support roller 165. The springs 131' (FIGURE 18) associated with the lower slicker bars 111', 112' apply sufficient upward pressure, although yieldable, to the corresponding lower slicker bars to insure that the medial portion of the mandrel 33 is maintained straight and aligned with the then rigidly supported end portions of the mandrel 33, thus further insuring that the paper is wound about the mandrel 33 under substantially uniform tension throughout the length thereof. However, as heretofore stated, undue vibration or distortion of the free end of mandrel 33 may be obviated, in most instances, by the use of a single one of the tube support rollers 161-164 alternating in its operation with the operation of the mandrel support roller 165. The additional tube support rollers are desirable to increase the efficiency of the machine.

It is thus seen that we have provided a new and improved method and apparatus for supporting elongate mandrels of a convolute tube winding machine particularly during such times as the front end of the mandrel is free and unsupported, thereby greatly facilitating the stripping of the tubes off the free end of the mandrel, facilitating the proper aligning of a succeeding sheet with the mandrel, and facilitating the production, by machinery, of convolute tubes of much greater length than has heretofore been possible on any prior convolute tube winding machine, to our knowledge. The production of an elongate tube according to the present invention is greatly facilitated by our novel series of relatively short upper and lower, overlapping slicker bars wherein the upper slicker bars are operated in unison in their movement toward and away from the mandrel and the tube

wound thereon and the lower slicker bars are successively moved upwardly against the mandrel as the rear portion of each successive tube passes beyond the same in the stripping operation, the overlapping of the upper and lower slicker bars insuring that all portions or adjacent layers of the sheet material are smoothly and tightly adhesively interconnected, even though the ends of the lower slicker bars are, in effect, cut away to accommodate the novel tube and mandrel support rollers of the present invention.

In the drawings and specification there has been set forth a preferred embodiment of the invention, and although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being defined in the claims.

We claim:

1. A method of stripping elongate convolute tubes forwardly off the free end of a mandrel whose rear end is journaled and about which each successive tube is wound which comprises the steps of

(a) engaging and applying a pushing force against the rear end of the tube and longitudinally of the mandrel while positively supporting the tube and mandrel at at least one point along a medial portion of said tube and said mandrel to maintain the mandrel substantially straight,

(b) withdrawing support from the tube as its rear end approaches said point of support, and

(c) positively supporting a medial portion of said mandrel to maintain the mandrel substantially straight when the trailing end of the tube passes therebeyond and during the remainder of the period in which the tube is being pushed off the free end of the mandrel.

2. A method of making elongate convolute tubes from relatively thin sheet material utilizing a substantially horizontally disposed, elongate, rotatable mandrel about which sheet material is adapted to be wound and having a front end beyond which each successive tube is stripped upon being formed, said method comprising,

(a) rotating said mandrel and taking up the sheet material thereon to form a tube while applying yielding force substantially laterally inwardly against the upper and lower surfaces of said mandrel and along each of a plurality of relatively narrow longitudinally extending areas of the tube being formed wherein the areas collectively embrace the entire length of the tube but each area is of substantially lesser length than that of the tube being formed,

(b) substantially simultaneously releasing the pressure from all of said areas upon the winding of a tube being completed.

(c) applying a pushing force against the rear end of the tube and longitudinally of the mandrel to strip the tube off the front end of the mandrel, and

(d) successively applying yielding upward pressure to a plurality of predetermined substantial areas of the length of the mandrel rearwardly of, during and in timed relation to the movement of the rear end of the tube forwardly beyond said substantial areas of the length of the mandrel.

3. In a method of winding elongate convolute tubes on a rotatable mandrel permanently supported for rotation at its rear end which comprises connecting one longitudinal edge of a sheet material to a longitudinal portion of the mandrel, and rotating the mandrel to wind the sheet material thereabout while positively rotatably supporting the front end of the mandrel; the steps of

(a) applying a yieldable pressure along a plurality of elongate relatively short overlapping areas which collectively extend substantially throughout the entire length of the tube and the mandrel during the winding of the tube on the mandrel,

(b) stopping the mandrel upon completion of the winding of the tube thereon,

(c) then releasing the tube from said yieldable pressure and releasing the front end of the mandrel,

(d) applying a pushing force against the rear end of the tube thus formed to strip the tube off the front end of the mandrel while positively supporting the tube and the mandrel at a plurality of points spaced longitudinally of said mandrel to maintain the mandrel substantially straight,

(e) successively withdrawing the support of the tube at said points, as its rear end approaches each successive point of support, and

(f) positively supporting a medial portion of said mandrel to maintain the mandrel substantially straight throughout its length when the trailing end of the tube passes therebeyond and during the remainder of the period in which the tube is being pushed off the front end of the mandrel.

4. A method of maintaining straight an elongate mandrel about which elongate convolute tubes are wound from a sheet material and wherein the mandrel has a straight groove throughout its length for receiving one edge portion of the sheet material therein preparatory to the winding of each successive tube on the mandrel, the rear end of the mandrel being permanently journaled and the front end of the mandrel being rotatably supported during each tube winding operation but being unsupported during insertion of said one edge portion of the sheet material in the groove thereof; said method comprising

(a) positively supporting the tube and mandrel at a plurality of points spaced longitudinally of the mandrel at the completion of winding each successive tube on the mandrel such that the mandrel and its groove are maintained substantially straight throughout their length,

(b) applying a pushing force against the rear end of a tube on the mandrel to strip the tube off the front end of the mandrel while pulling a succeeding length of sheet material behind the rear end of the tube with one longitudinal edge of the latter sheet material moving along within the groove in the mandrel,

(c) successively withdrawing the support of the tube and the mandrel at said points while the tube is moving and as the rear end of the tube approaches each successive point of support,

(d) positively supporting a medial portion of said mandrel at at least one stripped point to maintain the mandrel substantially straight throughout its length when the trailing end of the tube passes therebeyond and during the remainder of the period in which the tube is being pushed off the free end of the mandrel and said edge of the latter sheet material is being positioned in said groove, and

(e) then withdrawing the support of the mandrel at said stripped point preparatory to winding a succeeding tube on the mandrel from the latter length of sheet material.

5. A method according to claim 4 including the further steps of applying a strong but yielding force upwardly against the lower portion of the mandrel and along a substantial portion of the length thereof during the winding of the latter sheet material on the mandrel from sagging or bowing at its medial portion between the journaled rear end and the supported front end thereof so the sheet material is maintained at uniform tension throughout the length thereof during the winding operation.

6. In an apparatus having a rotatable mandrel about which sheet material is adapted to be wound in the forming of convolute tubes thereon, and said apparatus including a stripper for engaging the mandrel therebeneath and applying a pushing force against the rear end of the

tube and longitudinally toward and beyond the free front end of the mandrel for stripping the tube off the mandrel; the combination therewith of

- (a) a relatively small tube support positioned at a medial portion of said mandrel and engageable with the tube during forward movement of the tube longitudinally of the mandrel,
- (b) means to release said support from engagement with said tube as the stripper and the rear end of the tube approach the support, and
- (c) movable means positively supporting a medial portion of said mandrel when the trailing end of the tube passes therebeyond and during the remainder of the period in which the tube is being pushed off the free front end of the mandrel so as to prevent sagging of the mandrel and to prevent undue vibration of the mandrel as the stripper moves beyond the front end of the mandrel.

7. In an apparatus having a rotatable mandrel about which sheet material is adapted to be wound in the forming of convolute tubes thereon, and said apparatus including stripper means for engaging and applying a pushing force against the rear end of the tube and longitudinally toward the free front end of the mandrel for stripping the tube off the mandrel; the combination therewith of

- (a) a plurality of relatively small tube supports spaced longitudinally of said mandrel and engageable with the tube during forward movement of the tube longitudinally of the mandrel,
- (b) means to successively release said supports from engagement with said tube as the stripper and the rear end of the tube approach each successive support, and
- (c) movable means positively supporting a medial portion of said mandrel when the trailing end of the tube passes therebeyond and during the remainder of the period in which the tube is being pushed off the free front end of the mandrel.

8. Apparatus according to claim 7, in which each of said tube supports includes a freely rotatable roller journaled on an axis beneath the level of and transversely of the axis of the mandrel whereby said rollers are rotated by engagement of the tube therewith during forward movement of the tube.

9. Apparatus according to claim 8, in which each roller has a concave peripheral surface thereon.

10. Apparatus according to claim 7, including

- (d) a plurality of longitudinally extending circularly spaced and substantially longitudinally aligned upper and lower slicker bars adjacent upper and lower portions of said mandrel and normally spaced therefrom,
 - (1) each of said slicker bars being substantially shorter than the length of the mandrel,
 - (2) means for successively moving at least the lower slicker bars into yielding engagement with the mandrel as the rear end of the tube passes forwardly of each successive lower slicker bar, and
 - (3) means for moving the upper slicker bars into yielding engagement with the periphery of the mandrel substantially upon movement of the rear end of the tube beyond the front end of the mandrel whereby the lower slicker bars assist in supporting the mandrel during the stripping of the tube off the front end thereof and all the slicker bars may apply pressure longitudinally against the mandrel and the sheet material during the winding of a succeeding tube on the mandrel.

11. Apparatus according to claim 10, in which corresponding ends of the lower slicker bars terminate closely adjacent to the tube and mandrel supports, and said upper slicker bars terminate in relative overlapping

relationship and in overlapping relationship with respect to adjacent ends of the lower slicker bars.

12. In a convolute tube winding machine having an elongate rotatable mandrel about which sheet material is adapted to be wound in the forming of tubes thereon, said mandrel having a free end beyond which each successive tube is moved upon being formed, and stripper means movable along and closely adjacent said mandrel toward the free end thereof for stripping each successive tube off the mandrel; the combination of

- (a) a plurality of tube supports spaced longitudinally of and adjacent said mandrel,
- (b) a mandrel support adjacent a medial portion of said mandrel and normally being out of engagement therewith during the tube winding operation,
- (c) means for moving said tube supports against the lower surface of the tube upon each successive tube being wound on the mandrel and for progressively moving the tube supports away from said tube while said stripper means is moving the tube and as said stripper means approaches each successive tube support, and
- (d) means for moving said mandrel support into supporting engagement with said mandrel when said stripper means passes therebeyond and during movement of said stripper means in stripping a tube off the mandrel and for withdrawing the mandrel support at a predetermined period thereafter in preparation for the next tube forming operation.

13. A structure according to claim 12, in which each support includes a roller journaled for rotation about a transverse axis relative to the longitudinal axis of said mandrel, the rollers of the tube supports being engageable with the tube and the roller of the mandrel support being engageable with the mandrel.

14. In an apparatus for winding elongate convolute tubes having a rotatable mandrel permanently supported for rotation at its rear end, means for connecting one longitudinal edge of a sheet material to a longitudinal portion of the mandrel whereby the sheet material may be wound about the mandrel during rotation thereof, first movable means positively rotatably supporting the front end of the mandrel during rotation thereof, and a stripper for applying a pushing force against the rear end of the tube thus formed to strip the tube off the front end of the mandrel; the combination of

- (a) means for applying a generally radially inward yieldable pressure along a plurality of relatively narrow, elongate areas each of substantially lesser length than the tube to be formed, but which collectively extend substantially throughout the entire length of the tube during the winding thereof on the mandrel,
- (b) means for releasing the tube from said yieldable pressure applying means upon completion of the winding of each successive tube on the mandrel,
- (c) means for releasing the front end of the mandrel from said movable means,
- (d) second means positively supporting the tube and the mandrel at a plurality of points spaced longitudinally of said mandrel during the stripping of the tube off the mandrel by said stripper,
- (e) means to successively release the tube from said second supporting means as its rear end approaches each successive point of support, and
- (f) third means for positively supporting a medial portion of said mandrel when the trailing end of the tube passes therebeyond and during the remainder of the period in which the tube is being pushed off the front end of the mandrel.

15. Apparatus according to claim 14, in which each of said second supporting means includes a freely rotatable roller journaled on an axis beneath the level of and transversely of the axis of the mandrel whereby

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said rollers may be rotated by engagement of the tube therewith during forward movement of the tube.

16. In an apparatus for winding elongate convolute tubes having a rotatable mandrel permanently supported for rotation at its rear end, means for connecting one longitudinal edge of a sheet material to a longitudinal portion of the mandrel whereby the sheet material may be wound about the mandrel during rotation thereof, first means positively rotatably supporting the front end of the mandrel during rotation thereof and being movable away from the mandrel following the winding of each successive tube on the mandrel, and a stripper for applying a pushing force against the rear end of the tube thus formed to strip the tube off the front end of the mandrel; the combination of

- (a) means for applying a generally radially inward yieldable pressure along a plurality of elongate relatively narrow and overlapping areas each of substantially lesser length than the tube being formed which collectively extend substantially throughout the entire length of the tube during the winding thereof on the mandrel,
- (b) means for releasing the tube from said yieldable pressure applying means upon completion of the winding of each successive tube on the mandrel,
- (c) second means positively supporting the tube and the mandrel at a plurality of points spaced longitudinally of said mandrel during the stripping operation,
- (d) means to successively release the tube from said second supporting means as the rear end of the tube approaches each successive point of support, and
- (e) third means for positively supporting a medial portion of said mandrel when the trailing end of the tube passes therebeyond and during the remainder of the period in which the tube is being pushed off the front end of the mandrel.

17. In an apparatus having a rotatable mandrel about which sheet material is adapted to be wound in the form of convolute tubes thereon and said apparatus including means for engaging and applying a pushing force against the rear end of each successive tube and longitudinally thereof for stripping the same off the front end of the mandrel, the combination therewith of

- (a) a plurality of longitudinally extending upper and lower slicker bars adjacent respective upper and lower portions of said mandrel for engaging and pressing the sheet material during winding thereof into tubes,
- (b) means for moving said slicker bars away from said mandrel prior to stripping the formed tube therefrom,
- (c) each of said slicker bars being substantially shorter than the length of the mandrel, but collectively embracing at least the length of the tube being formed on the mandrel, and
- (d) means for successively moving successive lower slicker bars into yielding engagement with the mandrel as the rear end of the tube passes forwardly of each successive lower slicker bar and during forward movement of the tube whereby the lower slicker bars are in yielding supporting engagement with the periphery of the mandrel upon movement of the rear end of the tube thereby and off the front end of the mandrel.

18. A structure according to claim 17, including means for moving the upper slicker bars into yielding engagement with the upper portions of the periphery of the mandrel substantially upon movement of the rear end of the tube off the front end of the mandrel whereby the upper and lower slicker bars are again in position to engage and press adjacent convolutions of sheet ma-

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terial together during the subsequent forming of a tube on the mandrel.

19. In an apparatus having a rotatable mandrel about which sheet material is adapted to be wound in the form of convolute tubes thereon and said apparatus including stripper means for stripping each successive tube off the front end of the mandrel, the combination therewith of

- (a) a plurality of longitudinally extending circularly spaced and substantially longitudinally aligned upper and lower sets of slicker bars adjacent respective upper and lower portions of said mandrel for engaging and pressing the sheet material during winding thereof into tubes,
- (b) means for moving said slicker bars away from said mandrel prior to stripping the formed tube therefrom,
- (c) each of said slicker bars being substantially shorter than the length of the mandrel,
- (d) said slicker bars collectively embracing at least that much of the length of the mandrel about which successive tubes are wound, and
- (e) means for successively moving the lower slicker bars into yielding engagement with the mandrel as the rear end of the tube passes forwardly of each successive lower slicker bar and during forward movement of the tube whereby the lower slicker bars are in yielding and supporting engagement with the periphery of the mandrel upon movement of the rear end of the tube off the front end of the mandrel.

20. A structure according to claim 19, including means for moving the upper slicker bars into yielding engagement with the upper portions of the periphery of the mandrel substantially upon movement of the rear end of the tube off the front end of the mandrel whereby the upper and lower slicker bars are again in position to engage and press adjacent convolutions of sheet material together during the subsequent forming of a tube on the mandrel.

21. A structure according to claim 19, wherein the ends of adjacent upper slicker bars terminate in overlapping relationship.

22. In an apparatus for making elongate convolute tubes from relatively thin sheet material, said apparatus having a substantially horizontally disposed, elongate rotatable mandrel about which sheet material is adapted to be wound and having a front end beyond which each successive tube is stripped upon being formed, and means to apply a pushing force against the rear end of the tube and longitudinally of the mandrel to strip the tube off the front end of the mandrel; the combination therewith of

- (a) means applying a yielding force substantially laterally inwardly against the upper and lower surfaces of said mandrel and along each of a plurality of longitudinally extending areas of the tube being formed but of substantially lesser length than that of the tube being formed while said mandrel is rotating and taking up the sheet material thereon,
- (b) means to substantially simultaneously release the pressure of said yielding force from all of said areas upon the winding of a tube being completed, and
- (c) said last-named means being operable to cause said pressure applying means to successively apply a yielding upward pressure to predetermined substantial areas of the length of the mandrel rearwardly of and in timed relation to and during the movement of the rear end of the tube forwardly beyond said substantial areas of the length of the mandrel.

23. Apparatus according to claim 22, in which said pressure applying means comprises

- (d) a plurality of longitudinally extending pairs of circularly spaced and substantially longitudinally aligned slicker bars adjacent upper and lower portions of said mandrel and normally spaced therefrom,
- (e) means pivotally supporting each pair of slicker bars for movement about an axis substantially paral-

- lel to and spaced outwardly from said mandrel whereby each bar is self-locating when moved against the mandrel or the sheet material on the mandrel,
- (f) means for successively moving at least the lower pairs of slicker bars into yielding engagement with the mandrel as the rear end of the tube passes forwardly of each successive lower pair of slicker bars, and
- (g) means for moving the upper slicker bars into yielding engagement with the periphery of the mandrel substantially upon movement of the rear end of the tube beyond the front end of the mandrel whereby the lower pairs of slicker bars may support the mandrel during the stripping of the tube off the front end thereof and all the slicker bars may apply pressure longitudinally against the mandrel and the sheet material during the winding of a succeeding tube on the mandrel.
24. In an apparatus having a rotatable mandrel about which sheet material is adapted to be wound in the form of convolute tubes thereon and said apparatus including stripper means for stripping each successive tube off the front end of the mandrel, the combination therewith of
- (a) a plurality of relatively short upper and lower longitudinally extending and substantially longitudinally aligned slicker bars adjacent said mandrel for engaging and pressing the sheet material during winding thereof into tubes,
- (b) means for moving said slicker bars away from said mandrel prior to stripping the formed tube therefrom,
- (c) each of said slicker bars being substantially shorter than the length of the mandrel,
- (d) said slicker bars collectively embracing at least that much of the length of the mandrel about which successive tubes are wound, and
- (e) means for successively raising the lower slicker bars into yielding engagement with the mandrel as the rear end of the tube passes forwardly of each successive slicker bar whereby all the lower slicker bars are in yielding and supporting engagement with the periphery of the mandrel upon movement of the rear end of the tube off the front end of the mandrel.
25. In a tube winding machine having an elongate mandrel about which elongate convolute tubes are adapted to be wound from a sheet material, said mandrel having a straight groove throughout its length for receiving one edge portion of a sheet material therein preparatory to the winding of each successive tube on the mandrel, the rear end of the mandrel being permanently journaled and the front end of the mandrel being rotatably supported during each tube winding operation but being unsupported during insertion of said one edge portion of the sheet material in the groove thereof; the combination of
- (a) means positively supporting the tube and mandrel at at least one point located intermediate the ends of the mandrel at the completion of winding each successive tube on the mandrel such that the mandrel and its groove are maintained substantially straight throughout their length,
- (b) means applying a pushing force against the rear end of a tube on the mandrel while engaging the lower surface of the mandrel to strip the tube off the front end of the mandrel while pulling a succeeding length of sheet material behind the rear end of the tube with one longitudinal edge of the latter sheet material moving along within the groove in the mandrel,
- (c) means to withdraw the supporting means to release the tube therefrom as its rear end approaches said positive supporting means,
- (d) second positive supporting means engageable with a medial portion of said mandrel when the trailing end of the tube passes therebeyond and during the remainder of the period in which the tube is being pushed off the front end of the mandrel and said edge

- of the latter sheet material is being positioned in said groove, and
- (e) means to release said last-named medial portion from said second supporting means preparatory to winding a succeeding tube on the mandrel from the latter length of sheet material.
26. Apparatus according to claim 25, including means to apply a strong, yielding force upwardly against the lower portion of the mandrel and along a substantial portion of the length thereof during the winding of the latter sheet material on the mandrel to thereby prevent the mandrel from sagging or bowing at its medial portion between the journaled rear end and the then supported front end thereof so the sheet material is maintained at uniform tension throughout its length during the winding operation.
27. In an apparatus having a rotatable mandrel about which sheet material is adapted to be wound in the forming of convolute tubes thereon, and said apparatus including a stripper for engaging the mandrel therebeneath and applying a pushing force against the rear end of the tube and longitudinally toward and beyond the free front end of the mandrel for stripping the tube off the mandrel; the combination therewith of
- (a) at least one tube support positioned at a medial portion of said mandrel and engageable with the tube during forward movement of the tube longitudinally of the mandrel,
- (b) means to release said support from engagement with said tube as the stripper and the rear end of the tube approach the support, and
- (c) movable means supporting a medial portion of said mandrel when the trailing end of the tube passes therebeyond and during the remainder of the period in which the tube is being pushed off the free front end of the mandrel so as to prevent sagging of the mandrel and to minimize undue vibration of the mandrel as the stripper moves beyond the front end of the mandrel.
28. A method of stripping tubes from one end of a mandrel about which mandrel each successive tube is formed which comprises the steps of
- (a) moving the formed tube toward said one end of the mandrel while supporting the other end of the mandrel and while supporting the mandrel at at least one point along its length to maintain the mandrel substantially straight throughout its length,
- (b) withdrawing the support of the mandrel at said one point upon movement of the tube a predetermined distance along the mandrel, and
- (c) supporting the mandrel at at least one stripped point to maintain the mandrel substantially straight throughout its length while the tube is moving beyond said stripped point and off the end of the mandrel.
29. In an apparatus having a rotatable mandrel about which sheet material is adapted to be wound in the forming of convolute tubes thereon, and said apparatus including stripper means for engaging and moving the tube longitudinally toward and beyond one end of the mandrel for stripping the tube off the mandrel; the combination therewith of
- (a) at least one support supporting said mandrel at a point along its length to maintain the mandrel substantially straight during movement of the tube toward said one end of the mandrel,
- (b) means to withdraw said support from said mandrel upon predetermined movement of said tube toward said one end of said mandrel, and
- (c) movable means supporting the mandrel at at least one stripped portion of said mandrel to maintain the mandrel substantially straight while the tube is being moved beyond said stripped portion and off the free front end of the mandrel.
30. A method of maintaining straight an elongate mandrel about which elongate convolute tubes are wound

from a sheet material and wherein the mandrel has a straight groove throughout its length for receiving one edge portion of the sheet material therein preparatory to the winding of each successive tube on the mandrel, the rear end of the mandrel being permanently journaled and the front end of the mandrel being rotatably supported during each tube winding operation but being unsupported during insertion of said one edge portion of the sheet material in the groove thereof; said method comprising

- (a) supporting the tube and mandrel at a plurality of points spaced longitudinally of the mandrel at the completion of winding each successive tube on the mandrel to maintain the mandrel and its groove substantially straight throughout their length,
- (b) moving the tube toward the front end of the mandrel to strip the tube off the front end of the mandrel while pulling a succeeding length of sheet material behind the rear end of the tube with one longitudinal edge of the latter sheet material moving along within the groove in the mandrel,
- (c) successively withdrawing the support of the tube and the mandrel at said points as the rear end of the tube approaches each successive point of support,
- (d) supporting said mandrel at at least one stripped point to maintain the mandrel substantially straight while the tube is moving beyond said stripped point and off the free end of the mandrel and while said edge of the latter sheet material is being positioned in said groove,
- (e) then withdrawing the support of said mandrel at said stripped point, and
- (f) then winding a succeeding tube on the mandrel from the latter length of sheet material.

31. A method of making elongate convolute tubes from relatively thin sheet material utilizing an elongate rotatable mandrel about which sheet material is adapted to be wound and having a free end beyond which each successive tube is moved upon being formed; said method comprising

- (a) rotating said mandrel and taking up the sheet material thereon to form the tube,
- (b) then stripping the tube off the free end of the mandrel before forming a succeeding tube thereon by applying a pushing force against the trailing end of the tube opposite from the free end of the mandrel while supporting the tube and the mandrel at a plurality of points spaced longitudinally of said mandrel to maintain the mandrel substantially straight,
- (c) progressively withdrawing support from the tube as its trailing end approaches each successive point of support while maintaining the mandrel substantially straight, and
- (d) supporting a medial portion of said mandrel to maintain the mandrel substantially straight throughout-

out its length when said trailing end of the tube passes therebeyond and during the remainder of the period in which the tube is being stripped off the mandrel.

32. A method of stripping elongate convolute tubes forwardly off the free end of a mandrel about which each successive tube is wound which comprises the steps of

- (a) moving the formed tube forwardly toward said free end of the mandrel while positively supporting the tube and mandrel at a plurality of points spaced longitudinally of said mandrel to maintain the mandrel substantially straight,
- (b) successively withdrawing support of the tube and the mandrel as the trailing end of the tube approaches each successive point of support while maintaining the mandrel substantially straight,
- (c) positively supporting a medial portion of said mandrel to maintain the mandrel substantially straight throughout its length when the trailing end of the tube passes therebeyond and during the remainder of the period in which the tube is moving off the free end of the mandrel, and
- (d) successively applying a yielding upward pressure to predetermined substantial portions of the length of the mandrel but rearwardly of and in timed relation to the movement of the rear end of the tube forwardly of successive predetermined portions of the length of the mandrel.

33. A method of stripping elongate convolute tubes forwardly off the free end of a mandrel whose rear end is journaled and about which each successive tube is wound which comprises the steps of

- (a) engaging and applying an uninterrupted pushing force against the rear end of the tube and longitudinally of the mandrel while positively supporting the tube and mandrel at a plurality of points spaced longitudinally of said mandrel to maintain the mandrel substantially straight,
- (b) successively withdrawing the support of the tube and the mandrel at said points as the rear end of the tube approaches each successive point of support, and
- (c) positively supporting a medial portion of said mandrel at at least one stripped point to maintain the mandrel substantially straight throughout its length when the trailing end of the tube passes therebeyond and while the tube is being pushed beyond said stripped point off the free end of the mandrel.

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