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[54] **FOLDING DEVICE FOR TIRE BELTS**
15 Claims, 2 Drawing Figs.

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[50] **Field of Search** 156/204, 227, 394, 443, 444, 439, 460, 461, 465, 466, 474; 270/69

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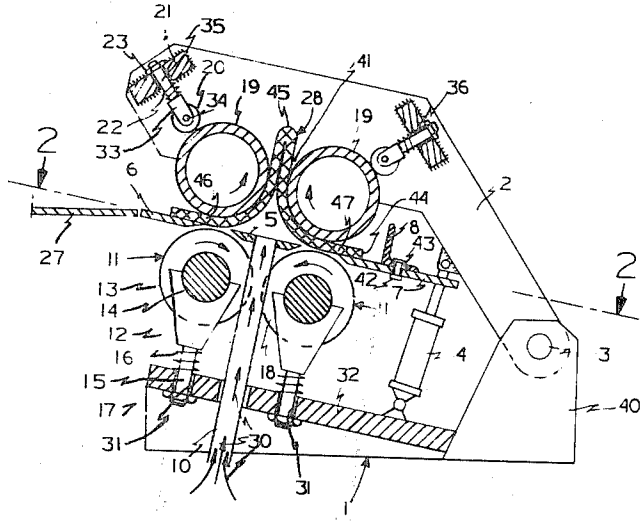
ABSTRACT: A device for folding strips of rubber-coated cord fabric so that the folded strips can be used as belt inserts in vehicle tires. The unfolded strip is fed down an inclined table into a folding zone where it is pinched between upper and lower pairs of rollers, both motor driven. Pressurized jets of air impinge upon the underside of the fabric at spaced intervals, and force the central portion of it upwardly into a folding gap between the upper pair of rollers. The upper rollers are smooth surfaced so as to achieve more intimate contact with the tacky rubberized fabric, and therefore drag the fabric into the folding gap to complete the folding operation. The lower rollers are grooved for less intimate contact, but temporary driving engagement with the fabric, and they can be driven at a different surface speed than the upper rollers to assist in conveying the fabric toward the entrance of the folding gap. Axially spaced bearings and rolling reinforcements for the lower and upper rollers respectively are yieldably and adjustably mounted. The upper rollers are mounted on a pivotable rack which is raised by an air cylinder to permit the insertion of the fabric, and then lowered by the cylinder to perform the folding operation.



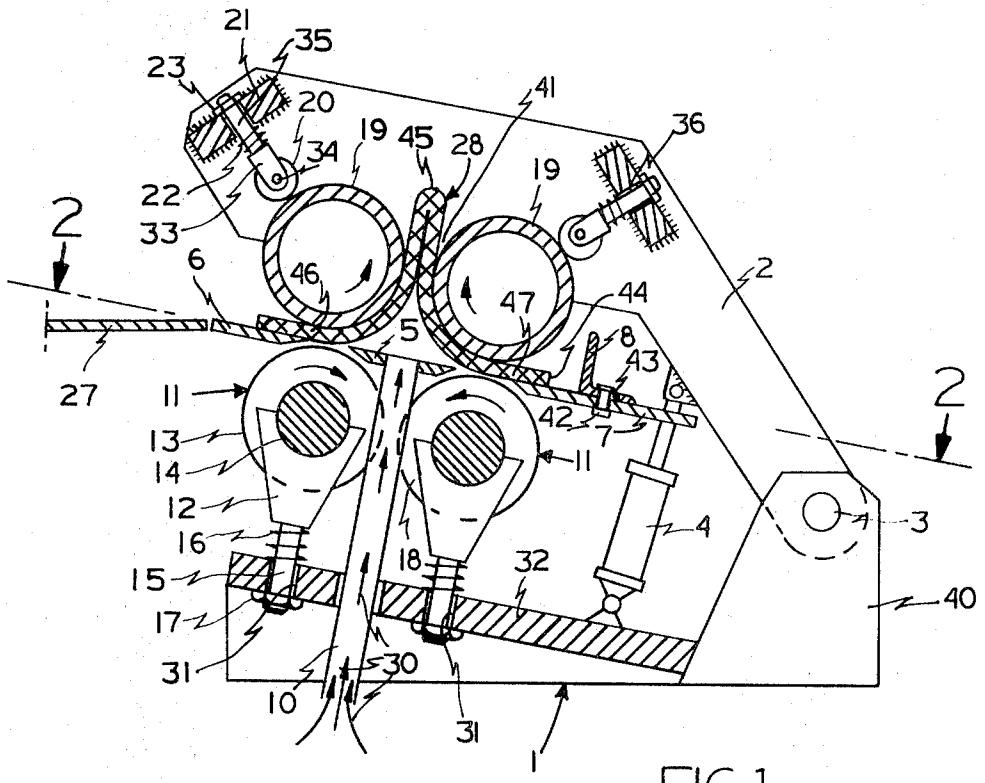


FIG. 1

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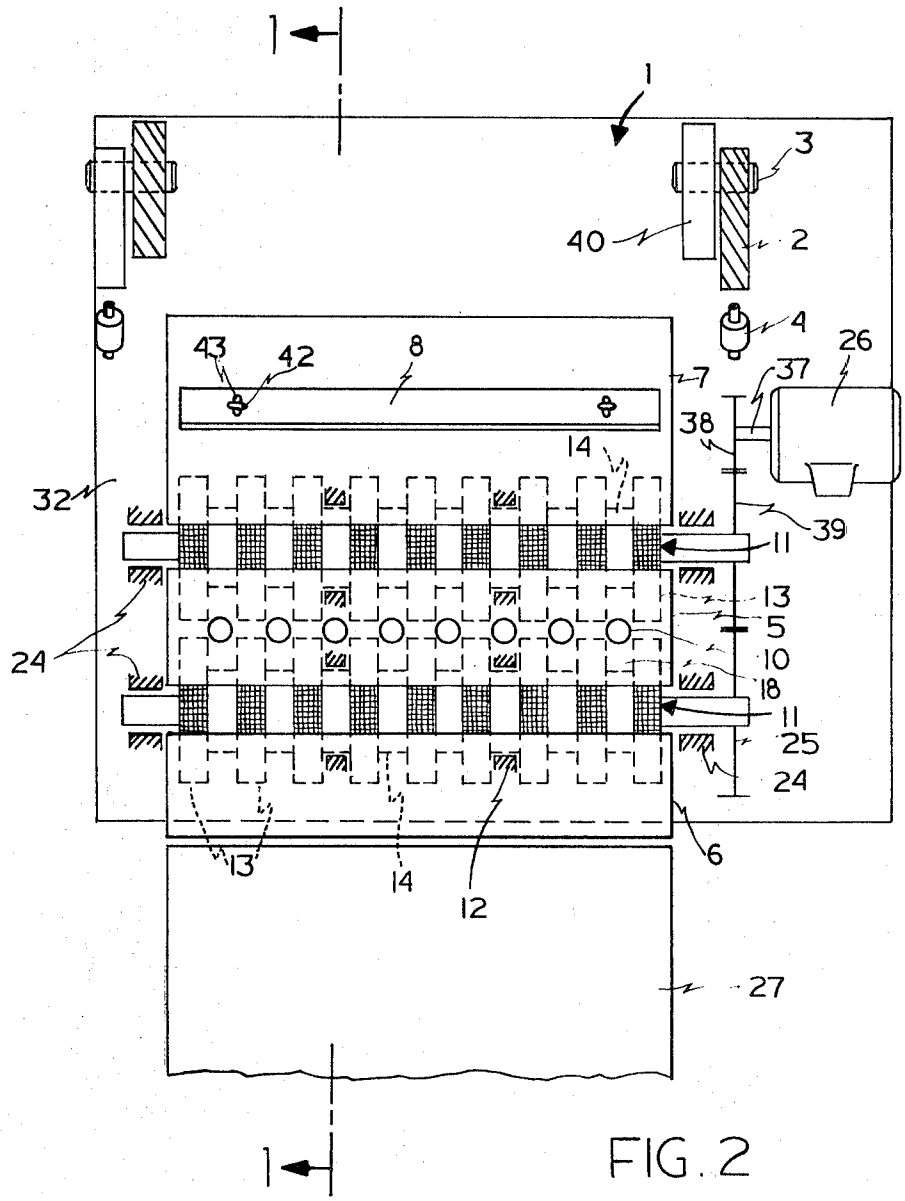

FIG. 2

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FOLDING DEVICE FOR TIRE BELTS

FIELD OF THE INVENTION

This invention relates generally to fabric-folding machinery, but is particularly concerned with a device designed especially for folding rubberized fabric strips to form belts which are incorporated into pneumatic tires for automotive vehicles.

THE PRIOR ART

Certain types of pneumatic tires for vehicle use incorporate an annular belt of folded rubber-coated fabric between the tread and casing of the tire. When such tires are mass produced by automatic machinery, the belts are made by feeding an elongated strip of rubber-coated fabric into a device which folds the strip along its longitudinal center line to form a double thickness suitable for incorporation into a tire.

The fabric-folding machines now available for this purpose have a number of shortcomings which adversely affect the quality of the resulting tire. A problem encountered with some of these machines, which feed the fabric longitudinally between a pair of motor-driven conveyor rollers, is that the folded belt is distorted by the rollers. This effect arises from the fact that the folded bight which forms one edge of the belt is bulkier than the other edge where two marginal fabric panels lie flat over each other. As a result, when the folded strip is fed longitudinally between the rollers the pressure exerted on the strip along the fold line is somewhat higher than along the open edge opposite the fold line and causes the belt to assume a curved shape which makes it unsuitable for incorporation into a tire.

Another type of folding machinery, which has been used for folding laundry, includes a single pair of rollers with a gap therebetween into which a central portion of the fabric is forced by means of a folding aid, such as a moving blade or a stream of compressed air. The fabric is initially above the rollers, and the blade or air stream engages a central portion of the fabric and pushes it downwardly into the gap between the rollers. Thus the blade or air stream forms a nucleus about which the margins of the fabric converge in a folding motion as the central portion thereof descends between the rollers. Subsequently the weight of the folded material cause it to fall the rest of the way through the gap, since the rollers are widely spaced, or in some laundry-folding machines the rollers may be motor driven to rotate in a direction which helps convey the folded material downwardly through the gap. This type of folding machinery, because it feeds the fold line laterally rather than longitudinally between the rollers, avoids the bending problem, but is still not acceptable for folding tire belts. Due to the wide spacing between the rollers, the folded belt is permitted to retain air entrapped between the confronting marginal fabric panels, and these air pockets remain to form inclusions in the finished tire. This of course weakens the tire and constitutes a road safety hazard.

THE INVENTION

The machinery of the present invention has the ability to fold a long strip of rubber-coated fabric in such a way that no bending distortion occurs and air inclusions are avoided. To accomplish this, the invention includes a pair of motor-driven folding rollers and a folding aid such as those employed in laundry-folding machines, plus an additional pair of motor-driven conveyor rollers located on the opposite side of the fabric from the folding rollers, the folding aid nesting between the conveyor rollers.

The fabric is fed laterally between the two pairs of rollers to position them for folding, and then is passed laterally through the folding gap. Thus any longitudinal motion which could result in bunching along the fold line is entirely avoided. In addition only the lateral portions of the fabric strip are grasped by the motor-driven rollers, not the bulky fold line in the center of the strip. Moreover the fabric strip is treated in a relatively uniform manner along its entire length, as a further precaution against the type of distortion which produces curvature.

The folding gap of this device is narrow enough so that the folding rollers compress the confronting fabric panels together and squeeze out entrapped air to preclude the formation of inclusions in the tire. The problem of how to convey flexible material through such a compressively narrow gap is solved in the following manner. The folding rollers have a smooth periphery to which the tacky rubberized fabric strip adheres, while the conveyor rollers are roughened so as not to adhere to the fabric, yet they exert a more positive driving grip thereon. This prevents slippage, which in turn avoids distortions of the folded belt that would affect the quality of the finished tire.

An upper rack mounts the folding rollers above the fabric strip, and is pivotally mounted so that the upper roller assembly can be rotated out of the way for initial insertion of the fabric strip.

The lower rollers are formed with annular recesses in which the folding aid nests, so that the conveyor rollers and the folding aids act at points which are distributed uniformly along the entire length of the fold line, another feature of which prevents local distortion.

Since the fabric strip is of considerable length, the folding and conveyor rollers have lengths to match, and bearings and other reinforcing means are distributed along the length of these rollers to prevent sagging. The bearings and reinforcing means permit the rollers to yield when fabric is inserted between them, and their biasing pressures are adjustable.

The machine includes a table over which the fabric strip is fed into position between the two pairs of rollers. This table is inclined to the horizontal, and includes an adjustable edge stop guide against which the fabric falls to establish the desired position prior to folding.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view, taken along the line 1—1 of FIG. 2, looking in the direction of the arrows, of a fabric-folding machine in accordance with the present invention.

FIG. 2 is a horizontal section of the same machine, taken along the line 2—2 FIG. 1, looking in the direction of the arrows.

The same reference characters refer to the same elements throughout the several views of the drawing.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The apparatus of this invention includes a fixed lower support 1 and an upper rack 2 which is pivotally mounted by means of pivot member 3 upon upstanding posts 40 of the lower support 1. A slanted feed table comprising spaced sections 5, 6 and 7 is situated between the rack 2 and the support 1, and is mounted on the latter. The upper rack 2 has rotatably mounted thereon a pair of spaced fabric-folding rollers 19, while the lower support 1 has rotatably mounted thereon a pair of conveyor rollers 11 which protrude upwardly through the spaces between feed table sections 5, 6 and 7. At the start of the folding operation, a pair of air cylinders 4 raise the upper rack 2 with its folding rollers 19, permitting a strip of rubber-coated fabric 28 to be slid horizontally across a supply table 27 and down the inclined feed table 5, 6 and 7 in order to insert the fabric strip 28 between the upper rollers 19 and lower rollers 11. Subsequently, the air cylinders 4 lower the upper rack 2 to bring the upper rollers 19 down into engagement with the fabric strip 28, and the folding operation is then carried out.

The fabric strip 28 is elongated in a direction perpendicular to the plane of FIG. 1, or left to right as seen in FIG. 2, and is initially slid laterally down over the slanted table 5, 6 and 7 in a flat condition. The downhill sliding motion of the flat fabric strip 28 continues until the lowermost lateral edge 44 thereof contacts an edge guide member 8 which is positioned so as to stop the fabric strip when the longitudinal center line 45 thereof is aligned with a folding gap 41 defined by the space between the upper rollers 19. The guide member 8 is secured

to feed table section 7 by fasteners 42 which are moveable within guide member slots 43 to adjust the position of the guide member.

After the flat fabric strip 28 is thus positioned, a series of longitudinally spaced tubes 10 emerging upwardly through the central region of the middle feed table section 5 issue respective blasts of compressed air (indicated by the arrows 30 in FIG. 1). These air blasts impinge upwardly against the bottom surface of the fabric strip 28 at spaced locations along the longitudinal center line 45 thereof, in order to push the central portion of the fabric strip upwardly into the folding gap 41 between the upper rollers 19. The uniform distribution of the air tubes 10 along the longitudinal center line of the fabric strip 28 is a distortion-preventing feature.

The rollers 19 above table 5, 6, 7 are smooth surfaced in order to make a more intimate, clinging contact with the tacky surface of the rubber-coated fabric 28, and are motor driven for rotation in mutually opposite angular directions as indicated by the arrows. As a result the opposite lateral portions 46 and 47 of the fabric strip 28, located on either side of the longitudinal center line 45 thereof, are dragged by the rollers 19 laterally inward toward the folding gap 41, and then upwardly for entrance into the folding gap between the rollers 19.

The lower rollers 11 are underneath the feed table 5, 6, 7 but protrude upwardly far enough through the gaps between sections 5, 6 and 7 thereof to contact the fabric strip 28 from underneath. These rollers, which, as shown in FIG. 1, preferably have the same outer diameter as the upper rollers 19, have knurled or grooved surfaces (as seen in FIG. 2) and are also motor driven so as to aid the upper rollers 19 in conveying the lateral margins 46 and 47 of the fabric strip 28 inwardly toward the central region 45. The knurled or grooved surface prevents the lower rollers 11 from making too intimate, clinging contact with the tacky rubber coated strip 28, while at the same time permitting positive traction for the purpose of exerting a nonslip drive against the strip. The tacky rubber-coated fabric has a greater tendency, therefore, to adhere to the smooth-surfaced upper rollers 19 and thus to ride upwardly into the folding gap 41 therebetween. It has a much lesser tendency to adhere to the lower rollers 11, and thus easily separates therefrom to enter the folding gap. In addition the air blast from the tubes 10 (arrows 30) positively impels the fabric strip 28 upwardly between the rollers 19.

The lower rollers 11 comprise individual discs 13 mounted at evenly spaced intervals along a small diameter shaft 14, the evenly distributed spaces between the successive discs 13 defining annular recesses 18 within which the compressed air tubes 10 are nested midway between the rollers 11, so that they can direct the compressed air flow to strike along the longitudinal center line 45 of the fabric strip 28. The uniform spacing of discs 13 longitudinally of the fabric strip 28 is another feature which tends to preclude local distortion of the folded belt.

The ends of the reduced diameter shaft 14 are supported upon bearings 24 affixed to the lower support 1. However, in order to prevent sagging over the length of the shaft 14 between the bearings 24, there are provided intermediate bearing blocks 12 which nest in spaces 18 between adjacent discs 13, and engage the reduced diameter shaft 14. These bearing blocks 12 are mounted upon supporting rods 15 which pass through suitable openings 31 in a horizontal plate 32 affixed to the lower support 1. Coil springs 16 surround the rods 15, and are in compression between their respective bearing blocks 12 and the plate 32 to provide a yieldable mounting for the lower rollers 11. Hexagonal nuts 17 are threaded to the lower end of each mounting rod 15 below the plate 32, and are usable for adjusting the compression of springs 16 to determine the gripping pressure which the lower rollers 11 exert on the fabric strip 28.

The upper rollers 19 are also yieldably reinforced or backed up at regular axial intervals, in this case by soft-surfaced rollers 20 rotatably mounted by shafts 34 upon clevis brackets 33. The latter have supporting rods 35 extending through openings 36 in supporting brackets 21 which are secured to the upper rack 2. Hexagonal nuts 23 are threaded to the rods 35 to adjust the compression of coil springs 22 which surround the rods 35 between clevis brackets 33 and supports 21. This structure provides a means of adjusting the pressure which the backing up rollers 20 transmit through the folding rollers 19 to the fabric strip 28.

For uniform force distribution in the longitudinal direction of fabric strip 28, each of the upper rollers 19 has reinforcing or backing up rollers 20 at locations opposite the bearing blocks 12 of the lower rollers 11. Moreover, the adjusting nuts 23 and 17 along the axial length of any one roller 19 or 11 are set for uniform pressure longitudinally of fabric strip 28, so that folding takes place at the same rate along the entire length thereof. For lateral balance of the pressures on the strip 28 the two opposite groups of upper adjusting nuts 23 are balanced against each other, and the two lower groups of adjusting nuts 17 are similarly balanced against each other, to prevent one of the lateral margins 46 or 47 of the strip 28 from feeding more rapidly into the folding gap 41 than the other. As an additional feature which contributes to the proper balance of forces, the axes of the lower bearing block supporting rods 15 are slightly inclined so as to be perpendicular to the plane of the slanted feed table 5, 6, 7. The plane of symmetry of the opposed upper reinforcement rods 35 is also inclined so as to be perpendicular to the slanted feed table plane, while the individual rods 35 are oppositely canted relative to their mutual symmetry plane in order to take account of the offset forces resulting from the rotation of rollers 19. All these features, by uniformly distributing the forces on the fabric strip 28, tend to overcome any problem of distortion of the folded belt.

The main drive to the mechanism of this invention comes from a motor 26 mounted on the lower support 1 and having an output shaft 37 which drives a pinion 38 and a pair of gears 39 and 25 through which it turns the lower roller shafts 14. A similar gear arrangement drives the upper rollers 19, and preferably the gear ratio for both sets of rollers is the same. The energizing circuits for the motor 26 and the motor for the air compressor supplying the tubes 10 are both controlled by conventional interlock switches (not shown) which interrupt the airblast (arrows 30) and the drive to rollers 11 and 19 while the upper rack 2 is pivoted upwardly during initial insertion of the fabric strip 28. Subsequently when the upper rack 2 is lowered to start the folding operation, the air blast is resumed and the drive to the rollers 11 and 19 is reconnected.

The air cylinder 4 can be used during the folding operation to exert a downward force upon the upper rack member 2, thus securing a greater pressure engagement of the rollers 11 and 19 against the fabric strip 28 interposed therebetween.

The presence of air inclusions between the confronting panels of the folded strip 28 was a problem with prior art mechanisms, particularly those in which the folded material was allowed to drop loosely down through a wide gap between a pair of rollers. In contrast the folding gap 41 is small, folding rollers 19 being spaced sufficiently closely together so that they exert a compressive force laterally upon the central folded bight 45 of the fabric strip 28, thus forcing out any air which is included therebetween. The fact that the direction of feed into the gap 41 is up instead of down assures that no material can fall through gravitationally. It must be driven through by rollers 19, which, if they can exert a driving grip on the material can also squeeze out trapped air. Of course such a narrow space 41 between the rollers 19 provides a difficult passageway for a double thickness of fabric 28 to enter, but nevertheless the fabric is positively driven into and through the gap because of several factors.

In the first place, the tacky fabric 28 adheres better to the smooth surface of the upper rollers 19 than it does to the knurled or otherwise roughened surface of the lower rollers 11, and therefore is positively pulled upwardly through the folding gap 41. Secondly, the knurled or roughened surface of the lower rollers 11 exerts a positive traction drive upon the

lateral margins 46 and 47 of the fabric 28 during the time when they are in contact therewith, thus conveying the material toward the centrally located folding gap 41. Thirdly, the blast of air (arrows 30) from the tubes 10 provides a positive impulse to assure that the fabric conveyed to the central region of the table section 5 will then diverge upwardly between the rollers 19 into the gap 41. Fourthly, the adjustable pressure grip on the fabric strip 28 which results from the action of the springs 16 and 22, in combination with the downward pressure exerted by the air cylinder 4, makes the rollers 11 and 19 exert a positive driving grip upon the lateral margins 46 and 47 of the fabric strip interposed between them.

An additional feature which may be employed to enhance the positive lateral driving of the fabric strip 28 is the use of a higher surface speed on the part of one of the rollers relative to the other rollers 11 or 19. This effect can be achieved either by adjusting the gear ratio from motor 26 to the lower rollers 11, relative to the gear ratio of the upper rollers 19, so that either pair of the rollers 11 or 19 has a slightly higher angular velocity, or alternatively either pair of rollers 11 or 19 can be provided with a somewhat larger diameter. Either method results in a greater surface speed at the point of engagement with the fabric strip 28. If this technique is employed, however, the surface speed differential between the rollers 11 and 19 should not be so great as to cause stretching of the fabric material 28.

It will now be realized that the present invention provides a unique combination of features which solves the difficult problem of rapid automatic folding of belts for mass-production of belted tires. In particular, the belts which are produced by this mechanism are free of air inclusions and distortions, either of which would make them unsuitable for incorporation into vehicle tires.

Since the foregoing description and drawings are merely illustrative, the scope of protection of the invention has been more broadly stated in the following claims; and these should be liberally interpreted so as to obtain the benefit of all equivalents to which the invention is fairly entitled.

I claim:

1. In a device for folding elongated strips of rubber-coated cord fabric for use as belts incorporated in vehicle tires; said device including a pair of folding rollers adapted to engage on side of a strip of said fabric to be folded, said folding rollers being spaced to define a folding gap therebetween, whereby when an elongated central portion of said fabric strip is drawn through said folding gap, elongated lateral portions of said fabric strip on either side of said central portion are drawn into a confronting folded relationship while following said elongated central portion through said folding gap, and folding aid means operable to act against the opposite side of said fabric strip in order to force said elongated central portion thereof into said folding gap; the improvement comprising:

a table for supporting said fabric strip in flat unfolded condition;

said folding rollers being disposed above said table with their downwardly facing surface portions so spaced from said table as to be able to engage said one side of said fabric strip when the latter is located on said table;

said table being provided with a pair of apertures in respective locations parallel to the axes of said folding rollers and just below the regions of closest proximity of the surfaces of said folding rollers to said table;

a pair of conveyor rollers located below said table parallel to and protruding upwardly somewhat through said apertures so as to be able to engage said opposite side of said fabric strip when the latter is located on said table;

said folding aid means being arranged below said table and intermediate said conveyor rollers and adapted to act upwardly against said central portion of said fabric strip when the latter is located on said table;

and means for driving both said pairs of rollers in such directions so as to enable the opposed folding and conveyor rollers to convey the respective interposed lateral portions of said fabric strip toward said central portion thereof and said folding gap.

2. A device according to claim 1, wherein:

said folding rollers have a substantially smooth periphery for intimate clinging contact with said fabric strip;

and said conveyor rollers have a rough periphery whereby to make more positive driving contact with said fabric strip without clinging thereto.

3. A device according to claim 1, further comprising:

a fixed support juxtaposed to said table;

a rack pivotally secured to said fixed support for angular movement into and out of an operating position;

one of said pairs of rollers being rotatably mounted on said fixed support;

and the other of said pairs of rollers being rotatably mounted on said rack;

said rack when pivoted into said operating position bringing said other pair of rollers into confronting relationship with said apertures in said table and said pair of rollers mounted on said fixed support.

4. A device according to claim 1 wherein:

each of said conveyor rollers is formed with annular recesses spaced at intervals along the axis of rotation thereof;

said annular recesses of one of said conveyor rollers being situated in confronting relationship to respective annular recesses of the other of said conveyor rollers whereby to provide a series of spaces distributed along the longitudinal direction of said fabric strip;

said folding aid means being arranged to act through respective ones of said distributed spaces.

5. A device according to claim 4, further comprising:

a plurality of bearings engaging and supporting said conveyor rollers within said annular recesses thereof;

means elastically supporting said bearings;

and means for adjusting said elastic supporting means.

6. A device according to claim 1, wherein:

said table is inclined to the horizontal in a direction perpendicular to said folding gap, whereby said fabric strip may be slid in a lateral direction downwardly across said table for ease of insertion between said pairs of rollers;

and a fabric edge positioning guide protrudes upwardly from said table at a location downhill from the highest portion thereof in position to engage a longitudinal edge of said fabric strip and to stop the downward motion of the latter in a desired location relative to said folding gap.

7. A device according to claim 3 wherein:

said rack extends above said table and pivots upwardly away from said table when moving out of said operating position, and downwardly toward said table when moving into said operating position, and said fixed support extends below said table;

said rollers on said rack are said folding rollers, and said rollers on said fixed support are said conveyor rollers;

means are provided on said rack for rollably engaging upper portions of the surfaces of said folding rollers for backing up said folding rollers from above;

means are provided on said rack for elastically mounting said backing up means;

and means are provided for adjusting said elastic mounting means.

8. A device according to claim 7, further comprising:

power means for raising said rack out of, and lowering it to, said operating position;

said power means being further operable to exert a downward force upon said rack after it reaches said operating position whereby to increase the gripping pressure exerted by said pairs of rollers on said fabric strip when interposed therebetween.

9. A device for folding a rubber-coated fabric strip to form a belt for incorporation into a tire, said device comprising:

a first pair of spaced parallel rollers for engaging one side of said fabric strip, said first rollers being smooth surfaced for intimate clinging contact with said fabric;

a second pair of rollers juxtaposed to said first rollers and parallel thereto for engaging the opposite side of said fabric strip at the same time, said second rollers being rough surfaced for positive driving engagement, but less intimate, nonclinging contact with said fabric strip;

means driving both said pairs of rollers for conveying the lateral margins of said fabric inwardly toward the longitudinal center line thereof;

and folding aid means nested between the rollers of said second pair and operable to push the central portion of said fabric strip into the space between said first pair of rollers.

10. A device according to claim **9**, further comprising:

means for effecting relative separating and approaching movements of said pairs of rollers;

and means for locating said fabric strip in flat condition between said pairs of rollers when the same are in their separated state.

11. A device according to claim **10** wherein:

said locating means comprises a table for supporting said fabric strip, said table slanting downwardly and being arranged to enable said fabric strip to slide downwardly over said table to a predetermined location between said pairs of rollers.

12. A device according to claim **11**, further comprising:

means arranged at the lower region of said table to engage a lateral edge of said fabric strip to stop its downward slide at said predetermined position.

13. A device according to claim **10**, wherein said relative movement effecting means comprises:

a lower support for one of said pairs of rollers;

and a rack supporting the other pair of rollers above said one pair, said rack being pivotally movable upwardly and downwardly relative to said support.

14. A device according to claim **13**, further comprising:

power means interconnected between said rack and said support for raising and lowering said rack.

15. A device according to claim **14**, further comprising:

means on said rack for backing up said other pair of rollers;

said backing up means being slanted to exert a net force on said other pair of rollers substantially perpendicularly to the plane of said table.

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