June 15, 1954 B. LIEBOWITZ 2,681,019

METHOD OF AND APPARATUS FOR MANUFACTURING BIELASTIC TAPES

Filed March 18, 1952 2 Sheets-Sheet 1

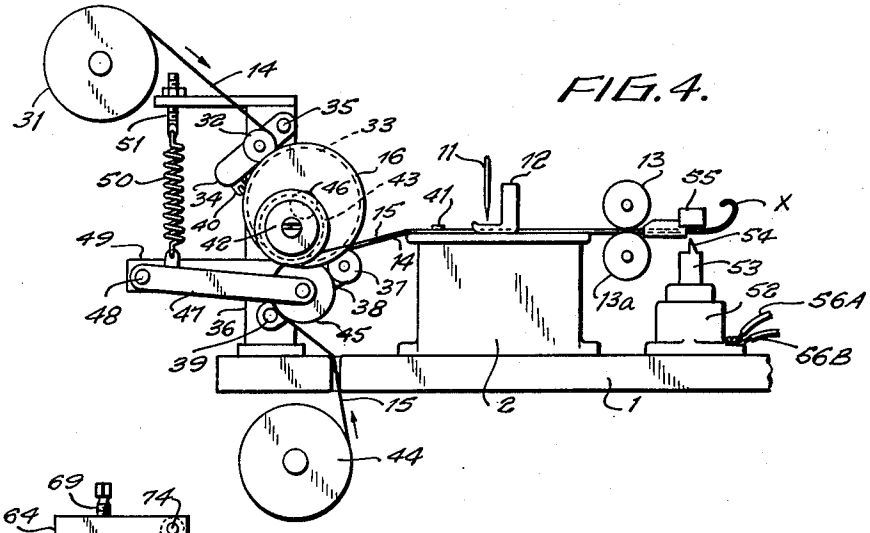


FIG. 4.

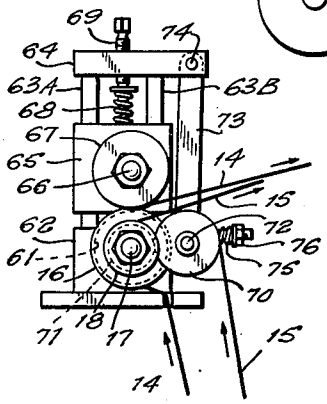


FIG. 5.

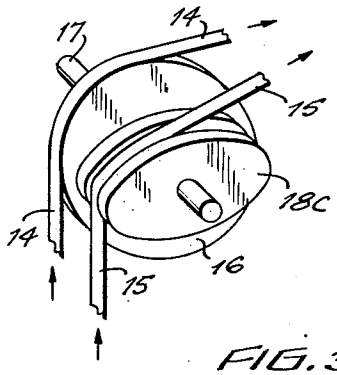


FIG. 3.

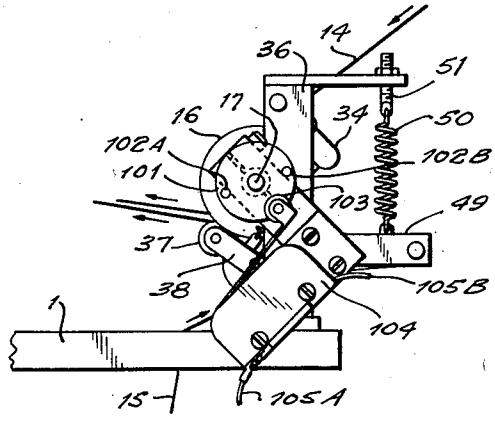


FIG. 6.

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METHOD OF AND APPARATUS FOR MANUFACTURING BIELASTIC TAPES

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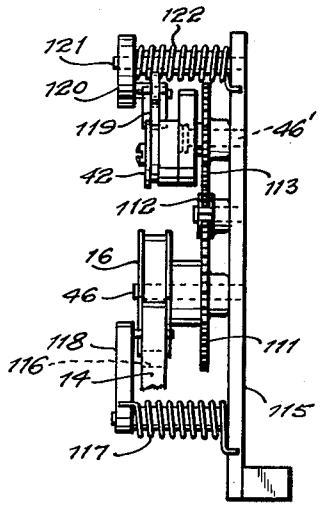


FIG. 8.

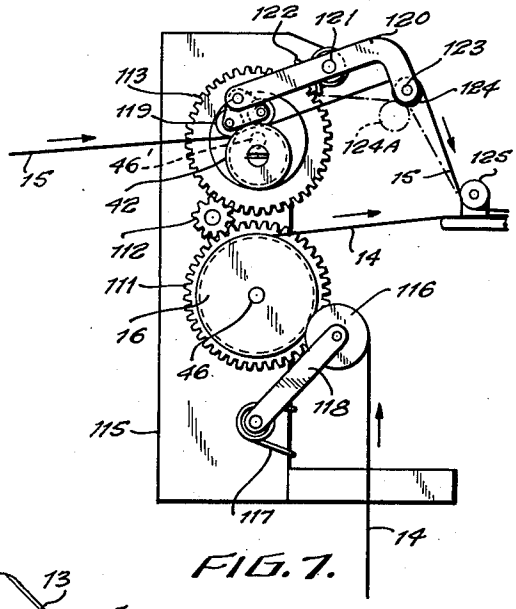


FIG. 7.

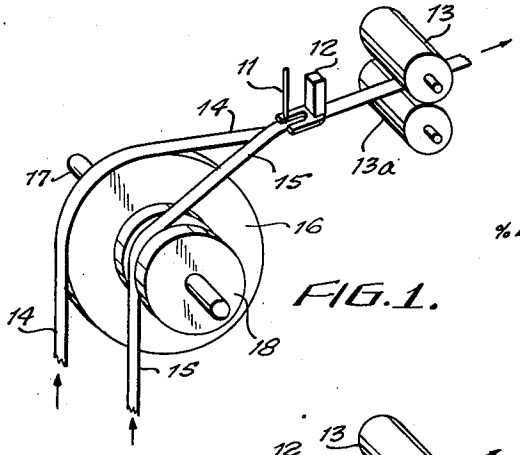


FIG. 1.

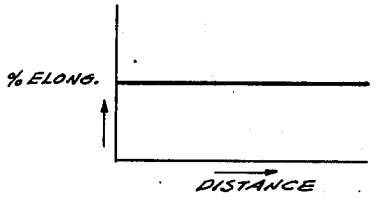


FIG. 1A.

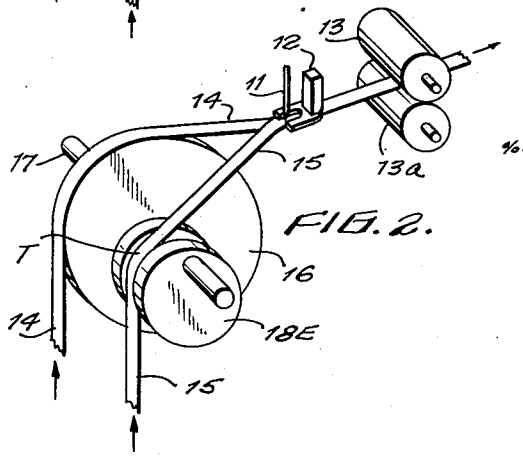


FIG. 2.

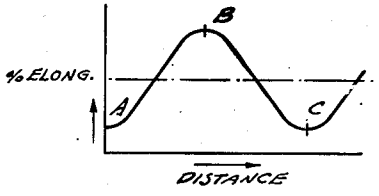


FIG. 2A.

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METHOD OF AND APPARATUS FOR MANUFACTURING BIELASTIC TAPES

Benjamin Liebowitz, Lewisboro, N. Y.

Application March 18, 1952, Serial No. 277,165

23 Claims. (Cl. 112—2)

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In my copending U. S. patent applications Serial No. 190,092, filed October 14, 1950, now Patent No. 2,601,035, dated June 17, 1952, for "Wearing Apparel and Methods of Producing the Same"; Serial No. 199,317, filed December 5, 1950, now Patent No. 2,601,036, dated June 17, 1952, for "Articles of Wearing Apparel"; Serial No. 217,341, filed March 24, 1951, now Patent No. 2,601,037, dated June 17, 1953, for "Collars and Method for Preventing Curling of Collars"; and Serial No. 247,910, filed September 24, 1951, now Patent No. 2,601,038, dated June 17, 1952, for "Anticurl Devices for Collars," of which the present application is a continuation-in-part, I have disclosed devices for causing a counter-curling tendency in a garment part to oppose the curling forces imposed on such garment part by the wearing thereof. For instance, the points of collars and the tops of girdles often tend to curl away from the body of the wearer; in the aforesaid applications it is shown how to oppose this curling tendency by anticurling forces produced by a bielastic structure comprising a flexible compression-resistant substantially non-stretchable element and a flexible permanently stretched elastic element attached in permanent tension-creating state to said compression-resistant element. Moreover, in my patent application Serial No. 247,910, I have pointed out that a very significant improvement is obtained in the functioning of the anticurl devices by having variable tension in the elastic element so as to create anticurling forces which are stronger in some regions than in others.

The object of this invention is to provide methods and apparatus for the manufacture of such anticurl strips, viz. apparatus and methods for feeding two strips, one a flexible compression-resistant substantially non-stretchable tape and the other a flexible elastic substantially non-compression-resistant strip or tape, e. g. a rubber tape, at required relative rates into a uniting machine, e. g. a sewing machine, so that the resulting composite bielastic tape structure will have the desired stretch in the rubber; and where that stretch is variable, the desired distribution of stretch along its length.

The method and apparatus for achieving this object will be understood by reference to the accompanying drawings, in which:

Fig. 1 is a diagrammatic isometric view of an arrangement designed to feed an elastic rubber tape at a predetermined rate relative to the feeding of a substantially non-stretchable tape so as to produce a uniform stretch in the elastic rubber tape relative to this non-stretchable tape;

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Fig. 1A is a graph showing the relationship between percentage elongation of the rubber tape and distance along the composite tape produced by the apparatus of Fig. 1;

Fig. 2 is a diagrammatic isometric view of an apparatus for feeding an elastic tape at a variable predetermined rate relative to the feeding of a substantially non-stretchable tape so as to produce a stretch in the elastic tape having a predetermined approximately sinusoidal variation along the length of the composite bielastic tape;

Fig. 2A is a graph showing the relationship between the stretch or percentage elongation of the rubber and the distance along the composite bielastic tape as produced by the arrangement of Fig. 2;

Fig. 3 is a diagrammatic isometric view of an apparatus similar to the apparatus shown in Fig. 2, but equipped with a cam instead of an eccentric roll;

Fig. 4 is a side elevation of an apparatus operating on the same principles as the apparatus shown in Fig. 2;

Fig. 5 is a side elevation of an apparatus operating on the same principles as the apparatus shown in Fig. 1;

Fig. 6 is a rear side elevation showing an arrangement for electrically operating a cutoff device of the type shown in Fig. 4;

Fig. 7 is a side elevation of a modification of the apparatus shown in Fig. 4 and operating primarily, but not altogether, on the principles of the apparatus shown in Fig. 2; and

Fig. 8 is an end elevation—as seen from the right of Fig. 7—of the apparatus shown in Fig. 7.

Referring to Fig. 1, the needle of a sewing machine is diagrammatically indicated at 11 in association with the presser foot 12 of the machine. As a feeding mechanism on the sewing machine I prefer to employ a pair of rolls 13—13A behind the presser foot instead of the usual feed-dog arrangement. These rolls are intermittently driven in proper relation to the needle motion so as to produce the desired feed.

The work being fed consists of two tapes, one shown at 14, being a compression-resistant relatively non-stretchable cotton or other tape, e. g. a woven tape treated with resin or a woven tape employing relatively large monofilaments in the warp. The other tape shown at 15 is an elastic tape preferably made of rubber, e. g. of the kind used in so-called elastic "garment tape." The compression-resistant non-stretchable tape 14 is

fed over a feed roll or drum 16 which rotates at such a rate that its peripheral speed is equal to the rate of feed of the feed rolls 13—13A. In practice I have found that the best method in this type of apparatus for producing equality of rate of feed due to the feed rolls 13—13A and the rate of feed due to the rotation of the feed drum 16 is to drive the feed drum 16 by means of the non-stretchable tape 14 which is pulled at any desired rate by the feed rolls 13—13A.

The feed roll 16 is mounted on a shaft 17 which in turn is mounted in appropriate bearings not indicated in the diagrammatic Figures 1, 2 and 3. Mounted on the same shaft 17 and concentric with the drum 16 is a smaller drum 18 over which the elastic, stretchable tape 15 must pass. The working surfaces of both drums, that is, the surfaces which are in contact with the respective tapes, are roughened to produce a high coefficient of friction, e. g. by pasting strips of emery cloth over the peripheral faces of the drums. The diameter of the drum 18 is chosen so as to produce a rate of feed of the elastic tape 15 lower than the rate of feed of the non-stretchable tape 14 by a predetermined amount so as to produce a uniform predetermined tension or elongation in the elastic tape. The formula for determining the elongation E in the rubber tape relative to the other tape is

$$E=2\pi\frac{D_{16}-D_{18}}{2\pi D_{18}}=\frac{D_{16}}{D_{18}}-1$$

where D_{16} is the diameter of the large feed roll 16 and D_{18} is the diameter of the small stretching roll 18.

Certain idler rolls for pressing the tapes 14 and 15 against their respective feed rolls are omitted from Fig. 1 in the interest of clarity but are shown in the corresponding Fig. 5.

The functioning of the device of Figure 1 will now be obvious: The sewing machine parts 11, 13 and 13A are driven at a specified rate of feed so as to feed the non-stretchable tape 14 at that specified rate. The tape 14 thereby drives the synchronizer roll 16 so that its peripheral speed is equal to the rate of feed produced by the stitching apparatus. This in turn determines the speed and hence rate of feed of the smaller stretching roll 18, whose smaller peripheral speed causes a slower rate of feed of the rubber tape to produce the desired stretch in the rubber as indicated in the formula above. The two tapes are superimposed by appropriate guides and sewn together by the stitching mechanism of the machine diagrammatically indicated by the needle 11 and the presser foot 12.

For purposes of comparison with modifications described below, I have shown in Figure 1A a graph showing the elongation of the rubber tape as a function of the distance along the finished composite bielastic tape. In this particular case the elongation does not vary as one goes along the tape, i. e. it is uniform.

Now, as mentioned above, a very important improvement in anticurling properties results from making the tension or stretch in the rubber variable along the finished bielastic strip. Figure 2 shows a modification of the apparatus of Figure 1 showing how the desired periodic variation in tension is obtained. It will be seen that the essential difference between the apparatus of Figure 1 and that of Figure 2 is that the rubber feeding roll 18 of Figure 1 is concentric with the shaft 17 and roll 16, whereas in Figure 2 the rubber feeding roll now indicated by 18E, is eccentrically mounted on the shaft 17. The effect of this eccentric mounting is to cause a variation in the rate of feed of the rubber tape 15 relative to the rate of feed of the tape 14 because the point of tangency T at which the rubber tape 15 leaves the roll 18E is closer to the axis of shaft 17 at one point of its cycle but much farther from the axis of shaft 17 at another point of the cycle and it is the distance of this point of tangency from the axis of the shaft 17 that determines the rate of feed at any given instant. The relative variation in tension is determined not only by the "throw" of the eccentric but also by the distance from the point of tangency T to the needle. An approximate formula for the elongation E as a function of the angular position A of the eccentric 18E is the following:

$$E=\frac{1}{\frac{D_{18}}{D_{16}}+\frac{e}{R}\sin A}-1$$

when D_{16} and D_{18} are the diameters of rolls 16 and 18E, respectively, e is the eccentricity (distance between roll centers) and R is the distance from the point of tangency T to the needle 11. This formula gives the instantaneous elongation as the stitching proceeds. The average elongation of the rubber is approximately given by the same formula as for Figure 1.

Figure 2A is a graph showing diagrammatically how the tension or elongation of the rubber varies approximately sinusoidally along the composite bielastic tape produced by the apparatus of Figure 2. It will be seen that there are points A, C, etc. where the tension is minimum, and other points B, etc. where the tension is maximum. The tape is subsequently cut at or near each point of maximum and minimum tension so that the resulting composite strip will have a maximum tension at or near one end and a minimum tension at or near the other end. It will be understood furthermore that each revolution of the roll 16 produces two finished tapes. Since prescribed lengths of strip will in general be required, the diameter of the drum 16 is preferably chosen so that the length of its periphery is just equal to the lengths of the two finished bielastic tape elements. Again, it will be understood that certain idler rolls are employed in the apparatus shown in Figure 2 which are not shown in this figure but are shown in the corresponding Figure 4.

Finally, it will be understood that the eccentric 18E of Figure 2 is merely one form of a cam. Other cam forms may be employed, e. g. as diagrammatically shown at 18C of Figure 3. This latter type of cam makes four bielastic strips for each revolution of the feed roll 16.

Figure 4 shows a side elevation of the essential parts of a complete apparatus similar to the one diagrammatically shown in Figure 2. In Figure 4, 1 is the table top and 2 is the base of a conventional sewing machine. 11 indicates the needle and 12 the presser foot as before; 13 and 13a are a pair of feed rolls which are driven by the sewing machine according to well known methods. The non-stretchable tape 14 is pulled off a roll 31 and passes around an idler roll 32 so that it is pressed between the idler roll 32 and the working surface 33 (shown dotted) of the synchronizer roll 16, the working surface 33 being the bottom of a groove which is covered with emery cloth. The idler 32 is carried by a lever 34 which is pivoted on a pin 35 which is carried in the upright member 36, the said upright member 36 forming

essentially the base of the entire feeding mechanism. After passing approximately 180° around the working surface 33, the non-stretchable tape 14 then passes under another idler roll 37 which is carried on a lever 38 pivoted at 39 on a pin which is also carried by the upright member 36. The two idler rolls 32 and 37 are pressed against the working surface 33 by means of a tension spring connecting the two levers 34 and 38. Only one end of this spring is indicated at 40 on lever 34. After leaving the nip between the idler roll 37 and the working surface 33 the non-stretchable tape 14 passes to a guide 41 which is just ahead of the presser foot 12. The tape is guided under the presser foot 12 by a groove in the bottom of the same indicated by the dotted line; the presser foot guides and controls the tapes but exerts no vertical pressure on them. The stretching mechanism thus is driven at a continuous rate determined entirely by the rate of feed of the feed rolls 13 and 13a.

Eccentrically carried on the face of the drum 16 is a grooved roll or disc 42. The bottom of the groove of 42 indicated by the dotted line 43 is the working surface of the roll 42 and serves as a feed roll for determining the rate of feed of the rubber tape 15. This tape is fed without appreciable tension from a roll or spool 44 and passes around an idler roll 45 which presses against the bottom of the groove that constitutes the working surface 43 in the feed roll 42. The feed roll 16 for the non-stretchable tape 14 is mounted on a shaft 46, which is carried in bearings mounted on the upright member 36. The feed roll 42 is fastened to the side of the feed roll 16 so as to have the desired eccentricity with respect to the shaft 46 as diagrammatically indicated. As a result of this eccentricity the idler roll 45 which coacts with the working surface 43 of the feed roll 42 must be capable of movement to and away from the center of the shaft 46. To allow for this movement the idler roll 45 is rotatably mounted on the end of a lever 47 which is pivotally mounted on pin 48 carried by an extension arm 49 mounted on the upright member 36. A tension spring 50 whose tension is adjustable by means of the screw and nut device 51 pulls the lever 47 upward so as to press the idler roll 45 against the coacting working surface 43. The rubber tape 15 is thereby caused to move between the nip of the working surface 43 and the idler roll 45 so that its speed is determined by the peripheral speed of the working surface 43. Due to the eccentric location of this working surface the said rate of feed is periodically variable as described in connection with Figure 2. From the nip between the working surface 43 and the idler roll 45 the rubber tape 15 passes under the guide 41 there joining in superposed relation with the non-stretchable tape 14. The two tapes then pass under the needle so that they are sewn together one on top of the other.

The composite bielastic tape takes the curly form indicated at X at the exit end of the apparatus. Here an electrical solenoidal cutoff device is shown at 52 which comprises a plunger 53 operated by the solenoid in casing 52 and carrying at its upper end a cutoff knife 54. This cutoff knife co-acts with an anvil 55 at an appropriate instant determined by the momentary switching on of the operating current for the solenoid 52 at the proper moment in the cycle of operations, as will be described below. For certain purposes it is preferable not to cut the tape apart by a cutoff mechanism shown at 54, 55 but merely to mark the tape with a good clear mark so that it can be cut off subsequently at the time that the tape is sewn into a collar, for example. A convenient way of marking the tape for this purpose is by heated means similar to cutoff knife 54, but with reduced energy in the solenoid. Current for operating the solenoid 52 is carried to the solenoid by the leads 56A and 56B. The method of momentarily switching on the current will be described below.

For certain purposes it is desirable to use a heated cutoff knife 54 even when the tapes are cut apart and not merely marked. Thus, when the non-stretchable tape 14 has nylon monofils in its warp to make it compression-resistant, it is desirable to heat-seal the ends of the tape to fix the nylon monofils at their ends. This heat-sealing is readily accomplished by heating the cutoff blade 54.

Furthermore, I have found it sometimes convenient and advisable to use nylon sewing thread in place of the usual cotton sewing thread. Also in this event, it is advantageous to use a heated cutoff or marking blade 54 in order to seal the ends of the nylon sewing threads as well as to seal the ends of the nylon monofils.

Figure 5 is a side elevation of an apparatus which functions so as to provide a uniform elongation or tension in the rubber in the same manner as the apparatus shown in Figure 1.

It will be understood that in this machine the same sewing machine elements and other parts are used as in the apparatus shown in Figure 4 and hence only the modified stretching and thus tensioning feed mechanism of the machine is shown, in Figure 5. The non-stretchable tape 14 comes up from below and passes around the working surface 61 of the roll 16, the said working surface 61 being the bottom of a groove cut in the roll 16 and surfaced with emery cloth. The roll 16 rotates on the shaft 17 which is mounted in a block 62. The two vertical bars 63A and 63B are pressed at their bottom ends into the block 62 and at their top ends into the bar 64. Another block 65 is bored so that it may slide on these bars. This block 65 carries a shaft 66 on which an idler roll 67 rotates freely. This idler roll 67 co-acts with the working surface 61 in the roll 16. A spring 68 whose compressive force is adjustable by means of the screw 69 urges the block 65 downward so as to cause the idler roll 67 to press against the working surface 61 of the roll 16. The relatively non-stretchable tape 14 is caused to pass between the nip of the idler roll 67 and the working surface 61 so that the rate of feed of the tape 14, which is determined by the rate of feed of the sewing machine, determines the rate at which the synchronizing feed roll 16 rotates. Concentric with the feed roll 16 in accordance with Figure 1 is the stretching feed roll 18 which is rigidly connected to the synchronizing feed roll 16 so that the two rotate at the same speed. The rubber tape 15 passes around an idler roll 70 and then around the working surface 71, shown in dotted lines, which is the bottom of a groove cut in the roll 18. The idler roll 70 is mounted so as to rotate freely on a pin 72 which is carried at the bottom end of the arm 73 which in turn is pivoted at 74 on the top member 64 of the assembly. A spring 75 whose compressive force is adjustable by means of the nut 76 urges the arm 73 to the left, thereby causing the idler roll 70 to press against the working surface 71 of the drum 18. The rubber tape therefore after pass-

ing part-way around the idler 70, passes between the nip of the roll 70 and the working surface 71 and then continues in contact with the working surface of 71 until it emerges tangentially therefrom as shown. Thus, the two tapes emerge side by side but at a differential rate of feed determined by the first formula given above.

Referring now to Figures 7 and 8, in these figures a mechanism is illustrated which operates primarily on the same principle as the apparatus shown in Figures 2 and 4 but in addition incorporates still other means for varying the tension of the elastic tape as will be explained. In the embodiment shown in Figures 7 and 8 there is also the practical advantage that the two tapes go through the feeding mechanism with their central lines co-planar. In these figures, 14 indicates the non-stretchable tape as before, which passes around a grooved pulley 16. As before, the bottom of the groove is covered with emery cloth so as to create high friction between the non-stretchable tape 14 and the pulley 16, thereby ensuring positive drive of the pulley 16 by the tape 14. Again 42 indicates an eccentric which rotates on shaft 46'. Unlike Figure 4, the axis of rotation of pulley 16 does not coincide with the axis shaft of rotation of the eccentric 42, but the two axes are separated and spaced parallel to each other, as shown in Figure 7. The drive of the eccentric 42 is now obtained by means of the gear 111 mounted on the shaft 46, the idler gear 112 and the gear 113 mounted on shaft 46'. In Figure 7 the diameter of the eccentric 42 is chosen so that it gives the required average stretch of the rubber tape when the gear ratio between 111 and 113 is 1 to 1. It will be readily understood, however, that any convenient diameter can be chosen for the eccentric 42 and then the gear ratio can be chosen so as to give the required average stretch to the rubber tape.

The shafts 46, 46', as well as the shaft for the idler gear 112 are all moutned on a plate 115 which acts as a base for the entire mechanism. As in Figure 7, an idler roll is shown at 116 which presses the tape 14 against the grooved pulley 16 so as to insure positive drive of the pulley 16 by the tape 14. To obtain this pressure, a torsion spring 117 urges the lever 118 toward the pulley 16, the pulley 116 being rotatably mounted on the end of the lever 118.

As before, the elastic tape 15 is pressed against the bottom of a groove in eccentric 42, e. g. by means of a small pair of closely spaced rolls 119 swiveled at the end of lever 120 which in turn is pivotally mounted on the base 115 at 121. A torsion spring 122 presses on the lever 120 so as to press the roller pair 119 and hence the rubber tape against the bottom of the groove in eccentric 42 which again is covered with emery cloth so that the instantaneous rate of feed of the rubber tape is determined entirely by the rate of feed given to it by the eccentric 42, as a function of the angular position of eccentric 42. Rotatably mounted at 123 at the end of lever 120 is a roller 124 over which the rubber tape passes on its way from the nips between eccentric 42 and the roller pair 119 to the guide roll 125 and thence to the sewing machine. It will be understood that in general the instantaneous rate of feed of the rubber is determined as in the apparatus shown in Figure 4 by the position of the eccentric in its cycle, the rate of feed being a minimum in the position shown in Figure 7, that is, where the nip is closest to the axis 46'. A half-revolution later the nip will rise to the point where its distance from the shaft 46' is a maximum; at this point the rate of feed is a maximum; also at this point the roller 124 will have moved into the position indicated by the dotted lines at 124a. It will also be clear that the path of the rubber tape 15 from the nip in its uppermost position over the roller in the position 124a and thence under the roller 125 is shorter than the corresponding path of the tape from the nip in its lowest position as indicated by the solid lines in Figure 7, that is, from the nip over roller 124 and thence under roller 125. This variation in the length of the path of the rubber tape constitutes an additional means for varying the tension. With the nip shown in the position of Figure 7, the rate of feed is a minimum and the path length over 124 and 125 is a maximum, hence both effects contribute towards making the tension of the rubber a maximum in the configuration shown by the solid lines of Figure 7. On the other hand, a half revolution later, the rate of feed is a maximum and the path length of the rubber tape over the rolls is a minimum and both effects contribute towards making the tension in the rubber a minimum. It is a fact that this latter means can be used alone to obtain variable stretch and tension in the rubber. That is to say, the rate of feed of the rubber tape 15 can be made constant relative to the rate of feed of the non-stretchable tape 14, in accordance with the scheme shown in Figure 1 and Figure 5, and an eccentric or other means can be used to move a pulley such as 124 cyclically so as to vary the length of the rubber periodically in its path from its feed roll to the guide of the sewing machine.

The actuating mechanism for the cutoff means described above in connection with Figure 4, is shown in Figure 6, including mainly those parts which are necessary to explain the operation of this cutoff mechanism.

The shaft 17 extends through the rear of the vertical base member 36 and carries a disc 101 so that the said disc rotates at the same speed as the roll 16. This disc 101 carries two pins 102A and B so that every half revolution one of them comes in contact with a roller 103 of a "microswitch" 104, thereby closing at every half cycle the microswitch 104 for a short time interval. The phase in the cycle where this circuit closing occurs is determined by the angular position of either the disc 101 or the microswitch 104. Hence, one or both of these angular positions is made adjustable so that the cutoff can be produced at the right moment in the cycle. Current from a power supply is carried through leads 105A and B of the microswitch to the solenoid leads 56A and B of Figure 4 so that the closure of the microswitch by either pin 102A or B will energize the solenoid 52 of Figure 4 and cause it to operate the cutoff mechanism. In order to avoid dependence of the operation of the cutoff mechanism on the length of time during which the microswitch is closed by the mechanisms as indicated, which time of closure may be too long and also may be variable, I prefer other methods of determining the time interval during which the solenoid 52 of Figure 4 is energized. In practice I have found it convenient to use a circuit in which a condenser is charged through a suitable resistance during the period preceding each operation of the solenoid and in which closure of the microswitch 104 operates a relay which discharges the said condenser into a relay which operates the solenoid 52. Details of such

a circuit are known in the electrical engineering art and need not be given here.

The cutoff device shown mainly in Figure 6 provides a simple solution for an otherwise difficult problem connected with the cutting off of the continuous bielastic tape as produced by the machine into short lengths required for use in collars, when the tension in the rubber is variable. Suppose, for example, that attempt was made to cut such continuous bielastic tape into short strips of equal length after the continuous strip has been removed from the machine. Even if an accurate starting point could be found, a few thousandths of an inch error in each length of strip would produce an error amounting to an inch or more in the location of the cutoff with respect to the region of minimum (or maximum) tension after a few hundred or a thousand of such strips had been cut from the continuous bielastic tape because of unavoidable cumulative errors. The apparatus illustrated in Figures 4 and 6 is designed to eliminate such cumulative errors and relies on a method of cutting the bielastic tape as it emerges from the machine at or close to such position in the bielastic tape where the tension in the rubber is a minimum or a maximum, the position of the cutoff being determined by the phase in the cycle of operation of the machine itself when the instantaneous tension produced by the machine is an extremum (i. e. a minimum or maximum).

To avoid unnecessarily cumbersome language, I have referred to the feed produced by the rolls 13—13A as "continuous," also implying that it is "uniform" in contrast to the variable rate of feeding of the rubber tape in the apparatus of Figure 2. As a matter of fact, as everyone skilled in the art knows, on most sewing machines the feed produced by the rolls 13—13A would actually be far from continuous; for instance, if the machine makes 3,600 stitches per minute, the feed rolls 13—13A will start and stop 60 times per second, so that there is no feed during the interval when the needle 11 is in the work. Due to elasticity of tape 14, which drives the pulley 16 (despite the fact that the said tape has been described as substantially non-stretchable), and also due to the elasticity of other parts, and due finally to the inertia of all the parts which are moved when the tape 14 is fed by the rolls 13—13A, the intermittent feeding of the work by the rolls 13—13A will be, to some extent, smoothed out so that the motion of the roll 16 and all parts associated with it will not follow rigorously the intermittent motion of the rolls 13—13A. Instead the motion of the roll 16 and its associated parts will be a "rippling" one which, for practical purposes associated with this invention may be regarded as "continuous," since the ripples will occur at a rate of about 60 ripples per second, more or less.

I claim:

1. Method of manufacturing bielastic tape elements comprising in combination the steps of feeding along a predetermined path, superimposed upon and facing each other a compression-resistant substantially non-stretchable tape and an elastic tape in considerably stretched tension-creating condition; cyclically varying the degree of stretch of said elastic tape so that during each of said cycles the stretch ranges between a maximum and a minimum; fastening said compression-resistant tape and said elastic tape to each other along their entire length while the stretch of the latter is cyclically varied and said tapes are fed along said predetermined path in superimposed condition, thus obtaining a continuous bielastic tape structure composed of said elastic tape fastened to one face of said compression-resistant tape and having in the direction of its length consecutive zones in each of which the stretch of said elastic tape ranges between a maximum in the region of one end thereof and a minimum in the region of the other end thereof; and severing said continuous bielastic tape structure between each two consecutive zones thereof in synchronism with and depending upon said cyclical variations of the degree of stretch of said elastic tape and at substantially the same phase of each of said cyclical variations so as to obtain a plurality of bielastic tape elements each composed of an elastic tape portion fastened to a compression-resistant tape portion so as to induce in the same a curvature which ranges between a maximum in the region of one end thereof and a minimum in the regicn of the other end thereof and is in the direction of that face of said comprssion-resistant tape portion to which said elastic tape portion is fastened.

2. Method of manufacturing bielastic tape elements comprising in combination the steps of feeding along a predetermined path, superimposed upon and facing each other a compression-resistant substantially non-stretchable tape and an elastic tape in considerably stretched tension-creating condition; cyclically varying the degree of stretch of said elastic tape so that during each of said cycles the stretch ranges between a maximum and a minimum; fastening said compression-resistant tape and said elastic tape to each other along their entire length while the stretch of the latter is cyclically varied and said tapes are fed along said predetermined path in superimposed condition, thus obtaining a continuous bielastic tape structure composed of said elastic tape fastened to one face of said compression-resistant tape and having in direction of its length consecutive zones in each of which the stretch of said elastic tape ranges between a maximum and a minimum; and severing said continuous bielastic tape structure between each two consecutive zones thereof in synchronism with and depending upon said cyclic variations of the degree of stretch of said elastic tape and at substantially the same phase of each of said cyclic variations so as to obtain a plurality of bielastic tape elements, each composed of an elastic tape portion fastened to a compression-resistant tape portion so as to induce in the same a curvature which ranges between a maximum and a minimum and is in the direction of that face of said compression-resistant tape portion to which said elastic tape portion is fastened.

3. Method of manufacturing bielastic tape elements comprising in combination the steps of feeding along a predetermined path, superimposed upon and facing each other a compression-resistant substantially non-stretchable fabric tape and an elastic rubber tape in considerably stretched tension-creating condition; cyclically varying the degree of stretch of said elastic rubber tape so that during each of said cycles the stretch ranges between a maximum and a minimum; fastening said compression-resistant fabric tape and said elastic rubber tape to each other along their entire length while the stretch of the latter is cyclically varied and said tapes are fed along said predetermined path in superimposed condition, thus obtaining a continuous bielastic tape structure composed of said elastic

rubber tape fastened to one face of said compression-resistant fabric tape and having in direction of its length consecutive zones in each of which the stretch of said elastic rubber tape ranges between a maximum in the region of one end thereof and a minimum in the region of the other end thereof; and severing said continuous bielastic tape structure between each two consecutive zones thereof in synchronism with and depending upon said cyclic variations of the degree of stretch of said elastic rubber tape and at substantially the same phase of each of said cyclic variations so as to obtain a plurality of bielastic tape elements each composed of an elastic rubber tape portion fastened to a compression-resistant fabric tape portion so as to induce in the same a curvature which ranges between a maximum in the region of one end thereof and a minimum in the region of the other end thereof and is in the direction of that face of said compression-resistant fabric tape portion to which said elastic rubber tape portion is fastened.

4. Method of manufacturing connected bielastic tape elements comprising in combination the steps of feeding along a predetermined path, superimposed upon and facing each other a compression-resistant substantially non-stretchable fabric tape and an elastic rubber tape in considerably stretched tension-creating condition; cyclically varying the degree of stretch of said elastic rubber tape so that during each of said cycles the stretch ranges between a maximum and a minimum; fastening said compression-resistant fabric tape and said elastic rubber tape to each other along their entire length while the stretch of the latter is cyclically varied and said tapes are fed along said predetermined path in superimposed condition, thus obtaining a continuous bielastic tape structure composed of said elastic rubber tape fastened to one face of said compression-resistant fabric tape and having in direction of its length consecutive zones in each of which the stretch of said elastic rubber tape ranges between a maximum in the region of one end thereof and a minimum in the region of the other end thereof; and marking said continuous bielastic tape structure between each two consecutive zones thereof so as to obtain a plurality of connected bielastic tape elements each composed of an elastic rubber tape portion fastened to a compression-resistant fabric tape portion so as to induce in the same a curvature which ranges between a maximum in the region of one end thereof and a minimum in the region of the other end thereof and is in the direction of that face of said compression-resistant fabric tape portion to which said elastic rubber tape portion is fastened.

5. Method of manufacturing connected bielastic tape elements comprising in combination the steps of feeding along a predetermined path, superimposed upon and facing each other a compression-resistant substantially non-stretchable tape and an elastic tape in considerably stretched tension-creating condition; cyclically varying the degree of stretch of said elastic tape so that during each of said cycles the stretch ranges between a maximum and a minimum; fastening said compression-resistant tape and said elastic tape to each other along their entire length while the stretch of the latter is cyclically varied and said tapes are fed along said predetermined path in superimposed condition, thus obtaining a continuous bielastic tape structure composed of said elastic tape fastened to one face of said compression-resistant tape and having in direction of its length consecutive zones in each of which the stretch of said elastic tape ranges between a maximum in the region of one end thereof and a minimum in the region of the other end thereof; and marking said continuous bielastic tape structure between each two consecutive zones thereof in synchronism with and depending upon said cyclical variations of the degree of stretch of said elastic tape and at substantially the same phase of each of said cyclical variations so as to obtain a plurality of connected bielastic tape elements each composed of an elastic tape portion fastened to a compression-resistant tape portion so as to induce in the same a curvature which ranges between a maximum in the region of one end thereof and a minimum in the region of the other end thereof and is in the direction of that face of said compression-resistant tape portion to which said elastic tape portion is fastened.

6. Method of manufacturing bielastic tape elements comprising in combination the steps of feeding along a predetermined path, superimposed upon and facing each other a compression-resistant substantially non-stretchable tape and an elastic tape in considerably stretched tension-creating condition; cyclically varying the degree of stretch of said elastic tape so that during each of said cycles the stretch ranges between a maximum and a minimum; fastening said compression-resistant tape and said elastic tape to each other along their entire length while the stretch of the latter is cyclically varied and said tapes are fed along said predetermined path in superimposed condition, thus obtaining a continuous bielastic tape structure composed of said elastic tape fastened to one face of said compression-resistant tape and having in direction of its length consecutive zones in each of which the stretch of said elastic tape ranges between a maximum and a minimum; and severing said continuous bielastic tape structure between each two consecutive zones thereof so as to obtain a plurality of bielastic tape elements, each composed of an elastic tape portion fastened to a compression-resistant tape portion so as to induce in the same a curvature which ranges between a maximum and a minimum and is in the direction of that face of said compression-resistant tape portion to which said elastic tape portion is fastened.

7. Method of manufacturing bielastic tape elements comprising in combination the steps of feeding along a predetermined path, superimposed upon and facing each other a compression-resistant substantially non-stretchable tape and an elastic tape in considerably stretched tension-creating condition; cyclically varying the degree of stretch of said elastic tape so that during each of said cycles the stretch ranges between a maximum and a minimum; fastening said compression-resistant tape and said elastic tape to each other along their entire length while the stretch of the latter is cyclically varied and said tapes are fed along said predetermined path in superimposed condition, thus obtaining a continuous bielastic tape structure composed of said elastic tape fastened to one face of said compression-resistant tape and having in direction of its length consecutive zones in each of which the stretch of said elastic tape ranges between a maximum in the region of one end thereof and a minimum in the region of the other end thereof; and severing said continuous bielastic tape structure between each two con-

secutive zones thereof so as to obtain a plurality of bielastic tape elements each composed of an elastic tape portion fastened to a compression-resistant tape portion so as to induce in the same a curvature which ranges between a maximum in the region of one end thereof and a minimum in the region of the other end thereof and is in the direction of that face of said compression-resistant tape portion to which said elastic tape portion is fastened.

8. Apparatus for manufacturing a bielastic tape structure comprising in combination uniting means for fastening to each other along their lengths two superimposed tapes; feeding means for pulling into said uniting means along predetermined paths a compression-resistant tape and an elastic tape; stretching means arranged in the path of the pulled elastic tape for stretching the same, during pulling by said feeding means, said stretching means including a means for cyclically varying the tension of said stretching means during each of the cycles between a maximum and a minimum so as to form in said stretched elastic tape consecutive zones in each of which the stretch of the tape ranges between a maximum and a minimum; and driving means for operating said stretching means during operation of said feeding means.

9. Apparatus for manufacturing a bielastic tape structure comprising in combination uniting means for fastening to each other along their lengths two superimposed tapes; feeding means for pulling into said uniting means along predetermined paths a compression-resistant tape and an elastic tape; stretching means arranged in the path of the pulled elastic tape for stretching the same, during pulling by said feeding means, said stretching means including a means for cyclically varying the tension of said stretching means during each of the periods between a maximum and a minimum so as to form in said stretched elastic tape consecutive zones in each of which the stretch of the tape ranges between a maximum and a minimum; and driving means operated in synchronism with said feeding means and operating said stretching means so that the same stretches said elastic tape in synchronism with said feeding means pulling both tapes into the uniting means.

10. Apparatus for manufacturing a bielastic tape structure comprising in combination uniting means for fastening to each other along their lengths two superimposed tapes; feeding means for feeding into said uniting means along predetermined paths a compression-resistant tape and an elastic tape; stretching means arranged in the path of the fed elastic tape for stretching the same, during feeding by said feeding means, said stretching means including a means for cyclically varying the tension of said stretching means during each of the cycles between a maximum and a minimum so as to form in said stretched elastic tape consecutive zones in each of which the stretch of the tape ranges between a maximum and minimum; and driving means for operating said stretching means during operation of said feeding means.

11. Apparatus for manufacturing a bielastic tape structure comprising in combination uniting means for fastening to each other along their lengths two superimposed tapes; feeding means for feeding into said uniting means along predetermined paths a compression-resistant tape and an elastic tape; stretching means arranged in the path of the fed elastic tape for stretching the same, during feeding by said feeding means, said stretching means including a means for cyclically varying the tension of said stretching means during each of the cycles between a maximum and a minimum so as to form in said stretched elastic tape consecutive zones in each of which the stretch of the tape ranges between a maximum and a minimum; and driving means operated in synchronism with said feeding means and operating said stretching means so that the same stretches said elastic tape in synchronism with said feeding means feeding both tapes into the uniting means.

12. Apparatus for manufacturing bielastic tape elements comprising in combination uniting means for fastening to each other along their lengths two superimposed tapes; feeding means for pulling into said uniting means along predetermined paths a compression-resistant tape and an elastic tape; stretching means arranged in the path of the pulled elastic tape for stretching the same, during pulling by said feeding means, said stretching means including a means for cyclically varying the tension of said stretching means during each of the cycles between a maximum and a minimum so as to form in said strethed elastic tape consecutive zones corresponding to said cycles and in each of which the stretch of the tape ranges between a maximum and a minimum; driving means for operating said stretching means during operation of said feeding means; cutting means arranged after said uniting means in the path of the joined tapes; operating means for operating said cutting means; and actuating means interconnecting said operating means with said stretching means for periodic actuation of said operating means at the same phase of each stretching cycle of said stretching means so as to sever said joined tapes between each two consecutive zones of said elastic tape.

13. Apparatus for manufacturing connected bielastic tape elements comprising in combination uniting means for fastening to each other along their lengths two superimposed tapes; feeding means for pulling into said uniting means along predetermined paths a compression-resistant tape and an elastic tape; stretching means arranged in the path of the pulled elastic tape for stretching the same, during pulling by said feeding means, said stretching means including a means for cyclically varying the tension of said stretching means during each of the cycles between a maximum and a minimum so as to form in said stretched elastic tape consecutive zones corresponding to said cycles and in each of which the stretch of the tape ranges between a maximum and a minimum; driving means for operating said stretching means during operation of said feeding means; marking means arranged after said uniting means in the path of the joined tapes; operating means for operating said marking means; and actuating means interconnecting said operating means with said stretching means for periodic actuation of said operating means at the same phase of each stretching cycle of said stretching means so as to mark said joined tapes between each two consecutive zones of said elastic tape.

14. Apparatus for manufacturing connected bielastic tape elements comprising in combination uniting means for fastening to each other along their lengths two superimposed tapes; feeding means for pulling into said uniting means along predetermined paths a compression-resist-

ant tape and an elastic tape; a rotatable synchronizer member arranged in the path of the pulled compression-resistant tape non-slidably engaging the same and rotated by said tape during pulling of the tape by said feeding means; stretching means arranged in the path of the pulled elastic tape for stretching the same, during pulling by said feeding means, said stretching means including a means for cyclically varying the tension of said stretching means during each of the cycles between a maximum and a minimum so as to form in said stretched elastic tape consecutive zones corresponding to said cycles and in each of which the stretch of the tape ranges between a maximum and a minimum; driving means operated by said rotatable synchronizer member and operating said stretching means so that the same stretches said elastic tape in synchronism with the feeding means pulling both tapes into the uniting means; marking means arranged after said uniting means in the path of the joined tapes; operating means for operating said marking means; and actuating means interconnecting said operating means with said stretching means for periodic actuation of said operating means at the same phase of each stretching cycle of said stretching means so as to mark said joined tapes between each two consecutive zones of said elastic tape.

15. Apparatus for manufacturing a bielastic tape structure comprising in combination uniting means for fastening to a compression-resistant tape passing through said uniting means an elastic tape superimposed upon said compression-resistant tape along the length thereof; feeding means for pulling said elastic tape at uniform speed into said uniting means; stretching means arranged in the path of the pulled elastic tape for stretching the same, during pulling by said feeding means, said stretching means including a means for cyclically varying tension produced by said stretching means during each of the cycles between a maximum and a minimum so as to form in said stretched elastic tape consecutive zones in each of which the stretch of the tape ranges between a maximum and a minimum; and driving means for operating said stretching means during operation of said feeding means.

16. Apparatus for manufacturing a bielastic tape structure comprising in combination uniting means for fastening to each other along their lengths two superimposed tapes; feeding means for pulling into said uniting means along predetermined paths a compression-resistant tape and an elastic tape; a rotatable synchronizer member arranged in the path of the pulled compression-resistant tape; means for maintaining the compression-resistant tape in non-slidable engagement with said synchronizer member so that the latter is rotated by said compression-resistant tape during pulling of the latter tape by said feeding means; stretching means arranged in the path of the pulled elastic tape for stretching the same during pulling by said feeding means; and driving means operated by said rotatable synchronizer member and operating said stretching means so that the same stretches said elastic tape in synchronism with the feeding means pulling both tapes into the uniting means.

17. Apparatus for manufacturing a bielastic tape structure comprising in combination uniting means for fastening to each other along their lengths two superimposed tapes; feeding means for pulling into said uniting means along predetermined paths a compression-resistant tape and an elastic tape; a rotatable synchronizer roller arranged in the path of the pulled compression-resistant tape; means for maintaining the compression-resistant tape in non-slidable engagement with said synchronizer roller so that the latter is rotated by said compression-resistant tape during pulling of the same by said feeding means; a rotatable stretching roller arranged in the path of said elastic tape non-slidably engaging the same; and driving means operated by said synchronizer roller and rotating said stretching roller so that the peripheral speed of said stretching roller is less than the pulling speed of said feeding means, resulting in stretching of the elastic tape pulled by said feeding means in synchronism with said feeding means pulling both tapes into the uniting means.

18. Apparatus for manufacturing bielastic tape elements comprising in combination uniting means for fastening to each other along their lengths two superimposed tapes; feeding means for pulling into said uniting means along predetermined paths a compression-resistant tape and an elastic tape; a rotatable synchronizer member arranged in the path of the pulled compression-resistant tape; means for maintaining the compression-resistant tape in non-slidable engagement with said synchronizer member so that the latter is rotated by said tape during pulling of the latter by said feeding means; stretching means arranged in the path of the pulled elastic tape for stretching the same during pulling by said feeding means with the degree of tension exerted by said stretching means on said elastic tape periodically varying during each of the periods between a maximum and a minimum so as to form in said stretched elastic tape consecutive zones in each of which the stretch of the tape varies between a maximum and a minimum; driving means operated by said rotatable synchronizer member and operating said stretching means so that the same stretches said elastic tape in synchronism with the feeding means pulling both tapes into the uniting means; cutting means arranged after said uniting means in the path of the joined tapes; operating means for operating said cutting means; and actuating means interconnecting said operating means with said stretching means for periodic actuation of said operating means at the same phase of each stretching period of said stretching means so as to sever said joined tapes between each two consecutive zones of said elastic tape.

19. Apparatus for manufacturing a bielastic tape structure comprising in combination uniting means for fastening to each other along their lengths two superimposed tapes; feeding means for pulling into said uniting means along predetermined paths a compression-resistant tape and an elastic tape; a rotatable synchronizer roller arranged in the path of the pulled compression-resistant tape; means for maintaining the compression-resistant tape in non-slidable engagement with said synchronizer roller so that the latter is rotated by said compression-resistant tape during pulling of the same by said feeding means; a stretching roller having a smaller diameter than said rotatable synchronizer roller and arranged in the path of said elastic tape non-slidably engaging the same, said stretching roller being arranged rotatably about an eccentric axis so as to exert during its rotation on said elastic tape a tension periodically varying between a maximum and a minimum and to

form in the elastic tape stretched by periodically varying tension consecutive zones in each of which the stretch of the tape varies between a maximum and a minimum; and driving means operating by said rotatable synchronizer member and rotating said stretching roller about its eccentric axis so that the same stretches said elastic tape in synchronism with the feeding means pulling both tapes into the uniting means.

20. Apparatus for manufacturing bielastic tape elements comprising in combination uniting means for fastening to each other along their lengths two superimposed tapes; feeding means for pulling into said uniting means along predetermined paths a compression-resistant tape and an elastic tape; a rotatable synchronizer roller arranged in the path of the pulled compression-resistant tape; means for maintaining the compression-resistant tape in non-slidable engagement with said synchronizer roller so that the latter is rotated by said compression-resistant tape during pulling of the same by said feeding means; a stretching roller arranged in the path of said elastic tape non-slidably engaging the same, said stretching roller being arranged rotatably about an eccentric axis so as to exert during its rotation on said elastic tape a tension periodically varying between a maximum and a minimum and to form in the elastic tape stretched by said periodically varying tension consecutive zones in each of which the stretch of the tape varies between a maximum and a minimum; driving means operated by said rotatable synchronizer member and rotating said stretching roller about its eccentric axis in such a manner that the average peripheral speed of said stretching roller is less than the pulling speed of said feeding means so that said stretching roller stretches said elastic tape in synchronism with the feeding means pulling both tapes into the uniting means; cutting means arranged after said uniting means in the path of the joined tapes; operating means for operating said cutting means; and actuating means interconnecting said operating means with said stretching roller for periodic actuation of said operating means at the same phase of each stretching period of said stretching roller so as to sever said joined tapes between each two consecutive zones of said elastic tape.

21. Apparatus for manufacturing bielastic tape elements comprising in combination uniting means for fastening to each other along their lengths two superimposed tapes; feeding means for pulling into said uniting means along predetermined paths a compression-resistant tape and an elastic tape; a rotatable synchronizer member arranged in the path of the pulled compression-resistant tape; means for maintaining the compression-resistant tape in non-slidable engagement with said synchronizer member so that the latter is rotated by said tape during pulling of the latter by said feeding means; a rotatable stretching member arranged in the path of the pulled elastic tape for stretching the same during pulling by said feeding means with the degree of tension exerted by said rotatable stretching member on said elastic tape periodically varying during each of the periods between a maximum and a minimum so as to form in said stretched elastic tape consecutive zones in each of which the stretch of the tape varies between a maximum and a minimum; driving means operated by said rotatable synchronizer member and operating said rotatable stretching member so that the same stretches said elastic tape in synchronism with the feeding means pulling both tapes into the uniting means; cutting means arranged after said uniting means in the path of the joined tapes; operating means for operating said cutting means; and actuating means interconnecting said operating means with said rotatable stretching member for periodic actuation of said operating means at the same phase of each stretching period of said rotatable stretching member so as to sever said joined tapes between each two consecutive zones of said elastic tape.

22. Apparatus for manufacturing a bielastic tape structure comprising in combination uniting means for fastening to each other along their lengths two superimposed tapes; feeding means for pulling into said uniting means along predetermined paths a compression-resistant tape and an elastic tape; a rotatable synchronizer roller arranged in the path of the pulled compression-resistant tape; means for maintaining the compression-resistant tape in non-slidable engagement with said synchronizer roller so that the latter is rotated by said compression-resistant tape during pulling of the same by said feeding means; a rotatable cam-shaped stretching member arranged in the path of said elastic tape non-slidably engaging the same so as to exert during its rotation on said elastic tape a tension periodically varying between a maximum and a minimum and to form in the elastic tape stretched by said periodically varying tension consecutive zones in each of which the stretch of the tape varies between a maximum and a minimum; and driving means operated by said rotatable synchronizer roller and rotating said rotatable cam-shaped stretching member so that the same stretches said elastic tape in synchronism with the feeding means pulling both tapes into the uniting means.

23. Apparatus for manufacturing a bielastic tape structure comprising in combination uniting means for fastening to a compression-resistant tape passing through said uniting means an elastic tape superimposed upon said compression-resistant tape along the length thereof; feeding means for pulling said elastic tape at uniform speed into said uniting means; stretching means arranged in the path of the pulled elastic tape for stretching the same, during pulling by said feeding means, said stretching means including a means for cyclically varying the tension of said stretching means during each of the cycles between a maximum and a minimum so as to form in said stretched elastic tape consecutive zones in each of which the stretch of the tape ranges between a maximum and a minimum; and driving means operated in synchronism with said feeding means and operating said stretching means so that the same stretches said elastic tape in synchronism with said feeding means pulling both tapes into the uniting means.

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Number	Name	Date
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