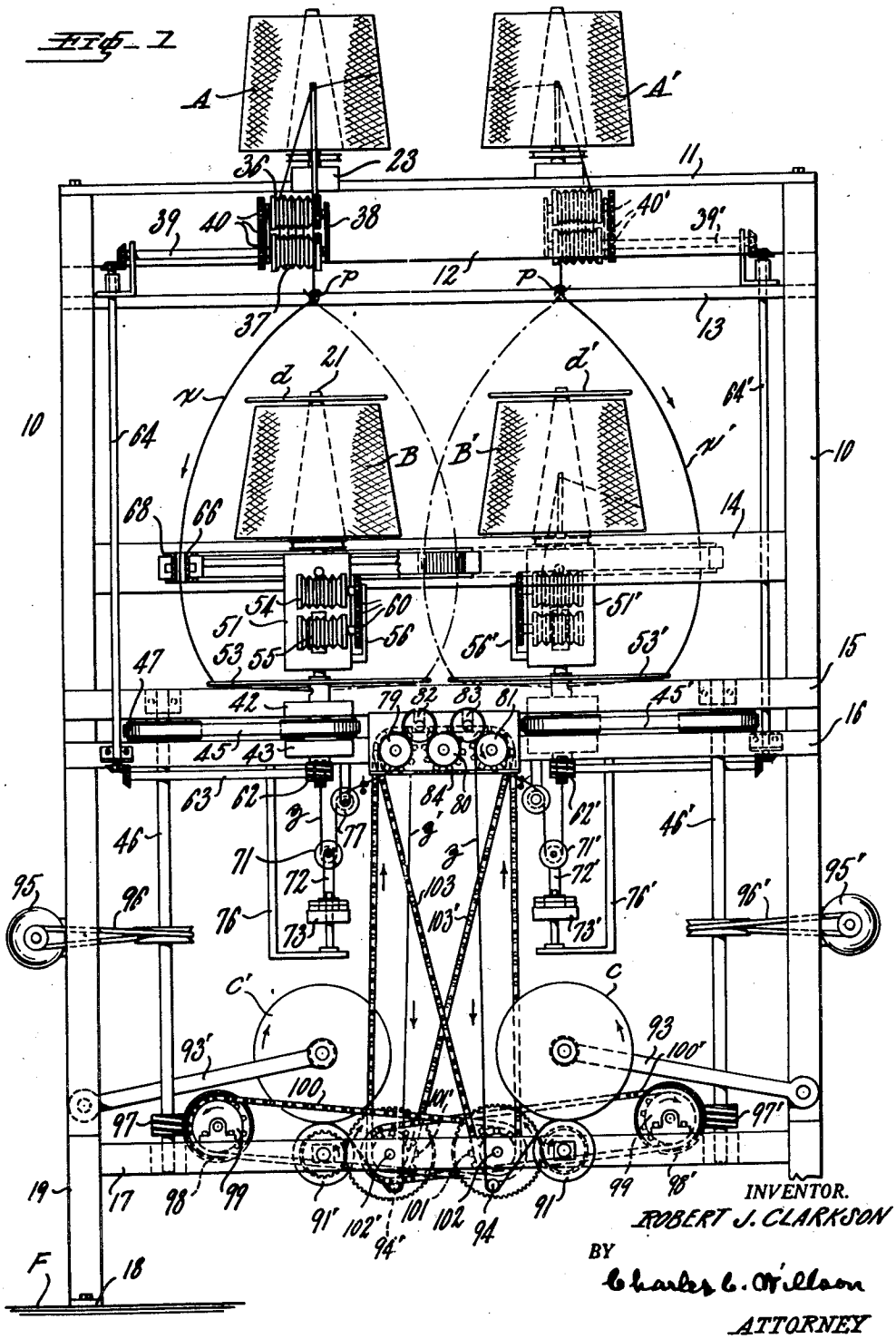
April 11, 1950 R. J. CLARKSON 2,503,242

MECHANISM FOR TWISTING TOGETHER TWO STRANDS

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Fig. 1



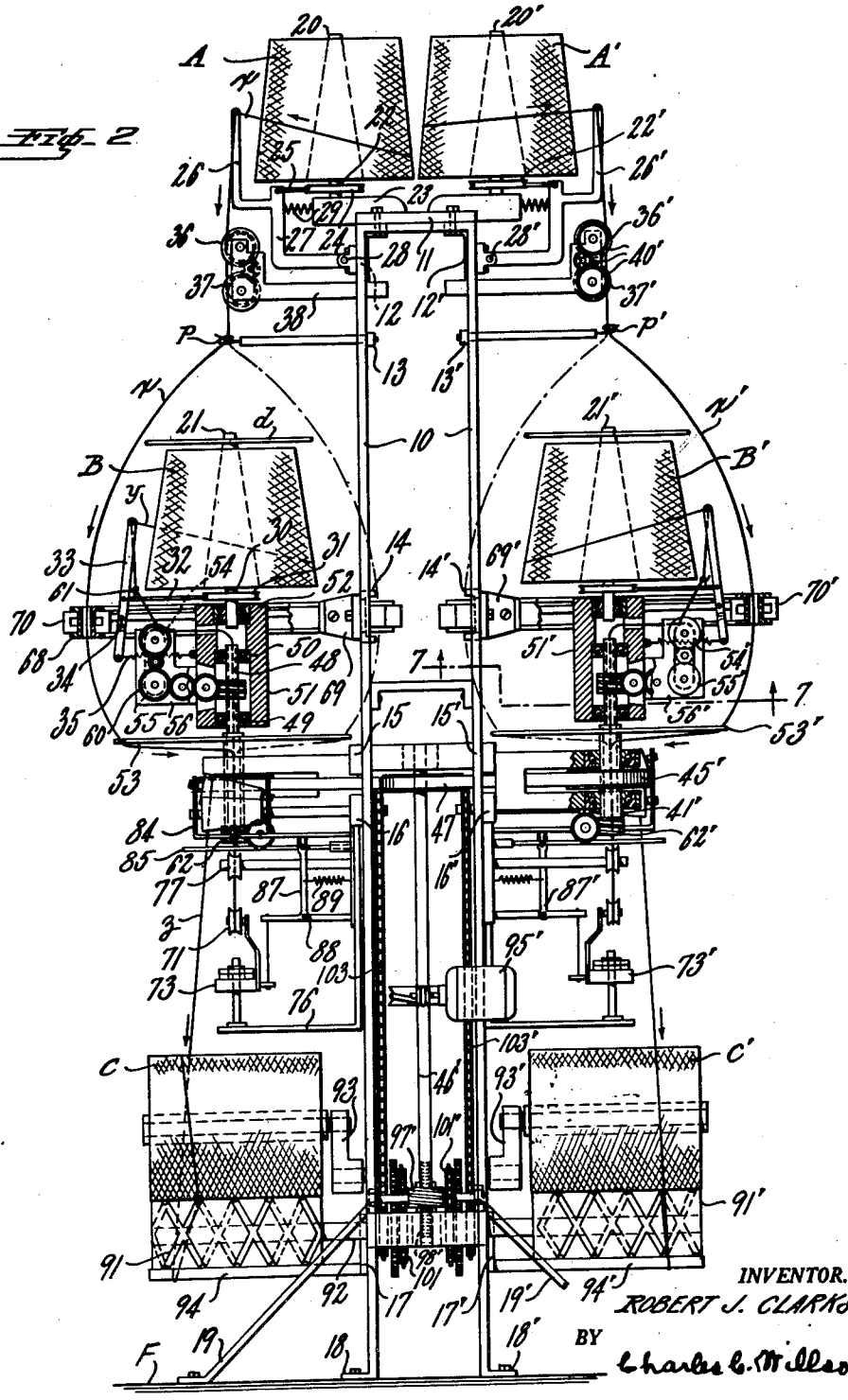
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MECHANISM FOR TWISTING TOGETHER TWO STRANDS

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Fig. 2



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MECHANISM FOR TWISTING TOGETHER TWO STRANDS

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Fig. 3

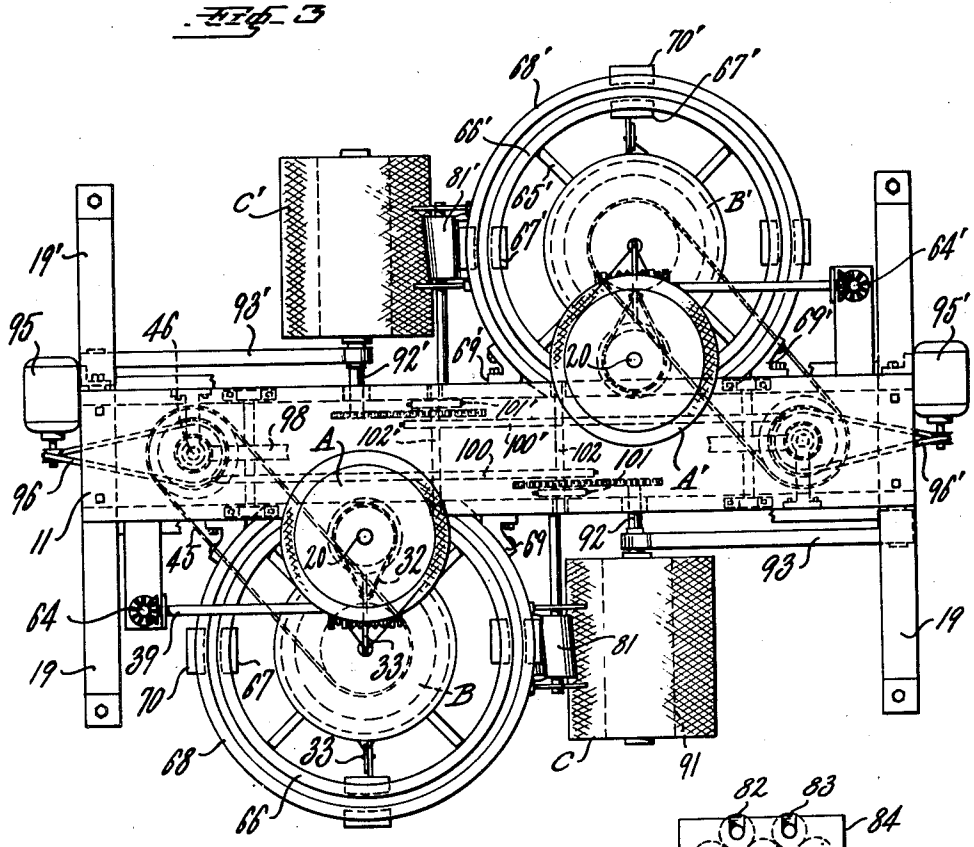


Fig. 5

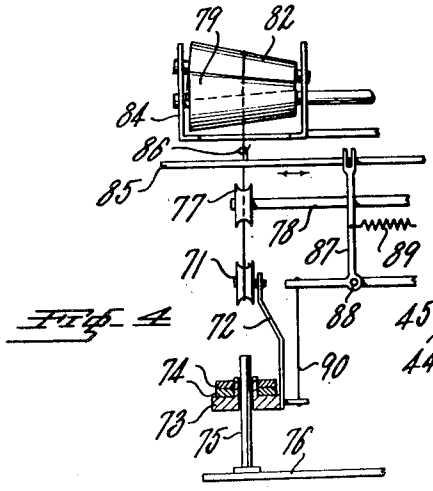


Fig. 4

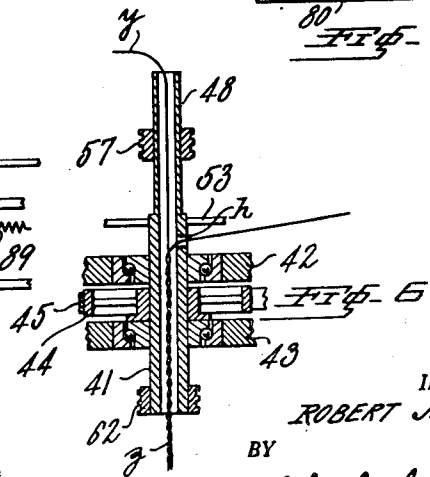


Fig. 6

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MECHANISM FOR TWISTING TOGETHER TWO STRANDS

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Fig. 8

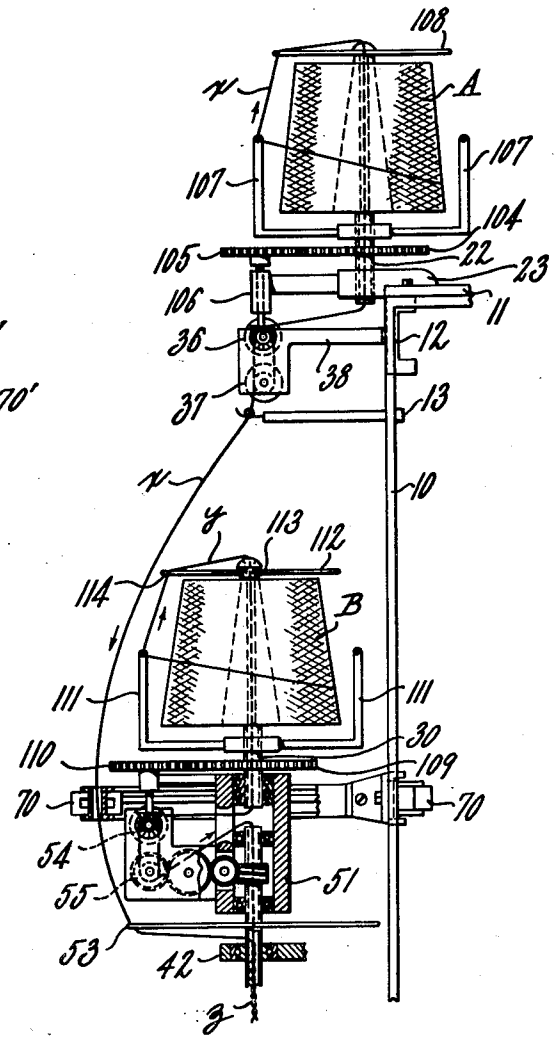
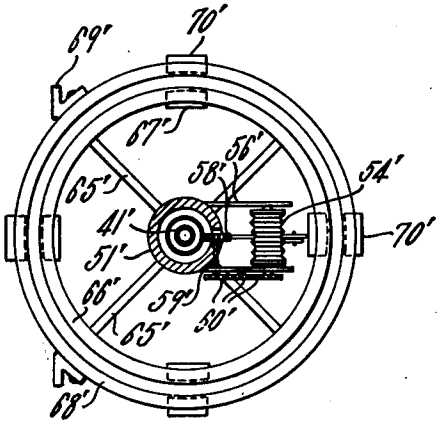


Fig. 7



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Patented Apr. 11, 1950 2,503,242

UNITED STATES PATENT OFFICE

2,503,242

MECHANISM FOR TWISTING TOGETHER TWO STRANDS

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Application October 28, 1948, Serial No. 56,964

14 Claims. (Cl. 57—1)

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This invention relates to mechanism for twisting together two strands to form a two-ply strand.

The present mechanism may be employed to twist or ply together various types of strands, such as wire, yarn or cord, and is particularly well adapted to twist together two large cotton or rayon yarns to form a heavy ply yarn or cord for use in the carcass of pneumatic tires and to reinforce belts and hose. While the invention relates primarily to the twisting together of two strands, it can be employed to ply together three or more strands.

The present inventiton is directed to an important improvement in a type of mechanism that is adapted to ply together two strands without changing appreciably the permanent twist of the individual strands. This is accomplished as heretofore by employing a rotating shaft that operates to rotate a balloon of the strand from one supply package about another supply package to thereby twist the strands together into a plied construction without the necessity of rotating either package at high speed. This method of twisting two strands together into a plied construction has been known for years but has not been extensively used, presumably because of the difficulty in controlling accurately the forward movement of equal lengths of the single strands so that they will produce a uniform ply construction.

One prior type of apparatus for plying together two yarns in this manner is shown, described and claimed in my Patent No. 2,343,535. In accordance with the disclosure of such patent the yarns to be plied together are pulled forward from their respective supply packages by a pulling force exerted on the plied yarn formed of such strands, and tension means is provided near the point where the yarns are twisted together to tension these yarns. It has been found in practice extremely difficult to so tension these yarns that the length of one will not vary with respect to the length of the other, and if the length of the two yarns is not the same as they are supplied to the plying point, a non-uniform ply yarn will be produced and its stength will be less than that of a ply yarn formed of equal lengths of the two single yarns.

Having in mind the foregoing a primary feature of the present invention resides in mechanism whereby each yarn or strand is positively pulled forward from its source of supply by a separate set of delivery rolls. These sets of rolls are driven at the same speed and at a constant

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ratio to the speed of the spindle that plies the yarns together. The effect of this is to supply equal lengths of the two yarns to the plying position. In this manner a highly uniform ply yarn is produced, and as this ply yarn is formed it is taken up under constant tension and wound into a package.

Plied yarn constructed in accordance with the present invention, when used in fields where strength is important, will have a number of advantages over the yarns manufactured by prior methods.

One such advantage is due to the fact that plied yarn can be made more uniform by operating in accordance with the present invention than by prior methods. This is because the apparatus of the present invention will supply, with a high degree of accuracy, equal lengths of the two yarns to the plying point, to thereby produce highly uniform plied yarn possessing high strength due to the fact that when the ply yarn is tensioned, each single yarn forming the ply will take its portion of the load.

Another advantage is secured by the simplicity of the construction and operation of the apparatus of the present invention, as compared with the more elaborate apparatus now in general use for making heavy ply yarn or cord. The present invention makes possible a substantial saving in equipment and labor, and produces a ply yarn with fewer knots in a larger package than heretofore, as well as a more uniform product.

Other advantages reside in a substantial saving in power since it is not necessary to rotate large packages at high speed as was the general practice heretofore; in the elimination of the ring and traveler commonly used heretofore; and in high speed operation.

In making rayon plied yarn or cord, a special advantage is secured by the present mechanism due to the short time that elapsed from the instant the yarns leave the supply packages until the ply yarn is produced. It is known that if twisted rayon yarn is held under tension for a period of hours or days, as is usually the case when it remains wound in a package, the yarn takes a permanent set or undergoes some other change that produces a substantial loss of strength. It is found that if a twisted rayon yarn is held under a substantial tension for a very short period, not exceeding one minute, no appreciable loss in strength occurs. When rayon heavy plied yarn or cord is produced by the conventional methods used heretofore, it undergoes several spooling operations and remains on the

spools under tension between these operations long enough for the yarn to take a set that permanently affects the properties of the yarn. In contrast with this, when the apparatus of the present invention is used, the time elapsed from the instant the yarn leaves its supply package until it is made up into a plied yarn, under normal running conditions, is only a few seconds, and not sufficient for the loss of strength to occur due to the causes above mentioned.

In making cotton plied yarn or cord, an advantage quite different from that just mentioned for rayon cord occurs. This is due to the fact that cotton and other yarns formed of relatively short fibers have to be twisted to a substantial degree to give the yarn handling strength. Therefore the single cotton yarns that are to be plied together have a considerable amount of twist, usually in the opposite direction to that of the twist which plies the yarns together. The plying operation commonly used heretofore changed greatly the original twist of the singles yarn. The apparatus of the present invention makes possible the formation of a plied yarn without changing appreciably the permanent twist of the singles yarns. This allows the use of cotton yarns having a low twist in the singles yarns with a saving in manufacturing costs. It also makes possible the construction of cotton plied yarn having a twist in each of the single yarns that is different from that which can be produced by the conventional apparatus used heretofore for plying yarns together.

The invention resides in mechanism for twisting together two yarns or strands so as to form a two ply construction, and comprises a support that carries a first yarn package and a support that carries a second yarn package. A revolving shaft is provided that operates to rotate a balloon of the yarn from the first package about the second package and also to ply together the yarns from the first and second packages. The new and highly important feature of the present apparatus resides in means for positively feeding forward equal lengths of the two strands to the junction point where they are plied together, so that a given length of the plied yarn will contain two single yarns that are of equal length to a high degree. As a result each of the single yarns will bear its portion of the load when the ply yarn is placed under tension.

The above and other features of the present invention, and good practical mechanism for carrying out the invention will be further understood from the following description when read in connection with the accompanying drawings, wherein:

Fig. 1 is a side elevation, with parts broken away and in section, of a machine equipped with two complete yarn plying units constructed in accordance with the present invention, one unit being disposed at one side and the other at the other side of the machine frame.

Fig. 2 is an end view looking from the right in Fig. 1, with parts removed and others broken away;

Fig. 3 is a top plan view of the machine of Fig. 1;

Fig. 4 is a detail view of apparatus employed in Fig. 1 for taking up the plied yarn under uniform tension;

Fig. 5 is a face view of the casing that supports the tapered take-up rolls shown in Fig. 4;

Fig. 6 is a vertical sectional view through the revolving hollow shaft which operates to rotate a balloon of the yarn from the first package about the second package and to ply the two yarns together;

Fig. 7 is a sectional view taken on the line 7—7 of Fig. 2; and

Fig. 8 shows a modification of one of the ply yarn producing units of Fig. 1, and illustrates gear mechanism for slowly rotating each single yarn package during the operation of the unit.

In the embodiment of the invention illustrated in the drawings only two yarn plying units are shown, one being at one side of the central longitudinal plane of the supporting frame and the other at the opposite side of such central plane. It is contemplated however that in practice a much longer frame than that shown in the drawings will be employed and a number of yarn plying units will be provided at each side of such frame. Each unit, in accordance with the present invention, is driven by an independent source of power so that it may be started or stopped without interfering with the running of the other units. The two yarn plying units shown in the drawing are identical in construction and operation so that the description of one will suffice for both, but in order to make the drawings easier to follow the parts of the operating unit disposed at the left hand side of the sheet in Fig. 1 of the drawing are designated by a series of reference characters, and the parts of the operating unit disposed at the right hand side of such view are designated by the same reference characters except that a prime has been added to each character. This makes it easier to distinguish the parts of one unit from those of the other unit.

In the drawings the various operating parts are shown as supported by an elongated upright frame having the hollow upright end posts **10**. These spaced end posts **10** have secured to their upper ends the longitudinally extending top plate **11**, and these two end posts are also connected by the longitudinally extending rails, **12**, **12'** disposed near the top of the posts, and the other longitudinally extending rails **13** and **13'**, **14** and **14'**, **15** and **15'**, **16** and **16'**, **17** and **17'**, such rails serve to impart rigidity to the machine frame and also to support various operating parts as will hereinafter appear. The end posts **10** may be bolted to the floor F as indicated at **18** and **18'** and are provided with the incline braces **19**, **19'**.

The strand plying unit contemplated by the present invention may, as above stated, be employed to ply up various types of strands but is designed more particularly to ply up textile strands such as cotton yarn, rayon yarn or the like so as to produce a highly uniform two ply yarn.

In the embodiment of the invention shown in the drawings each yarn plying unit is provided with a first or upper yarn package A and second or lower yarn package B and after the yarns from these two packages are plied together they are wound upon the take-up package C. The yarn packages A and B are preferably given the well known tapered shape shown, and the yarn of package A is wound upon a supporting cone **20** whereas the yarn of package B is wound upon a similar supporting cone **21**. The cone **20** is snugly fitted upon a supporting spindle **22** which is journalled in the supporting bracket **23** that is bolted to the top plate **11** of the main frame.

The left-off packages A and B are not positively driven during the operation of the machine but rotate under the pull of the yarn being withdrawn therefrom, and since it is desired

to prevent the packages from rotating too freely the package supporting spindle 22 has mounted thereupon the brake wheel 24 about which is looped the brake strap 25. It is desirable to provide means for varying the braking action of this strap 25 and this is accomplished in the construction shown by causing the yarn x which is being unwound from the package A to pass through an eye in the upper end of the guide arm 26 which is supported by the lever 27 that is pivotally mounted upon the rail 12 at 28. The lever 27 is continuously urged in the strap tightening direction by the coiled compressed spring 29. The arrangement is such that if the yarn x is under slight tension the lever 27 will be forced outwardly by the spring 29 in the strap tightening direction, whereas if the yarn x is under relatively high tension this will serve to move the lever 27 inwardly to slack off the brake strap 25.

The second yarn package B has its cone 21 snugly fitted upon the rotating spindle 30 which is supported by a special construction to be described, and to this spindle is secured the brake wheel 31 having looped about the same the brake strap 32. The tension of this strap is controlled by the rocking lever 33 that is pivotally supported at 34, and this lever is urged in the brake applying direction by the contracting spring 35. The arrangement is such that as long as the tension of the yarn y being withdrawn from the package B is slight the strap 32 will apply considerable braking force, and as the tension of the yarn y increases the braking action will be reduced. As a result of the constructions just described the yarns x and y will leave their respective packages under nearly uniform tension. This is important because if the tension of one yarn differs from that of the other yarn the delivery rolls, to be described, will deliver metered lengths of yarns that will be different in stretch.

The present invention, as above stated, is directed to the type of mechanism that is adapted to ply together two strands without changing appreciably the manufactured twist of the individual strands. This is accomplished by causing the strand x supplied by the package A to revolve in the form of a balloon about the second or lower package B as shown, and by causing the yarns x and y to come together at a point below the package B, where they are plied together by a revolving shaft or spindle to form the desired ply yarn z. In order to produce a uniform ply yarn by uniting two single yarns in the manner just described, it is extremely important that the rate of feed of the two single yarns be accurately controlled so as to deliver equal lengths of the two yarns to the junction point where they are plied together. The present invention resides primarily in means for positively feeding forward equal lengths of the strands x and y so that a given length of the finished ply yarn z will contain equal lengths of these two yarns. This is accomplished in accordance with the present invention by providing positive feed means for the yarn x and positive feed means for the yarn y and by driving each of these feed means at the same speed and at a definite ratio to the speed of the rotating shaft which plies these two yarns together.

The positive feed means for the yarn x comprises a pair of slightly spaced grooved positively driven rolls 36 and 37, see Fig. 1. These grooved rolls are herein called delivery rolls, feed rolls or metering rolls and are employed to deliver a metered length of the yarn x. These rolls are supported by the bracket 38 extending outwardly from the rail 12, and they are driven by the shaft 39 and gears 40. As the yarn x passes downwardly from the guide lever 26 it is looped several times around the grooved rolls 36 and 37 so as to prevent relative slippage between the yarn and rolls, so that these rolls will withdraw this yarn from the package A at a definite speed. The yarn x upon leaving these feed rolls passes through the pigtail guide p supported by a bracket so that this guide is positioned some distance above and in alignment with the axis of the lower package B. The yarn x upon leaving the pigtail guide p is whipped in the form of a balloon about the second package B.

In order that the yarn from the let-off package A may be revolved in the form of a balloon about the second let-off package B it is necessary to support the package B in a special manner. This is accomplished in the construction shown by providing the hollow power driven shaft 41 which is supported from the main frame of the machine by the spaced brackets 42 and 43 that carry the anti-friction shaft bearings best shown in Fig. 6. This shaft is provided with a driving pulley 44 and driving belt 45 that is driven by an upright power shaft 46 and pulley 47 thereupon. Since the shaft 41 supports the weight of the lower package B it is provided with a thrust bearing which is shown in Fig. 6 as provided between the pulley 44 and bearing carried by the bracket 43.

The hollow shaft 41, as will be apparent from Fig. 6 is provided with a reduced upper portion 48 upon which is mounted by means of anti-friction bearings 49 and 50, see Fig. 2, the cylindrical housing 51. This housing is provided at its upper end with the bearing 52 which rotatably supports the spindle 30 for the package B. The arrangement is such that the hollow shaft 41, 48 may be rotated at high speed by the driving means 45, 46, without rotating the package B which is supported by the upper end of this shaft. In order to revolve the yarn x with a ballooning action about the package B, the shaft 41 has extended outwardly therefrom the flier arms 53, one of which is provided with a yarn guiding eye and the other helps to balance the rotating parts. The yarn x passes from the guide eye of the flier 53 inwardly towards the hollow shaft 41 and enters a hole h in a side wall of this hollow shaft.

In order to ply the yarns x and y together they are caused to meet within the hollow shaft 41, 48. The manner in which the yarn x is positively drawn forward from its supply package A and is revolved in the form of a balloon about the second package B and is then led inwardly through a hole in the shaft 41 has been described. The manner in which the yarn y from the package B is led into the same shaft will now be described.

In order positively to pull forward the yarn y from its supply package B at an accurately controlled rate of speed, two grooved positively driven feed rolls are provided which operate similar to the feed rolls 36 and 37 above described, but these feed rolls for the yarn y have to be supported from the cylindrical housing 51 and have to be positively driven from the shaft 41, 48. The grooved feed rolls for the yarn y are designated by the numerals 54 and 55 and are supported by a bracket 56 that projects laterally outwardly from the cylindrical housing 51 as best shown in Fig. 7. These rolls 54 and 55 are positively driven from a worm 57 secured to the shaft 48 and this worm drives a worm gear 58 that drives a

shaft 59. The shaft 59 drives gears 60 attached to the rolls 54 and 55. The yarn *y* passes from the end of the guide lever 33 through a guide 61 and then is wrapped several times around the grooved feed rolls 54 and 55, and upon leaving these feed rolls it passes through an opening in the cylinder housing 51, as shown in Fig. 2, and then downwardly into the upper end of the shaft 48 as shown in Figs. 2 and 6. The two yarns *x* and *y* come together within the hollow shaft 41 at a point adjacent the side hole *h* in this shaft 41. The rapid rotation of this shaft 41 serves to ply these two yarns together to thereby form the ply yarn *z* without greatly changing the manufacturing twist of the yarns *x* and *y*.

The grooved feed rolls 54 and 55 for the yarn *y* are, as just pointed out, positive driven by the worm 57. The feed rolls 36 and 37 for positively advancing the yarn *x* are driven from a worm 62 secured to the lower end of the shaft 41. This worm 62 drives a horizontally extending shaft 63 and upwardly extending shaft 64, which drives the horizontal extending shaft 39 above described. It will therefore be seen that the feed rolls for the yarns *x* and *y* are positive driven at a much slower speed than the hollow shaft 41 but at a definite ratio to the speed of such shaft. As a result an equal length of the yarn *x* and the yarn *y* will be supplied to the plying point within the shaft 41 during the normal operation of the machine. The expression normal operation is used because as the machine is starting up or slowing down the size of the balloon of the yarn *x* will vary, due to the variation in the centrifugal force, and this will effect slightly the relative length of the two yarns as the machine starts or stops.

Since the package B and associated parts are supported solely by the rapidly rotating shaft 41, 48, such package may tend to rotate with the revolving shaft, but this is not desirable. Therefore in order to prevent the supporting structure for the package B from rotating special means has to be provided which will not interfere with the rotation of the yarn *x* in the form of a balloon about the package B. To prevent the supporting structure for the package B from rotating magnet means are preferably provided, and to this end in the construction shown the cylinder housing 51 has rigidly secured thereto near its upper end a wheel-like member comprising the outwardly extending spokes 65 which serve to support the ring 66 from the housing. This ring has secured thereto the magnets 67, such as four permanent magnets. Outside of the ring 66 and in spaced relation thereto is provided a second ring 68 which is supported from the machine frame by the brackets 69, see Fig. 3, and this outer ring 68 has secured thereto the magnets 70 which may be permanent or electric magnets. The arrangement is such that the outer ring 68 is rigidly supported by the machine frame, and the inner ring 66 that is attached to the housing 51 would be free to rotate were it not for the attraction between the magnets 67 and 70 which holds the inner ring 66 and housing 51 from rotating through an angle of any appreciable size. The rings 66 and 68 provide a clearance space therebetween in which the yarn *x* may freely revolve as will be apparent from Fig. 1. A guide disk *d* at the upper end of the core 21 helps to keep the yarn *x* clear of the package B.

In order to produce a ply yarn having the highly uniform properties contemplated by the present invention it is important not only to advance the single yarns *x* and *y* to the plying

position at the same speed and at a definite ratio to the rotation of the shaft 41, but it is also important to provide take-up means which will maintain a uniform tension upon the ply yarn *z* as it is produced. This uniform tension is secured in the construction shown by causing the plied yarn *z* upon leaving the lower end of the revolving spindle 41 to form a loop as best shown in Fig. 1. In this loop is suspended the free running roller 71. This roller 71 is attached to an upright arm 72 which is attached to the weight supporting plate 73 having mounted thereupon the weights 74, see Fig. 4. The weight supporting plate 73 slides up and down on a guide post 75 that is supported by the bracket 76. The ply yarn *z* passes from the roller 71 upwardly about the groove roll 77 supported by a bracket 78, and then to a series of tapered feed rolls, consisting of the lower positively driven tapered rolls 79, 80 and 81 and the tapered floating upper rolls 82 and 83. These rolls are operatively supported by the box shaped bracket 84 which is supported in spaced relation to the side rails 15 and 16 of the machine frame as shown in Fig. 2. The ply yarn *z* passes from the roller 77 to the take-up rolls just described and between these rolls along a serpentine path as shown in Fig. 1. It then passes downwardly to traverse mechanism, to be described and finally to the take-up package C.

In order that the floating weights 74 may effectively control the tension of the ply yarn and at the same time move up and down through only a short distance, means is provided for shifting the yarn back and forth lengthwise of the initial tapered roll to thereby vary the rate of feed of this yarn. This automatic shifting of the yarn relative to the tapered roll is secured, in the construction shown, by providing in front of the first tapered roll 79 the sliding traverse rod 85 having the pigtailed guide 86. This rod is supported as shown in Fig. 4 for sliding movement in a horizontal direction, and such sliding movement is imparted to the rod by the bell-crank lever 87 which is pivotally supported at 88 on a fixed bracket. This bell-crank lever is continuously urged in one direction by the coiled contracting spring 89, and is urged in the opposite direction by the downward pull of the weight supporting bracket 73 which is connected by the wire 90 to the horizontally extending arm of the bell-crank lever. As a result of this construction a slight movement up or down of the weights 74 will shift the traverse rod 85 to thereby move the yarn *z* towards the large or small end of the tapered take-up roll 79 to vary the rate of feed.

The yarn *z* as it reaches the take-up package C is wound thereupon by traverse mechanism, which in the construction shown, comprises a grooved traverse roll 91 of well known construction. This grooved roll is supported and positively driven by a shaft 92, and the take-up package C rests upon this grooved traverse roll as shown. The package is held thereupon by the rocking arm 93 having one end pivotally secured to the machine frame and to the other end is secured a spindle that is adapted rotatably to support the package C so that this package may rise as it increases in size. As the yarn *z* travels downwardly from the tapered feed rolls it passes around a fixed guide bar 94 and then upwardly over the grooved traverse roll 91 and then to the package C as shown in Fig. 1.

Each yarn plying unit is, as above stated, preferably driven independently of the other plying units so that one unit may be stopped with-

out disturbing the operation of the other units. To this end each unit has all its operating parts driven by a suitable source of power such as an electric motor 95 adapted to drive by a belt 96 the upright shaft 46 above referred to. This shaft 46 is provided near its lower end with the driving worm 97 adapted to drive the worm gear 98 and sprocket 99, which drives the relatively long sprocket chain 100 to thereby drive the sprocket 101 and shaft 102. This shaft 102 serves to drive, through suitable gears the traverse roll 91, it also drives the upwardly extending sprocket chain 103 which serves to drive all three of the lowered tapered rolls 79, 80 and 81 by engaging sprockets secured to the shafts of these rolls.

It is desired to point out, as shown in Fig. 1, that the take-up package C does not lie directly below the supply package B but is spaced some distance there below and lengthwise along the machine frame, so that access can be had to the take-up package C without the necessity of working directly below the floating weights 74. This makes it possible to change the package C without stopping the operation of the yarn plying unit.

Having described the apparatus shown, the method of its operation will now be briefly set forth. The primary object of the present invention is, as above stated, to provide means for positively advancing uniform lengths of the two yarns x and y to be plied together to the plying point, and at a definite ratio to the speed of rotation of the shaft used to ply these yarns together. The yarns x and y are unwound from their respective packages, which rotate only fast enough to feed off these yarns, by the positive pulling force exerted by the power driven feed rolls 36 and 37 upon the upper yarn x, and the positive pulling force exerted by the rolls 54 and 55 upon the lower yarn y. These feed rolls are driven at a relatively slow speed from the rapidly rotating hollow shaft 41, 48, the feed rolls 36, 37 being driven from the worm 62 and the feed rolls 54, 55 being driven from the worm 57. As a result of the positive feed means just described yarns x and y will be supplied to the interior of the power shaft 41 in equal lengths so that a given length of the finished ply yarns z will contain the same length of the yarn x and of the yarn y. The rapidly rotating shaft 41, 48 by means of its laterally extending flier arm 53 whips the yarn x in the form of a balloon about the package B, and then plies the two yarns together within this shaft as best shown in Fig. 6. This yarn is then drawn downwardly through the hollow shaft 41 under uniform tension due to the floating weights 74 and cooperating traverse rod and tapered take-up rolls that are positively driven. The ply yarn z upon leaving the tapered take-up rolls passes downwardly to a position to be wound upon the package C by the grooved traverse roll 91 which supports and rotates this take-up package.

The apparatus of the present invention is well adapted to handle large supply packages to thereby provide the finished ply yarn such as tire cord with very few knots. For example it is contemplated that the packages A and B may each weigh eight or ten pounds so that the ply yarn produced from the yarns supplied by these two packages will weigh nearly twenty pounds. Since in accordance with the present invention both packages A and B rotate only fast enough to permit the yarn to be drawn therefrom, and the take-up package C rotates only fast enough to wind the finished ply yarn thereupon, power is not consumed in rotating large packages at high speed, therefore a saving in power is secured over the conventional types of yarn plying machines which necessitate the rotation of a relatively large package at high speed, and also uses rings and travellers with their accompanying problems. The present machine may therefore be operated at a considerably higher rate of production than the yarn plying machines now in general use, but what is more important is that the present machine will produce a more uniform ply yarn than it has been possible to produce heretofore.

In the manufacture of tire cord from rayon yarn such for example as a 1650 d./2 ply yarn, it is customary for some yarn manufacturers to supply the single rayon yarns to the manufacturer who produces the ply yarn with single yarns that have what is known as a zero twist. In some cases it may be desirable to impart a small amount of twist to these zero twist rayon yarns before they are plied together. Having this in mind, Fig. 8 illustrates a modified construction over the yarn plying unit above described, in that in this modified construction of Fig. 8 it is possible to impart a small amount of twist to each of the single yarns x and y as they are advanced to the yarn plying position. In order to accomplish this it is only necessary to modify slightly the apparatus shown in Figs. 1 to 7 inclusive. This modification consists in removing the brake mechanism provided for retarding the rotation of packages A and B in Figs. 1 to 7 inclusive, and substitute in place thereof means for positively driving at a slow speed the supporting spindles for the packages A and B.

Referring to Figs. 1 and 8, it will be noted that the spindle 22 for supporting the package A has had the brake wheel 24 removed therefrom and that this brake wheel has been replaced in Fig. 8 by the gear 104 which is rigidly secured to the spindle 22. This gear 104 in turn is driven by the gear 105 secured to the shaft 106 which is driven through beveled gears from the upper grooved roll 36. In Fig. 8 it will be noted that the guide lever 26 of Fig. 2, for example, has been replaced by the double end flier yarn guide 107, the second arm 107 is provided to balance the first. A further departure in the modified construction of Fig. 8 over that shown in Figs. 1 to 7 inclusive resides in the construction whereby the package supporting shaft 22 is made hollow in Fig. 8 so that the yarn x passes from the eye in the guide arm 107 upwardly over the guide disk 108 at the upper end of the package supporting spindle, and then downwardly through this hollow spindle and to the delivery rolls 36, 37, whereupon the yarn x passes downwardly to the plying position as shown in Fig. 1.

In the modified construction of Fig. 8 a change similar to that just described has been made in respect to the package B wherein it will be noted that the package supporting spindle 30 has had the brake wheel 31 of Fig. 1 removed and the same has been replaced by a gear 109 which is positively secured to the spindle 30, and this gear is driven by the gear 110 which is positively driven from the delivery roll 54. The spindle 30 has mounted thereto the flier yarn guide 111 so that as the yarn leaves the package B it passes through an eye at the upper end of a flier arm 111 and then to the guide disk 112 and downwardly through the hollow spindle 30 to the delivery rolls 54, 55. The yarn y preferably passes

through an internal yarn eye 113 in the disk 112 as shown, as this helps to keep it from contacting the ballooning yarn x. The flier 111 is frictionally secured to the spindle 30 so that it can rotate to accommodate the unwinding yarn y. Likewise the flier 107 is frictionally mounted upon the spindle 22.

By employing the modified construction of Fig. 8 it is possible to impart a few twists per inch to the yarn x and to the yarn y before these yarns reach the point at which they are plied together to form the ply yarn z. The twist acually is inserted in the yarn x between the let-off package A and the feed rolls 36, 37, and the twist is inserted in the yarn y between the let-off package B and the feed rolls 54, 55. The apparatus of Fig. 8 in other respects operates the same as that described in Figs. 1 to 7 inclusive.

The hollow shaft 41 may be rotated in either direction depending upon the type of twist desired in the finished ply yarn. If it is desired to rotate this shaft in a clockwise direction, looking down from the top of the machine, then the supply packages A and B should rotate in a counter-clockwise direction under the pull of the yarn unwinding therefrom. The automatic tension control comprising the floating weights 74 maintains a uniform tension upon the ply yarn z as it is produced, and the take-up package C is frictionally driven at a sufficiently high speed to take up the yarn z supplied thereto. In order to produce the desired highly uniform ply yarn it is necessary, as above pointed out, to positively pull forward a definite length of the yarn x and a definite length of the yarn y so that equal lengths of these two yarns will lie in the finished ply yarn. By positively pulling forward these single yarns at an equal rate as contemplated by the present invention it is possible to produce a ply yarn which, it is believed, is more uniform than the ply yarns produced heretofore.

Having thus described my invention, what I claim and desire to protect by Letters Patent is:

1. Mechanism for twisting together two strands so as to form a two-ply strand, comprising a support carrying a first let-off strand package and a support carrying a second let-off strand package, a revolving shaft operable to rotate a balloon of the strand from the first package about the second package and also to ply the two strands together, and means for positively feeding forward equal lengths of the two strands to the junction where they are plied together.

2. Mechanism for twisting together two strands so as to form a two-ply strand, comprising a support carrying a first let-off strand package and a support carrying a second let-off strand package, a revolving shaft operable to rotate a balloon of the strand from the first package about the second package and also to ply the two strands together, means located between these respective packages and the junction point at which the strands are plied together for positively advancing equal lengths of the two strands towards the plying position, and means for taking up the plied yarn thus produced.

3. Mechanism for twisting together two strands so as to form a two-ply strand construction, comprising a support carrying a first let-off strand package and a support carrying a second let-off strand package, a power driven hollow shaft operable to rotate a balloon of the strand from the first package about the second package and also to ply together the two strands, and means

for positively advancing each of these strands a definite distance for each rotation of said shaft.

4. Mechanism for twisting together two strands so as to form a two-ply strand construction, comprising a support carrying a first let-off strand package and a support carrying a second let-off strand package, a power driven hollow shaft operable to rotate a balloon of the strand from the first package about the second package and also to ply together the two strands, positive strand feeding means for the strand from the first package and for the strand from the second package, and mechanism for operating each of these positive feeding means at a definite ratio to the shaft speed.

5. Mechanism for twisting together two strands so as to form a two-ply strand construction, comprising a support carrying a first let-off strand package and a support carrying a second let-off strand package, a power driven hollow shaft operable to rotate a balloon of the strand from the first package about the second package and also to ply together the two strands, two strand take-up feeds, one for the first package and the other for the second package, and means for positively driving each of said take-up feeds at a constant ratio to the speed of said shaft.

6. Mechanism for twisting together two strands so as to form a two-ply strand construction, comprising a support carrying a first let-off strand package and a support carrying a second let-off strand package, a power driven hollow shaft operable to rotate a balloon of the strand from the first package about the second package and also to ply together the two strands, strand feed rolls for the strand from the first package and other strand feed rolls for the strand from the second package, and means for positively driving both sets of said rolls at the same speed and at a definite ratio to the speed of said rotating shaft.

7. Mechanism for twisting together two strands so as to form a two-ply strand construction, comprising a support carrying a first let-off strand package and a support carrying a second let-off strand package, a power driven hollow shaft operable to rotate a balloon of the strand from the first package about the second package and also to ply together the two strands, feed means for the strand from the first package and separate feed means for the strand from the second package, and mechanism for positively driving each of said means from said shaft at a definite relation to the speed of said shaft and adapted to supply equal lengths of the two strands to the plying point.

8. Mechanism for twisting together two strands so as to form a two-ply strand construction, comprising a support carrying a first let-off strand package and a support carrying a second let-off strand package, a revolving shaft operable to rotate a balloon of the strand from the first package about the second package and also to ply the two strands together, means for positively feeding forward equal lengths of the two strands to the junction point where the ply strand is formed, and uniform tension take-up means for taking up the plied strand.

9. Mechanism for twisting together two strands so as to form a two-ply strand, comprising a support carrying a first let-off strand package and a support carrying a second let-off strand package, a revolving shaft operable to rotate a balloon of the strand from the first package about the second package and also to ply the two strands together, means for positively feeding forward

equal lengths of the two strands to the junction where the ply strand is formed, and uniform tension take-up mechanism for taking up the plied strand comprising a tapered roll and traverse means and a floating weight supported by the plied strand and adapted to operate the traverse means to shift the ply yarn along the tapered roll.

10. Mechanism for twisting together two strands so as to form a two-ply strand, comprising an upper support carrying a first let-off strand package, a lower support carrying a second let-off strand package, a revolving hollow shaft below the second package and operable to rotate a balloon of the strand from the first package about the second package and also to ply the two strands together, and means for positively feeding forward equal lengths of the two strands to the junction where they are plied together.

11. Mechanism for twisting together two strands so as to form a two-ply strand, comprising an upper support carrying a first let-off strand package, a lower support carrying a second let-off strand package, a revolving hollow shaft below the second package and operable to rotate a balloon of the strand from the first package about the second package and also to ply the two strands together, means for supporting the second package upon the upper end of said shaft without imparting the rotation of the shaft to such package, and means for positively feeding forward equal lengths of the two strands to the junction where they are plied together.

12. Mechanism for twisting together two strands so as to form a two-ply strand construction, comprising a support carrying a first let-off strand package and a support carrying a second let-off strand package, a revolving shaft operable to rotate a balloon of the strand from

the first package about the second package and also to ply the two strands together, strand feeding rolls for each package that are positively driven at a constant ratio to the speed of said shaft to supply equal lengths of the two strands to the plying point, and means for rotating each of said packages to twist the yarn drawn therefrom.

13. Mechanism for twisting together two yarns so as to form a ply yarn, comprising a yarn package having a hollow supporting spindle and a second yarn package having a hollow supporting spindle so that the yarn from each package can be drawn through its hollow spindle, a revolving shaft operable to rotate a balloon of the yarn from the first package about the second package and also to ply the two yarns together, means for pulling said yarns forward, and means for positively rotating each package at a definite ratio to the speed of said shaft to thereby twist these yarns before they are plied together.

14. Mechanism for twisting together two yarns so as to form a ply yarn, comprising a yarn package having a hollow supporting spindle and a second yarn package having a hollow supporting spindle so that the yarn from each package can be drawn through its hollow spindle, a revolving shaft operable to rotate a balloon of the yarn from the first package about the second package and also to ply the two yarns together, means for positively feeding forward equal lengths of the two yarns to the junction point where the strand is formed, and means for positively rotating each package at a definite ratio to the speed of said shaft to thereby twist these yarns before they are plied together.

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No references cited.