

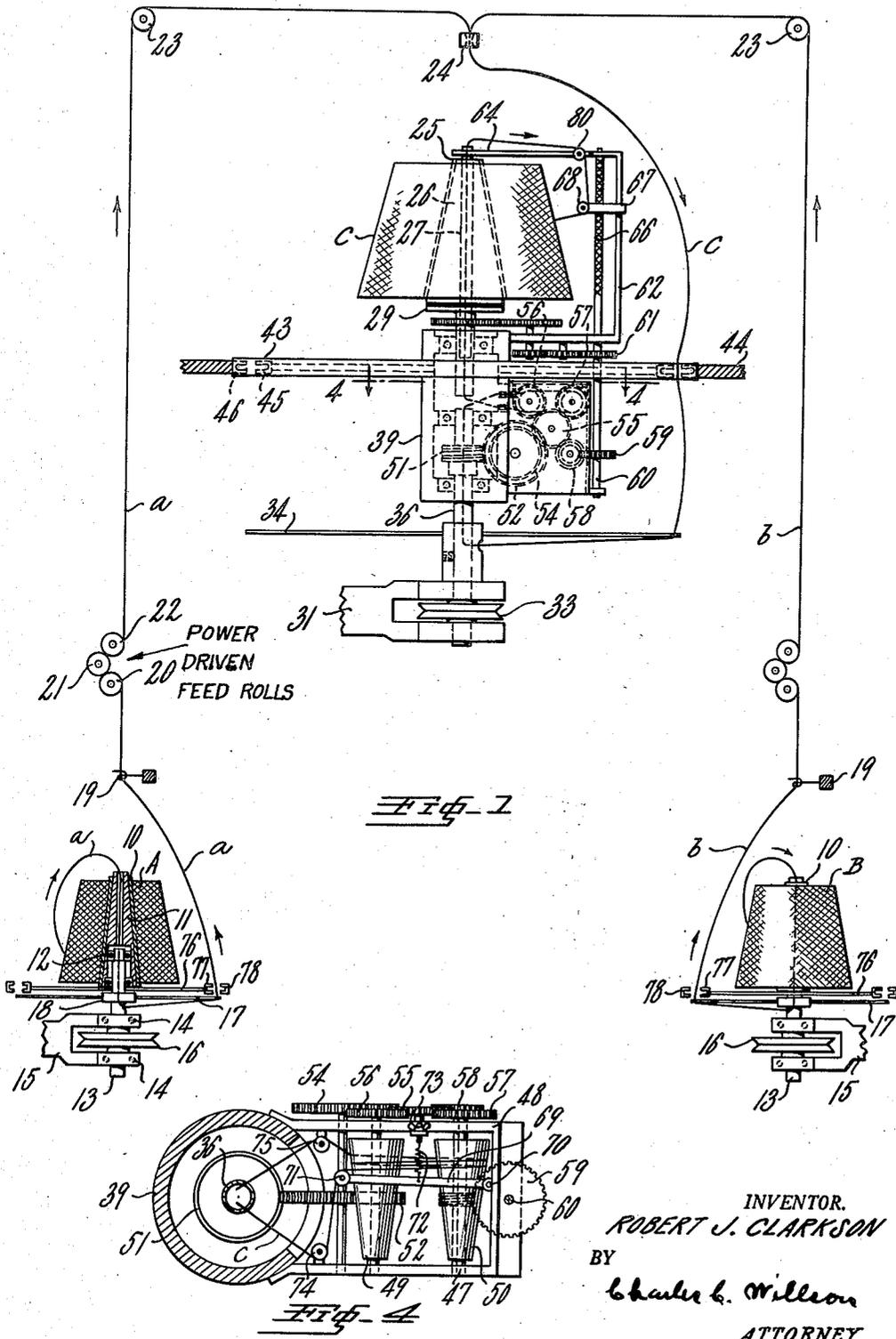
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METHOD OF TWISTING STRANDS TOGETHER TO FORM A PLY
CONSTRUCTION

2,550,136

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2 Sheets-Sheet 1



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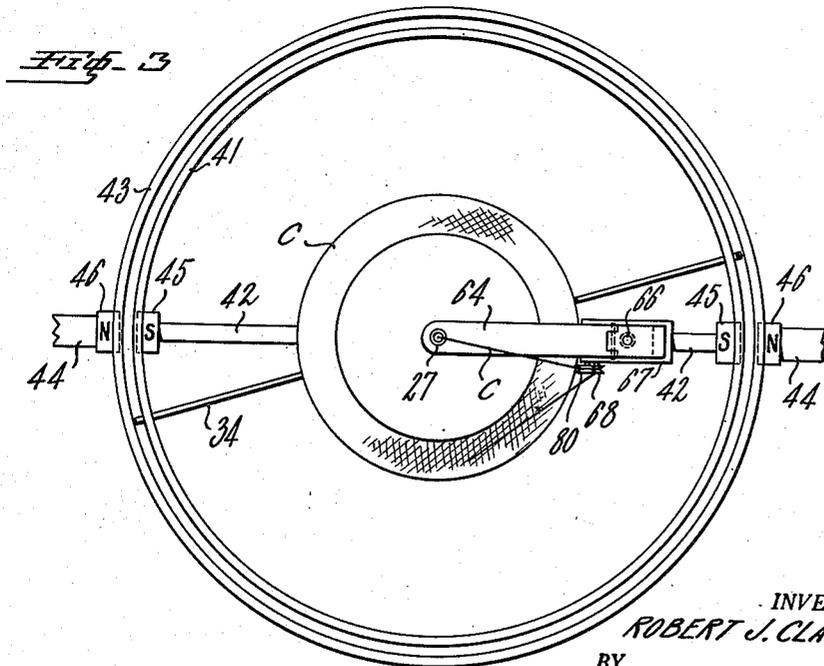
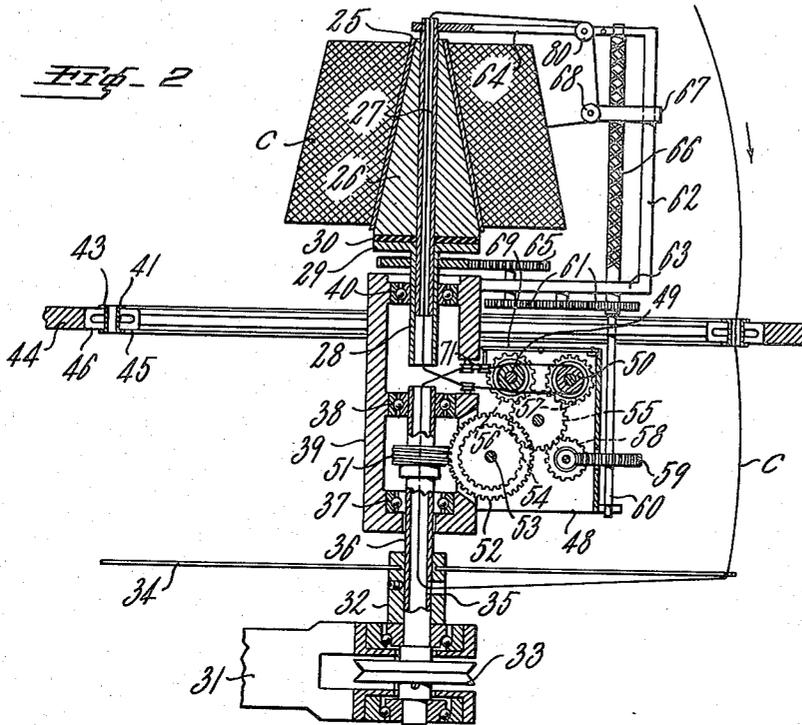
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UNITED STATES PATENT OFFICE

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METHOD OF TWISTING STRANDS TOGETHER TO FORM A PLY CONSTRUCTION

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This invention relates to a novel method of twisting together two or more strands so as to form a highly uniform ply strand.

The present invention may be employed to twist or ply together various types of strands, such as wire, yarn or cord, but is particularly well adapted to twist together two or more 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.

When relatively heavy ply yarn or cord is to be used in mechanical fabrics, it is highly desirable that the individual yarns forming the ply be plied together under uniform tension and of equal lengths, so that when the ply yarn is subjected to high tension each single yarn will bear its portion of the load. If the lengths of the single yarns forming the ply construction are not equal a non-uniform ply yarn will be produced and its strength will be less than that of a ply yarn made up of equal lengths of the single yarns.

In apparatus commonly employed heretofore for plying two or more strands together it is customary to use some form of friction retarding means for tensioning the single yarns as they are drawn from their supply packages to the plying position. This however does not produce a highly uniform ply yarn and if such prior ply yarns are carefully examined the lengths of the strands forming the ply will frequently be found to be unequal.

The present invention contemplates a novel method of forming a ply strand, and which consists in pulling the single strands that are to form the ply strand forward from their respective sources of supply with separate metering actions to thereby insure that equal lengths of the single strands will be advanced to the plying position, where the strands are twisted into a ply strand by revolving them as a balloon about a take-up package. The ply strand thus produced is pulled forward under the action of tension control means. In this way the lengths of the individual strands supplied to the plying position are made equal, and the ply strand which they produce is advanced under approximately constant tension, and with very little variation in the twist imparted to the ply strand. The term "single strand" is herein used to cover a construction which may be formed of a single yarn or ply yarn or other type of strand.

One feature of the present invention resides in a novel method whereby the single strands which are to make up the ply are independently twisted and are then supplied to the plying position and

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are twisted together into a ply strand as a continuous operation. In order to insure that a uniform number of twists per inch are imparted to the single strands, and also to insure that equal lengths of these single strands will be embodied in the ply construction, metered lengths of the twisted single strands are advanced towards the plying position, and the ply strand is advanced under substantially constant tension to its take-up package, to thereby maintain to a high degree of accuracy a definite ratio between the lengths of the individual strands and the length of the ply strand they form.

Another feature of the present invention resides in the method of using a plurality of individual twisting units, of the so-called two-for-one type so that they will twist their respective strands and then supply them to plying apparatus. In this manner the single strands which leave their respective supply packages are twisted individually to the desired amount and are plied together with the proper amount of twist, and are then wound onto the take-up ply strand package in one continuous operation. In this manner the prior practice of winding the strands onto packages at intermediate stages in the manufacture of the ply construction is avoided, and an accurate control of the length of the single strands which are twisted together to form the ply strand is secured, and a highly uniform ply strand is produced.

This so-called two-for-one method of twisting a strand has been known for years, and is carried out by passing the strand to be twisted axially through the center of a let-off package or take-up package for the strand, so that the strand will form a loop that is positioned with one leg of the loop passing centrally through the package and the other leg extending along the outer surface of the package upon which the strand is being wound or unwound. When such a two-for-one construction is employed the package is mounted on a supporting spindle so that the spindle can be rotated without rotating the package. This supporting spindle is made hollow so that the strand may extend axially some distance within the spindle and then laterally through a side opening in the spindle. The construction is such that when this spindle is rotated one leg of the strand loop will revolve about the other leg to thereby impart two twists to the strand for each revolution of the spindle.

In accordance with the preferred method of the present invention, a ply strand formed of two or more single strands is produced, and each

single strand is drawn forward from a supply package that is supported by a conventional two-for-one spindle. The arrangement is such that as each single strand is withdrawn from its package it will receive two twists for each revolution of the supporting spindle. Such strand is pulled forward from its supply package by combined delivery and feed rolls or metering rolls that insure that a definite length of the strand will be advanced for each rotation of the package supporting spindle. These twisted strands are then brought together and are twisted to form a ply strand by revolving them as a balloon about a take-up package. The ply strand thus produced is pulled forward by tension controlled means located adjacent the spindle that forms the balloon, and this spindle is rotated at a definite ratio to the speed of the metering rolls that draw the single strands from their respective sources of supply. This advancing ply strand is then passed axially through the take-up package and is wound upon such package with a traverse movement.

Advantages of the one process conversion obtained by practicing the present method are; increased strength of the ply construction; the ability to use large packages since no package employed has to be rotated at high speed; low waste factors; low power consumption, and high twisting speeds. All of these advantages have a favorable effect in reducing cost.

The above and other features of the present invention will be further understood from the following description when read in connection with the accompanying drawings which illustrate one practical construction for carrying out the method.

In the drawings:

Fig. 1 is a more or less schematic side view with parts in section, of one complete ply forming unit, for twisting together in a single process a plurality of strands, using the so-called two-for-one principal;

Fig. 2 is a vertical sectional view of the upper part of the equipment shown in Fig. 1;

Fig. 3 is a top plan view of the apparatus shown in Fig. 2; and

Fig. 4 is a sectional view taken on the line 4-4 of Fig. 1.

In the apparatus illustrated in Fig. 1 only two let-off packages are shown to produce a two ply construction, but it will be apparent that the apparatus shown in Fig. 1 may readily be employed to produce a ply strand formed of three or more single strands by simply increasing the number of units used to twist the single strands and supply them to the point where these single strands come together.

Since, as above stated, the method of the present invention is particularly well adapted to produce strong coarse ply yarn or cord for use in mechanical fabrics it will be hereinafter described as employed to produce such a ply yarn.

Referring more particularly to Fig. 1 of the drawing, there is shown at the left hand side of the sheet a yarn let-off package A and at the right hand side of the sheet a similar yarn let-off package B. The equipment shown for twisting the yarns supplied by these packages A and B and for pulling each yarn from its package with a metering action is the same for both packages and therefore the description of one will suffice for both. The tapered package A is preferably wound upon the usual paper cone 10 adapted to fit snugly over a tapered supporting spindle 11.

This spindle 11 is rotatably supported by means of the anti-friction bearings 12 upon the upper end portion of a power driven spindle 13. This spindle 13 is shown as mounted by means of the anti-friction bearings 14 in a supporting bracket 15, and the spindle 13 may be driven by the whirl or pulley 16.

The yarn *a* which is drawn off of the package A passes upwardly around the upper end of the package as shown and downwardly through the hollow tapered spindle 11, and then downwardly some distance within the central opening in the upper end of the power driven spindle 13. It then passes laterally out through a side hole in this spindle and outwardly until it passes upwardly through an eye formed at the outer end of a flyer rod 17 which is rigidly secured to a sleeve 18 secured to the spindle 13, and this rod 17 extends outwardly in opposite directions from the sleeve 18 to balance the spindle when it is rotated at high speed. The yarn *a* passes upwardly from the eye of the flyer rod 17 to a pigtail 19 supported above the tapered spindle 11 and in axial alignment therewith. This construction constitutes a well known type of two-for-one spindle and operates in a well known manner, whereby as the yarn *a* is drawn upwardly through the pigtail 19 and the spindle 13 is rotated, the yarn will form a balloon that revolves about the package A and two twists will be imparted to the yarn *a* as it approaches the pigtail 19 for each revolution of the spindle 13.

It is important that the yarn *a* be drawn forward from its supply package at a definite rate with respect to the rotations of the spindle 13 and with respect to the yarn plying mechanism to be described. To accomplish this there is provided, in the construction shown, combination delivery and feed rolls or metering rolls which are conveniently given the form of the three co-operating rolls 20, 21 and 22 disposed a short distance above the pigtail 19. These rolls are adapted to have the yarn *a* passed part way around the lower roll 20 then looped around the intermediate roll 21 and then passed part way around the upper roll 22. The rolls 20 and 22 are preferably power driven so that they operate at a definite surface speed with respect to the rotation of the spindle 13.

The mechanism so far described serves to impart to the yarn *a* a predetermined number of twists per inch as this yarn is drawn forward from its supply package by the metering rolls 20, 21 and 22. Likewise the yarn *b* from the package B is twisted and drawn forward from its source of supply by the metering rolls shown. These yarns *a* and *b* in the construction shown pass upwardly about the free running guide rollers 23 and then inwardly to the guide eye 24 where they come together, and are then twisted to form a ply yarn in the manner now to be described.

The ply yarn formed of the single yarns *a* and *b* after receiving the desired amount of twist is wound upon the take-up package C which is mounted upon the usual paper cone 25 that fits tightly upon the tapered support 26. This tapered support is rigidly secured to the hollow spindle 27 the lower end of which projects downwardly within and is journaled in a hollow power driven spindle 28. The upper end of this spindle 28 has the outwardly flaring head 29 upon which is secured the friction disc 30 so that the lower face of the tapered support 26 may rest upon 75 and be driven by this disc. The arrangement is

such that the power driven spindle 28 serves to frictionally drive the package C at the proper speed to accommodate the ply yarn *c* being wound thereupon.

The ply yarn *c* formed of the single yarns *a* and *b* has the desired amount of twist imparted thereto by causing it to rotate as a balloon about the supply package C, and in order to accomplish this special means are provided to support the package C so that the ballooning yarn may revolve about this package and be wound thereupon.

Most of the apparatus shown in Figs. 2 and 3 is supported by the fixed bracket or frame 31 in which is rotatably mounted the upright spindle 32 adapted to be driven by the whirl or pulley 33. This rotating shaft or spindle 32 is provided near its upper end with the flyer rod 34 which extends outwardly in opposite directions from the spindle 32 and is provided at one end with an eye through which the ply yarn *c* passes. This yarn then passes inwardly through a hole 35 in a side wall of a shaft 32 so that it may pass upwardly within a central opening in this shaft 32. The shaft 32 has rigidly secured therein and extending upwardly therefrom a smaller hollow spindle 36. This spindle by means of the anti-friction bearings 37 and 38 supports a cylinder casing 39 so that the spindles 32 and 36 may rotate rapidly without rotating the cylinder 39. The upper portion of the cylinder 39 serves rotatably to support by means of the anti-friction bearing 40 the power driven shaft 28 above mentioned.

The construction just described serves to rotate the ply yarn *c* in a balloon about the package C when the spindle 32 is rotated, but it is desired to prevent the rotation of the spindles 32, 36 from turning the cylinder 39. This is accomplished in the construction shown by providing an inner ring 41 which is supported from the cylinder 39 by outwardly extending arms 42, and by providing the outer ring 43 which is rigidly supported from the machine frame by the brackets 44. These rings serve to define a path in which the balloon of the yarn *c* may revolve, and in order to prevent the cylinder 39 and associated parts from rotating, a magnetic field is established between the rings 41 and 43. This may be accomplished by providing the ring 41 with permanent magnets 45 and by providing the ring 43 with the permanent or electric magnets 46, so that the attraction between these magnets will keep the inner ring from rotating. The spindle 32 is rotated at a definite ratio to that of the spindle 13.

In order to produce a uniform ply yarn it is important to supply metered lengths of the yarns *a* and *b* to the fixed guide eye 24 where these yarns come together. This is accomplished by the power driven metering rolls 20, 21 and 22. It is also important to pull the ply yarn *c* forward under controlled tension at a point between the ballooning portion of this yarn and the take-up package C. This controlled tension feed for the ply yarn *c* is secured in the construction shown by employing tapered feed rolls and means for shifting the yarn along such rolls. These tapered rolls which are best shown in Fig. 4 are disposed adjacent to and are supported by the cylinder 39 that is provided with the spaced outwardly extending walls 47 and 48. These walls rotatably support the tapered feeding rolls 49 and 50 which serve as combined delivery and feed rolls for the ply yarn *c*. These rolls are made tapered so that

the ratio at which the yarn *c*, engaging the rolls, is pulled forward can be varied by shifting such yarn along these rolls. Power supplied by the spindle 36 drives the rolls 49 and 50, and to this end the spindle 36 has rigidly secured thereupon the worm 51 adapted to drive the worm gear 52 and its horizontally extending shaft 53. This shaft has secured thereto a gear 54 disposed adjacent the outer wall of the supporting plate 48, and this gear 54 drives an intermediate gear 55 that drives gears 56 and 57 secured rigidly to the tapered rolls 49 and 50 respectively. The gear 55 also drives a gear 58 which is provided to drive a pair of worm gears one of which is designated by 59 and is rigidly secured to a vertical shaft 60. This shaft 60 serves to drive a series of gears 61 that are rotatably supported by the U-shaped bracket 62 having its lower leg 63 rigidly secured to a side wall of the cylinder 39 and its upper leg 64 pivotally secured to the portion 62 and having a rotating bearing that receives the upper end of the spindle 27. This leg 64 is pivotally secured to the portion 62 so that it can be swung upwardly when the package is to be doffed. The gears 61 are provided to drive gears 65 one of which is rigidly secured to and rotates the shaft 28, to thereby frictionally rotate the package C fast enough to wind the yarn thereupon. The upright shaft 60 serves also to drive the right and left hand threaded shaft 66 provided to operate the traverse slide 67 that slides back and forth along the frame 62 and is provided with a roller guide 68 that serves to guide the ply yarn *c* and traverse it back and forth upon the take-up package C.

The tapered feed rolls 49 and 50 are positively driven from the worm 51 through the train of gears above described and they therefore tend to advance the ply yarn at a definite ratio to the speed of the spindle 32, but since the single yarns *a* and *b* are positively fed forwardly by the metering rolls 20, 21 and 22 it is important to provide some form of tension control for the means for advancing the ply yarn. This is accomplished in the construction shown by providing adjacent the tapered rolls 49 and 50 a yarn shifting arm 69 that is pivoted to the supporting frame at 70 and the outer end of this arm is provided with a yarn guiding roll 71. This arm 69 is continuously urged in one direction by the pull springs 72 the tension of which may be adjusted by the threaded wing nut 73. The arrangement is such that as the ply yarn *c* passes outwardly through an opening in the wall of the cylinder casing 39 it passes around a roller 74 and then to the roll 71. It is then wound several times around the tapered rolls 49 and 50, and upon leaving these pull rolls it passes around the roller 75 and then into the cylinder 39 and upwardly within the hollow shaft 28. As a result of this construction a high tension upon the yarn *c* will cause the arm 69 to swing toward the smaller end of the roll 49 to reduce the yarn feeding speed, and as the tension decreases the spring 72 will move the arm 69 in the opposite direction to cause the yarn to engage the larger portion of the rolls 49 and 50 to increase the yarn feeding speed. The longitudinal axes of the rolls 49 and 50 may, if desired, be disposed at a slight angle to each other so as to cause the successive windings around the rolls 49 and 50 to spread out slightly and not engage each other.

Since the let-off packages A and B and the take-up package C are all supported by rotating

spindles, it is important to provide means for preventing each of these packages from being rotated by its supporting spindle. The rings 41 and 43 and magnets 45 and 46 perform this service for the package C. Packages A and B may similarly be prevented from turning with their supporting spindles by securing to the spindle 13 above the flier 34 a spider 16 that supports an inner ring 77 that is provided with a plurality of magnets, and by rigidly mounting outside this ring a second ring 78 that supports a plurality of magnets. In such a construction the rings will provide a guide way for the yarn balloon and the magnets will keep the support for the yarn package from rotating.

Having described the apparatus that is shown as constituting one practical form of apparatus for carrying out the present method, the manner in which such apparatus operates will now be briefly described.

The power driven pulley 16 on the spindle that supports the package A and the similar power driving pulley 16 on the spindle that supports the package B should be rotated at the same speed, and at a speed that bears a definite ratio to the speed at which the pulley 33 for the shaft 32 rotates. The metering rolls 20, 21 and 22 for the yarn *a* and the yarn *b* should be driven at the same speed, and at a definite ratio to the speed of the spindle 32. If these speeds all bear the proper ratio to each other a definite number of twists per inch will be imparted to the yarn *a* and yarn *b* during the operation of the machine, and a measured length of each of these yarns will be advanced towards the uniting eye 24 so that the ply yarn *c* will be formed of equal lengths of these two yarns. The number of twists imparted to the yarn *c* will depend largely upon the rate at which the spindle 32 rotates, and to some extent upon the variable take-up action of the tapered rolls 49 and 50. The rotating flyer 34 revolves the ply yarn *c* around the supply package C within the space between the rings 41 and 43, and this twisted ply yarn passes inwardly from the eye of the flyer into the hollow spindle 32 through an opening 35. It then passes to the upper end of the spindle 36, whereupon it passes outwardly through a hole in the side wall of the casing 39 and is guided by the swinging arm 69 on to the tapered rolls 49 and 50. The yarn passes several times around these rolls to prevent it from slipping thereupon. It then passes upwardly through the hollow power driven spindle 28 and through the friction driven spindle 27 to pass out of the upper end of this spindle 27 and then laterally to a roller 80 and then to the guide roller 68, whereupon it is wound on the take-up package C which is frictionally driven by the mechanism above described.

The construction is such that a definite ratio is maintained between the speed of the spindles 13 and that of the metering rolls 20, 21, 22, and between these rolls and the spindle 32. The variation in the feed of the tapered rolls 49 and 50 is only that required to keep an approximately constant tension on the ply yarn *c*.

The yarns *a* and *b* pass downwardly through the hollow spindles of their two-for-one apparatus and are plied together to form the ply yarn *c*. This ply yarn, it will be noted, passes upwardly through the hollow spindle of the two-for-one apparatus that supports the take-up package C. This permits the take-up package C to be wound within the revolving balloon of the ply yarn and also permits the tapered feed

rolls 49 and 50 to be placed between the balloon and the take-up package C, to advance this yarn under substantially uniform tension. The speed at which the spindles 13 are rotated relative to that of the metering rolls 20, 21 and 22 will depend upon the amount of twist it is desired to impart to the yarns *a* and *b*, and the speed at which the spindle 32 is rotated will depend upon the amount of twist to be imparted to ply yarn *c*. It will be understood that by employing the method of the present invention it is possible to manufacture a highly uniform ply yarn and to accomplish this in a continuous operation from the time the yarn leaves the supply packages A and B to the time it is wound on the take-up package C. It will also be apparent that this is accomplished without the necessity of rotating any large package at high speed. By employing the herein described construction in which the single yarns pass quickly in a continuous operation from their supply packages to the ply yarn take-up package, an improved ply yarn is secured because the single yarns are not given an injurious permanent set before they are embodied in the ply construction.

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

1. The method of making a ply strand, which consists in independently pulling two strands forward from their respective sources of supply along different paths to two different metering devices, adapted to insure that equal lengths of the two strands be advanced, bringing these strands together and twisting them into a ply strand by revolving them as a balloon about a take-up package, feeding this ply strand forward at a point between said balloon and its take-up package by exerting a power actuated pulling force within the balloon at such point, and winding the ply strand about said package within the balloon.

2. The method of making a ply strand by separately twisting two strands and then plying them together in a continuous operation, which consists in simultaneously pulling strands from their supply packages along separate paths to two different metering devices and so that each passes axially through its package and through a rotating spindle that twists the strand and whereby the metering actions insure that equal lengths of the two strands are advanced, then bringing these strands together and twisting them into a ply strand by revolving them as a balloon about a take-up package, exerting a uniform advancing pull upon the ply strand at a point between the take-up package and balloon, and winding the ply strand upon said take-up package.

3. The method of making a ply strand by separately twisting two strands and then plying them together in a continuous operation, which consists in simultaneously pulling strands from their supply packages along separate paths to two different metering devices and so that each passes axially through its package and through a rotating spindle that twists the strand and whereby the metering actions insure that equal lengths of the two strands are advanced, then bringing these strands together and twisting them into a ply strand by revolving them as a balloon about a take-up package, exerting a uniform advancing pull upon the ply strand at a point between the take-up package and balloon, and passing the ply strand axially through the

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take-up package and winding it upon said package.

4. The method of making a ply strand, which consists in independently pulling two strands forward from their respective sources of supply with separate metering actions adapted to insure that equal lengths of the two strands be advanced, bringing these strands together and twisting them into a ply strand by revolving them together as a balloon that swings around and passes axially through a take-up package, exerting a uniform advancing pull upon the ply strand at a point between the take-up package and balloon, and winding the ply strand about such package.

5. The method of making a ply strand, which consists in independently pulling two strands forward from their respective sources of supply with separate metering actions adapted to insure that equal lengths of the two strands be advanced, bringing these strands together and twisting them into a ply strand by revolving them together as a balloon that swings around and passes axially through a take-up package, exerting a uniform advancing pull upon the ply strand at a point between the take-up package and balloon, and winding the ply strand upon such package with a traverse wind.

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6. The method of making a ply strand, which consists in independently pulling two strands forward from their respective sources of supply with separate metering actions adapted to insure that equal lengths of the two strands be advanced, bringing these strands together and twisting them into a ply strand by revolving them as a balloon about a take-up package, exerting a uniform advancing pull upon the ply strand at a point between the take-up package and balloon, and winding the ply strand upon said package.

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