ABSTRACT OF THE DISCLOSURE

A method for manufacturing a doubled cord using a hollow spindle capable of rotating at high speed. A twisted continuous filament yarn, carried on the spindle, is passed down the centre of the hollow spindle substantially parallel to the longitudinal axis thereof. The yarn initially in a twisted condition is carried by the hollow spindle and the hollow spindle being rotated to cause the twisted yarn to unwind therefrom and to become doubled together in a cord. The rate of input of untwisted yarn must be greater than the rate of take-up of cord to allow for the apparent reduction in length of the yarn during doubling. Due to the tension in the balloon of the yarn initially in a twisted condition a twisting action is produced on the yarn initially in the untwisted condition, and this yarn becomes twisted between the feed rollers and the spindle but as it is doubled together with the twisted yarn unwinding from the spindle the untwisted yarn is removed as is the twist in the twisted yarn, and the initially untwisted yarn and the twisted yarn unwinding from the spindle adopt an identical helical path. The control which the present invention enables to be exercised over both the feed-in and take-up rates is advantageous in that it enables a degree of control to be exercised over the uniformity of the doubled cord. A disadvantage of the prior processes discussed above is that either the rate of feed-in of yarn is controlled and not the rate of take-up (down-twisting) or vice-versa, (up-twisting), and this tends to result in irregularities in the resulting cord. Although there is no direct control in the method of the present invention over the rate of feed-in of the twisted yarn unwinding from the spindle it has been found that providing the speed of rotation of the spindle is sufficiently high, irregularities due to non-uniform feed-in of this yarn do not tend to arise. Spindle speeds in excess of 5000 r.p.m. are preferred and speeds of up to about 9000 r.p.m. can be attained. The important features to obtain a uniform yarn are the spindle speed and the rate of throughput of the yarns. It is usual to fix the spindle speed and to adjust the rate of throughput of the yarns accordingly. The actual doubling step is the same as in conventional methods, i.e., it involves the doubling together of two twisted yarns in such a way that the twist in the individual yarns is re-
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moved. However, the method of the present invention has the advantage that due to the control it is possible to exercise over rate of feed-in and take-up, a cord of greater twist uniformity can be produced.

As hereinbefore stated the rate of production of a doubled cord by conventional techniques is controlled by the speed of a ring-traveller or a flyer. The speed is limited due to the fact that the ring-traveller or the flyer moves in contact with a metal surface and the frictional forces developed result in build-up of heat which if it becomes excessive could result in stoppage of the machine. Spindle speeds of up to about 4000 r.p.m. are the maximum which could be expected from conventional apparatus. As hereinbefore explained, the present invention is not limited in this way and high spindle speeds, and correspondingly high rates of production of cord are possible. For example, using a spindle speed of 6700 r.p.m. carrying a yarn of twist 12.4 turns per inch, it is possible to draw cord off from the bottom of the spindle at a rate of 15 yards per minute.

The present invention is applicable to the production of cords from any synthetic continuous filaments, e.g., rayon, but it is particularly applicable to the production of cord from thermoplastic filaments since it is possible in this case to heat-set the resulting cord. Usually, both the initially twisted yarn and the initially untwisted yarn are multifilament yarns but it is to be understood that, if desired, both yarns can be a single monofilament yarn, or one yarn can be monofilament and the other multifilament. In the case where a multifilament yarn is used it is not necessary to employ yarns in which all the filaments are thermoplastic to make a cord which can be heat-set and, in fact, as little as 10 percent of the filaments need be thermoplastic in order to confer heat-settability on the yarn. Examples of suitable thermoplastic filaments are nylon, poly(ethylene terephthalate) and polypropylene.

The present invention has the further advantage that due to the control which can be exercised over cord draw-off it enables the cord prior to wind-up to be treated by any conventional textile processing technique. For example, the cord can be dyed, coated or rubberized prior to wind-up. A particularly suitable technique is to pass the cord directly into a fluidized bed of solid particles which can conveniently be heated at an elevated temperature, for example, 250 °C., to heat-set the cord. Stretching of the cord during passage through the fluidized bed of solid particles followed by heat-setting and extruding can be performed to produce a heat-set cord which is less susceptible to shrinkage or excessive stretching than a cord which has not been subjected to the treatment. By heat-setting or hot-drawing the cord immediately after doubling, before the foldings have adopted a permanent set, any small non-uniformity, produced for instance by slight maladjustment of the machine, will be reduced.

The method of the present invention is particularly applicable to the production of tyre cords, especially when the process involves treatment with a fluidized bed of solid particles as described above. It is a particularly desirable feature of tyre cords that there should be little tendency for the cord to untwist (i.e., it should be heat-set) and excessive potential stretching or shrinking of the cord should be avoided. The present invention enables the production of a cord which fulfills each of these requirements.

One form of apparatus suitable for performing the process of the present invention will now be described by way of example only, with reference to the accompanying drawing in which FIGURE 1 is a diagrammatic representation of an apparatus for supplying a twisted yarn on to a hollow spindle and subsequently doubling the twisted yarn on to a previously untwisted yarn.

As shown in FIGURE 1, a combined bobbin and hollow spindle 1 is vertically mounted in a bearing 2 and is encircled by a ring 3 on which is slidably carried a traveller 4. Above the centre of the hollow spindle is mounted a pigtail guide ring 5 and a guide roller 12 which is adjacent a system of feed rollers 6. Below the centre of the hollow spindle 1 is mounted a take-off nip roller system 7.

In operation, to form a cop-build of twisted yarn 8 on the combined bobbin and spindle 1, a yarn 9 is drawn through the feed roller system 6 over the guide roller 12, through the pigtail guide ring 5, along the path 10 (shown as a dotted line), through the traveller 4 and on to the combined bobbin and spindle 1 by rotation of the spindle 1. The movement of the yarn 9 through the traveller 4 causes the traveller 4 to circumnavigate the spindle by sliding on the ring 3 and thereby inserts twist into the yarn. In operation, to double the twisted yarn 8 with a further yarn, a yarn 9, together with the twisted yarn 11 from the combined bobbin and spindle 1, is fed through the centre of the hollow spindle 1. The combined bobbin and spindle 1 is rotated to remove the twist from the twisted yarn 11 and to double wrap this yarn with the yarn 9. The twisted yarn 11 thus becomes untwisted and doubled together with the yarn 9 and the resulting cord 12 is taken off by the nip-roller system 7.

During this operation, it is to be noted that the rate at which the yarn 9 is fed from the feed roller system 6 is greater than the rate at which the yarn 9 is taken up by the nip-roller system 7 owing to the apparent decrease in length resulting from the helical path taken by the yarn 9 when doubled with the yarn 11 in the cord 12.

The relation between the speed of rotation of the combined bobbin and the hollow spindle 1 and the rate of feed of the yarn 9 determines the amount of twist removed from the yarn 11. The number of turns per inch in the doubled cord obtained is also determined by the relationship between the rate of feed of the yarn 9 and the speed of rotation of the combined bobbin and spindle 1. Thus, for example, if the speed of rotation of the spindle 1 is kept constant, the number of doubling turns per inch in the cord may be increased by lowering the rate of feed of the yarn 9. But it is to be noted that in this case more twist would be taken out of the yarn 11 and therefore to maintain twistless yarn in the doubled cord, the amount of twist initially in the yarn 11 would need to be greater.

For a tyre cord, the optimum condition is that where-in the yarns in the cord contain no residual twist and in the method of the present invention this may be achieved by previously putting into the yarn 11 forming the cop build of twisted yarn 8 exactly that amount of twist which will be removed by the rotation of the spindle 1. However if desired the method of the present invention may be used to produce cord wherein pre-determined amounts of residual twist are retained by the constituent yarns.

The invention is illustrated by the following example.

**EXAMPLE**

An 840 denier multi-filament nylon 66 yarn consisting of 140 mono-filaments each of denier 6 was twisted with 12 turns per inch by down-twisting using a ring-traveller, and was collected on a bobbin. The bobbin was mounted on a hollow spindle of diameter ¾ ins. in such a way that the bobbin was carried by the spindle and rotated with the spindle.

A multi-filament nylon 66 yarn consisting of 840 mono-filaments each of denier 140 completely free from twist was wound from a package through nip rollers and through the hollow spindle parallel to the longitudinal axis of the spindle, and through take-up rollers.

The free end of the twisted yarn from the bobbin was attached at the entrance to the spindle to the untwisted yarn. The spindle was caused to rotate at a speed of 6,700 r.p.m. and at the same time the untwisted yarn was passed through the system of feed-in and the yarn was wound on to the spindle at a rate of 15.3 yards per minute. The cord was wound up on a bobbin and a length thereof was examined.
The properties of the cord are shown in Table I below. In Table I the result given for doubling twist indicates the number of turns per inch of each yarn in the cord and is irrespective of the singles twist (if any) in the individual yarns. The results for singles twist were determined as follows. A length of the cord was cut off and one of the yarns was removed leaving a single yarn which retained its helical configuration. This helical configuration was removed by twisting in the opposite sense and this twisting induced a singles twist in the yarn. It is this singles twist which is quoted in Table I, but it is to be understood that in the cord each yarn was substantially free from singles twist. The results given as “percentage coefficient of variation of doubling twist” represent the percentage maximum variation from the mean obtained over a number of determinations. A sample of the cord prepared as above was then passed through a fluidized bed of glass particles which were maintained at a temperature of 240°C. The rate of feed-in of the cord was 10 yards per minute and the stretch applied to the cord was 8 percent. The cord was heat-set whilst stretched by this treatment. The properties of this cord are also shown in Table I below.

| TABLE I |
|---|---|---|
|   | Untreated | Hot stretched |
| Denier | 1,628 | 1,640 |
| Tensile (g.m./denier) | 7.4 | 7.7 |
| Free shrinkage | 2.3 | 2.4 |
| Percent extension at 10 lbs./denier | 11.2 | 6.0 |
| Tensile strength (lbs.) | 31.9 | 22.4 |
| Doubling twist | 12.1 | 11.8 |
| Singles twist | 12.8 | 12.1 |
| Percent twist (turns/inch) | 12.4 | 12.1 |
| Coefficient of variation of doubling twist | 1.74 | 1.44 |

Having now described my invention, what I claim is:

1. A method for the manufacture of a cord which comprises passing together longitudinally through a rotating hollow spindle a positively fed continuous-filament yarn initially substantially free from twist and a continuous-filament yarn initially in a twisted condition, and drawing off the resulting cord at a rate which is less than the rate at which the yarn initially substantially free from twist is supplied to the hollow spindle, the yarn initially in a twisted condition being carried by the hollow spindle and the hollow spindle being rotated to cause the initially twisted yarn to unwind therefrom and to become doubled with the yarn initially substantially free from twist.

2. A method according to claim 1 in which the speed of rotation of the hollow spindle is greater than 5,000 r.p.m.

3. A method according to claim 2 in which the speed of rotation of the hollow spindle is up to 9,000 r.p.m.

4. A method according to claim 1 in which both the yarn initially substantially free from twist and the yarn initially in a twisted condition are multifilament yarns.

5. A method according to claim 1 in which both the yarn initially substantially free from twist and the yarn initially in a twisted condition are monofilament yarns.

6. A method according to claim 1 in which at least one of the yarns comprises a non-thermoplastic filament.

7. A method according to claim 1 in which at least one of the yarns comprises a thermoplastic filament.

8. A method according to claim 1 which includes the step of heat-setting the yarns after they have become doubled together.

9. A method according to claim 8 in which the steps of heat-setting the yarns are carried out by passing the cord through a fluid-bed heated to an elevated temperature.

10. A method according to claim 1 in which the yarn initially substantially free from twist is supplied to the hollow spindle at a constant rate bearing a constant ratio to the rate at which the cord is drawn off.

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