Dec. 10, 1940. W. H. BRADSHAW ET AL 2,224,665

PRODUCTION OF RAYON STRUCTURES

Filed April 22, 1939 2 Sheets-Sheet 1

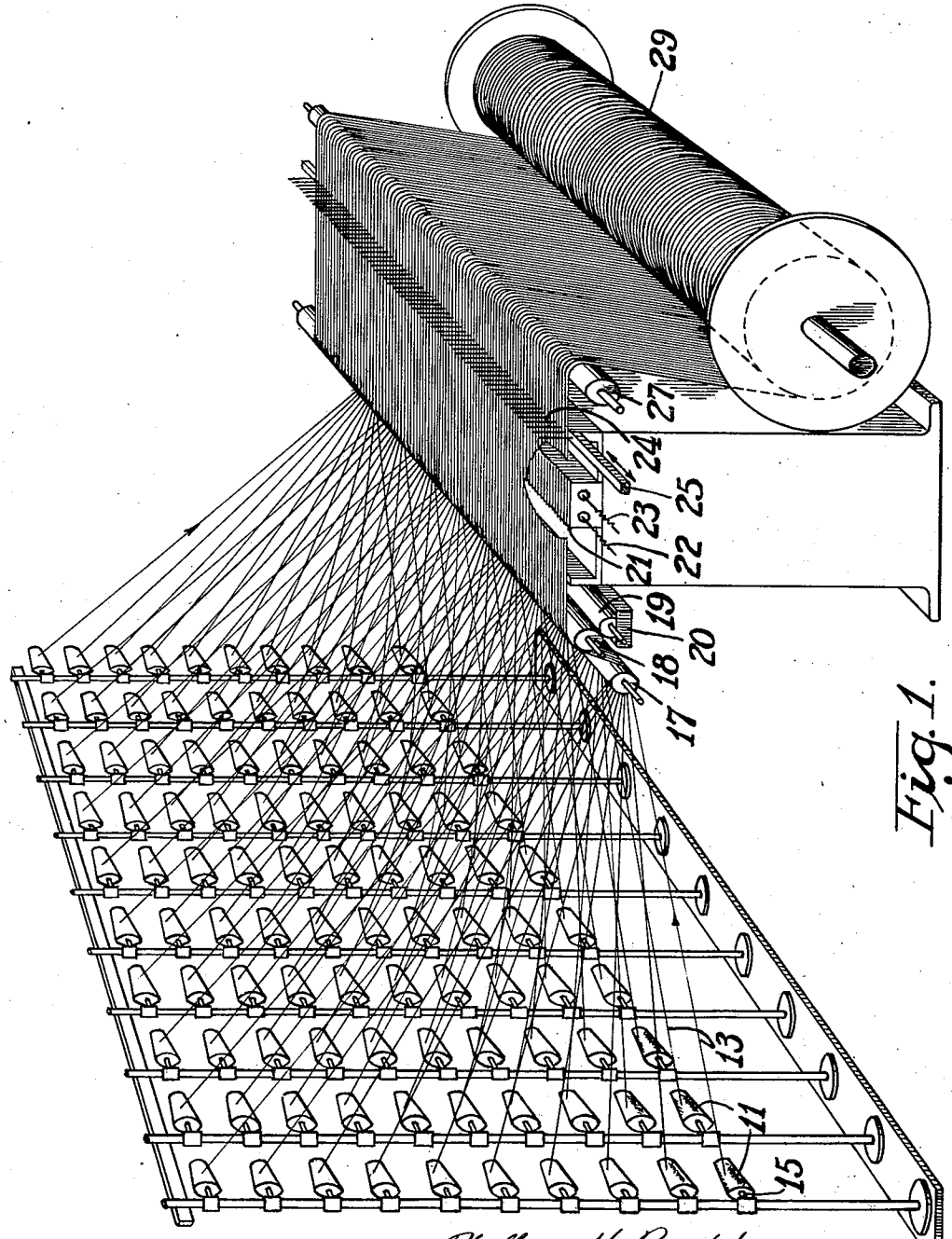

Fig. 1.

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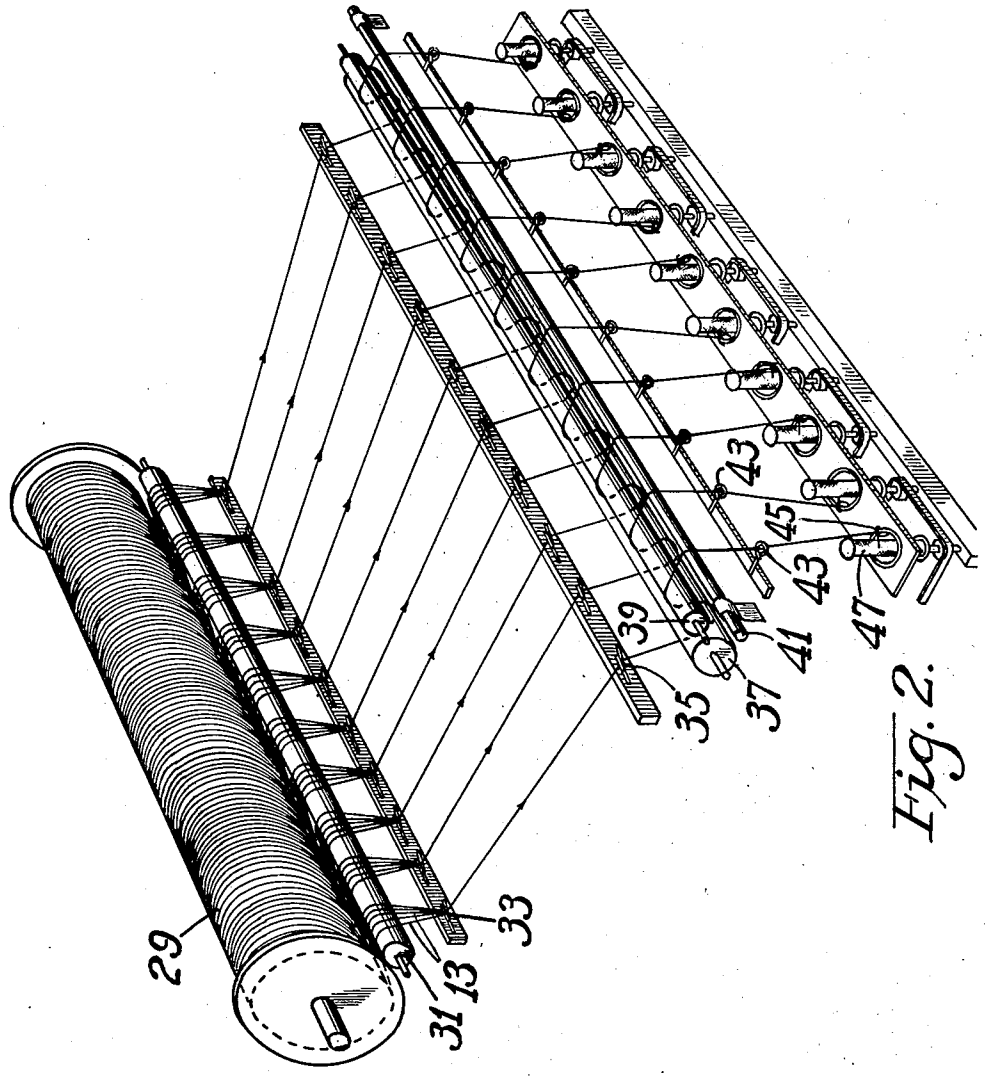

Fig. 2.

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PRODUCTION OF RAYON STRUCTURES

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Application April 22, 1939, Serial No. 269,404

7 Claims. (Cl. 28—28)

This invention relates to the production of rayon cords and, more specifically, it relates to the winding of a rayon yarn, which is free from twist, on to a beam for the formation of a novel beam package from which the yarn may be withdrawn to be twisted into threads, strands or cords which are particularly suitable for use in the reinforcement of rubber tires and similar vulcanized rubber structures.

Customarily, rayon suitable for use in the production of tire cords is supplied to the tire cord manufacturer in the form of a large beam package containing from 100 to 500 or more pounds of twisted yarn.

Such beam packages have been formed, heretofore, by simultaneously winding, with very slight traverse, in side-by-side relationship, on a single large core provided with suitable end flanges, a large number of ends, generally 100 to 500 or more, of uniformly twisted yarn from a corresponding number of small yarn packages. In the winding of such previously known beam packages of rayon yarn, it has been considered essential, particularly with respect to high denier yarn; i. e., yarn having a denier of at least 500, to first impart a twist of about 2 to 4 turns per inch to the yarn to prevent the tangling or snagging, during the winding and unwinding operations, of the filaments of the various separate yarns which are wound in side-by-side relationship on the beam.

The tire cord manufacturer unwinds simultaneously all the ends of twisted yarn from the beam, and simultaneously directly plies and twists uniformly two or more of the twisted yarn ends, at individual plying and twisting positions, to form a strand, or in certain cases, a cord. If strands are formed in the first plying and twisting operation, two or more strands are plied and twisted uniformly together to form a cord which may be used as such, or in the form of a fabric as a reinforcement structure in the carcasses of pneumatic rubber tires. The cord manufacturer, however, is frequently hampered in, if not prevented from, constructing desirable cords by the presence of the initial twist in the individual yarns.

It is an object of this invention to provide an improved method for the production of rayon cord which comprises the winding of untwisted continuous filament yarn on beams.

It is another object of this invention to provide a beam package of untwisted continuous filament yarn, the yarn containing a sufficient quantity of sizing composition to prevent snagging and tangling of the yarn filaments.

It is still another object of the present invention to provide a beam package comprising a plurality of sized, heavy denier, high tenacity, untwisted yarn ends having only a sufficient amount of size on the individual yarn ends to hold the parallel filaments thereof together and to prevent the snarling, tangling and tearing of adjacent filaments and yarns, which would otherwise occur during winding and unwinding of the beam package.

It is still another object of this invention to provide a beam package comprising a plurality of sized, heavy denier, high tenacity, untwisted yarn of substantially circular cross-section, the yarn being free to twist uniformly during subsequent twisting operations.

It is also an object of this invention to provide a sizing composition suitable for application to a heavy denier, no-twist yarn, which size will serve to hold the filaments of the yarn together during the formation of a beam package but which will also permit subsequent uniform twisting of the yarns.

Other objects of the invention will appear hereinafter.

It has now been found that several continuous filament rayon yarns can be satisfactorily wound on to a beam in side-by-side relationship to form a beam package, without first imparting a twist to the yarns. Thus, in accordance with the present invention, a plurality of sized, untwisted—that is to say, having no twist deliberately imparted thereto, although there may be a twist of the order of one turn per foot arising from mere handling of the yarn—yarn ends having a length of 5,000 to 20,000 or more yards are simultaneously wound side-by-side upon a beam core to form a beam package containing 100 to 500 or more pounds of yarn. Contrary to expectations, in spite of the no-twist nature of the yarn, the plurality of yarn ends may thereafter be continuously unwound from the beam package, and in spite of the presence of the sizing composition, the yarns may be simultaneously twisted uniformly. Thus, the yarns may be converted into a strong tire cord without any objectionable difficulty from tangling, snagging or tearing of the yarn filaments.

The mode of operation, in accordance with the present invention, will be more clearly apparent by reference to the following detailed description when taken in connection with the accompanying illustrations, in which:

Figure 1 is a diagrammatic, perspective view illustrating the beaming of a plurality of yarn ends which are free from twist.

Figure 2 is a diagrammatic, perspective view showing the unwinding of the yarn from a beam which is wound in accordance with the procedure outlined in Figure 1, and the simultaneous twisting together of a plurality of yarns to form a strand structure.

In referring to Figure 1 of the drawings, reference numeral 11 designates a plurality of individual yarn packages containing untwisted multifilament rayon yarn. The individual yarn packages 11 are mounted on freely rotatable spindles 15. These spindles may be provided with a spring tensioning, or braking, element to prevent over-running of the yarn packages during withdrawal of the yarn therefrom. The individual ends 13 of the yarn are unwound from the packages 11 and passed about guide roll 17 of a beaming mechanism, thence about size-applying roll 18 for the uniform application of a sizing composition to the individual yarn ends. Roll 18 is mounted to rotate in contact with roll 19 which is positioned in a container 20 holding a quantity of sizing composition. After the application of the sizing composition to the individual thread ends, they are passed across a grooved drying element 21. Each individual thread end passes along a separate groove which is designed to maintain a substantially circular cross-section of the yarn during the drying thereof. The drying element 21 may be heated by means of resistance heating elements 22 and 23, or in any other desired manner.

The individual thread ends are then passed between the teeth of a comb guide 24. The comb guide 24 is mounted on a reciprocable traverse bar 25. A short traverse of preferably from ⅛" to ½" may be imparted to the traverse bar to cause the comb to be reciprocated and to thereby traverse the yarns back and forth across the guide roll 27, so that they will be wound with a slight traverse on the core of beam 29.

Referring to Figure 2 of the drawings, the individual yarn ends 13 are simultaneously unwound from the beam 29. A plurality, for example, 5, as shown in the drawings, of the thread ends are brought together after passing over guide roll 31. The yarn ends are passed through pigtail guides 33 and then through pigtail guides 35 and around rollers 37 and 39. After passing around the said rollers, the yarn is passed over guide bar 41, thence through pigtail guides 43 to the travelers 45 of a ring twisting mechanism to be twisted and wound about pirns 47. The said rollers 37 and 39 may be positively rotated at any desired speed with respect to the pirn speed to regulate the amount of twist imparted to the strand.

In the preferred embodiment of the invention, 100 to 500 or more pounds of sized, no-twist yarn are wound on a beam core as illustrated in Figure 1 of the drawings to form a beam package. Thus, for example, 100 to 500 or more bobbin packages, or the like, of a high denier, high tenacity, multifilament, no-twist yarn are arranged on a creel rack comprising freely rotatable spindles. The individual yarn ends are drawn from the yarn packages thereby causing the yarn packages to rotate upon the spindles. The individual yarn ends are brought forward over suitable guides and/or rollers to form a sheet of individual yarn ends which are, in a single operation, successively sized, dried, and wound in side-by-side relationship on a beam core to form the desired package.

In the handling of bobbin packages, especially those of rather large diameter, it may be found desirable to provide the creel rack with non-rotatable spindles. This will necessitate drawing the yarn off the end of the bobbin package. By so doing, a twist of the order of a turn per foot will be imparted to the yarn but since this amount of twist is negligible for all practical purposes, no harm will be done. As a matter of fact, considerable advantage may accrue from the use of a stationary spindle because then the creel can be constructed as a magazine creel and a reserve bobbin provided for each position to enable continuous operation. If a suitable "tail" is provided on each bobbin, the lead end from the new bobbin can be tied in at any time so that when the first bobbin is emptied, the yarn supply will be transferred, immediately and automatically, from the expired bobbin to the fresh one. Obviously, this mode of operation will eliminate expensive shutdown of the equipment to tie in new ends.

The present invention relates particularly to the beaming of no-twist yarn having a high denier and having high tenacity and low substantially uniform elongation throughout its length. Thus the invention in its specific aspect involves the beaming of a no-twist yarn of 500 to 1100 denier or more, usually consisting of 100 to 600 or more parallel filaments, having a tenacity of at least 2.5 grams per denier and an elongation of about 7–13% substantially uniform throughout its length.

Uniformity of elongation is especially desirable in a yarn destined for the manufacture of a high strength tire cord. By the expression "uniformity of elongation throughout its length" reference is made to uniformity comparable to that of a yarn having a spread in its elongation at a load of 3300 grams, of not more than 2% when the yarn has a commercial denier of 1100. However, with somewhat less advantage, the invention may also be applied to high tenacity yarn having a low elongation varying in uniformity throughout its length by about 3–4%.

The no-twist yarn, in its initial condition; that is, in its condition in the bobbin package, may be a gel yarn; that is, one that has never been dried; or the yarn may be substantially dry yarn; or it may be one which is still quite wet from washing or other finishing operations.

The physical characteristics of the yarn referred to throughout the specification and claims are those possessed by the yarn when determined at a temperature of 70° F. and 60% relative humidity.

The sizing composition applied to the yarn ends is particularly important. It is the function of the sizing composition to hold the individual filaments of the yarn together during the winding and unwinding operations so as to maintain a substantially circular cross-section in the yarn, but the sizing composition must also be of such a character that it will permit the sized filaments to separate sufficiently just before or during the twisting operations to permit uniform twist to be imparted to the yarn. Thus, for example, the sizing composition should be of such character that the centrifugal forces exerted by the ballooning of the yarn during twisting can free the filaments sufficiently for proper twisting.

Furthermore, the sizing composition should preferably be of a softening and lubricating type in order to facilitate the passage of the yarn over

the various surfaces with which it comes in contact and to facilitate proper arrangement of the filaments with respect to each other, as twisting proceeds. This softening and lubrication is particularly desirable when twisted structures of high strength and durability, such as tire cords, are to be obtained.

It has been found that the following softening and lubricating type of aqueous sizing composition containing polymerized methyl methacrylate as the sizing agent will function to particular advantage in accordance with the present invention:

	Per cent
Polymerized methyl methacrylate	0.05–1.00
Sulfonated olive oil	0.10–0.60
Sperm oil	0.10–0.60

Various other combinations of sizing agents and lubricating agents may also be used to give the desired sizing composition. For instance, as sizing agents, instead of the preferred polymerized methyl methacrylate, one may use polyvinyl alcohol, polymerized ethyl methacrylate, gelatine or casein. It is desirable that the sizing agent be applied to the no-twist yarn in sufficient amount to act as a thin protective covering to hold the filaments together during winding and unwinding of the beam package and should not be applied in such excessive amounts as will interfere with at least partial separation of the sized filaments from each other during the subsequent twisting operation. The specific amount of size applied to the yarn will, of course, be contingent on the particular sizing agent chosen. In the case of polymerized methyl methacrylate, a suitable amount is 0.05% to 1.0% based on the conditioned weight of the yarn. By "conditioned" weight of the yarn is meant yarn at its final condition—usually about 12% moisture which is the moisture content if yarn is conditioned at 70° F. and 60% relative humidity. As softening and lubricating agents instead of the preferred sperm oil and sulfonated olive oil, it is possible to use various other animal, mineral or vegetable oils, such as rape-seed oil, tea-seed oil, and sulfonated higher aliphatic alcohols or mixtures thereof.

The drawings and the above description disclose the application of the sizing composition by means of rolls, but it is within the scope of this invention to employ any suitable means. For example, the yarns may be passed through the sizing composition by the use of a dip tank or the composition may be sprayed on or otherwise applied.

The drying of the size applied to the yarn is accomplished, preferably in the absence of any substantial tension on the yarn, or at least under a uniform tension, by passing the yarn over suitable heated drying elements as illustrated in Figure 1 of the drawings until the moisture content is brought within the preferable range of 5–15%, based on the dry weight of the yarn. It is preferable to dry the wet sized yarn while it is constrained to a substantially circular cross-section in a suitable shaping or forming device because, particularly in the case of heavy denier yarns of high filament count, there is a strong tendency to dry with a flat or ribbon cross-section and when these ribbon-like yarns are twisted it is very difficult to secure satisfactory uniform twist. The grooved drying element shown in Figure 1 and described above may be used to impart the desired circular cross-section to the yarn end.

If the yarn is dried by passage simply over the surface of heated drier drums, then the surface of at least the first drum should be provided with a plurality of peripheral grooves of such shape as to impart a size-set, substantially circular cross-section to the individual yarn ends during drying. Any other method of drying the yarn while holding the same in its circular shape may, of course, be used.

In winding the sized yarn ends simultaneously in side-by-side relationship on the beam core, a slowly reciprocating comb guide may be used to traverse the yarn ends about ⅛" to ½" along the length of the beam core, as above described with reference to Figure 1. The slight traverse is especially effective in preventing the wrappings of individual yarn ends from rolling or slipping sidewise and becoming bound or tucked under one or more preceding wrappings of adjacent yarn ends. Such "tuck-ins" cause snarling and tangling and interfere with uniform delivery of the yarn ends from the beam package during the unwinding thereof. The comb guide, which may be an ordinary warp reed, is preferably positioned in front of a roll guide from which the yarn passes as a warp to be wound on the beam. The traverse of the comb guide shifts the position of the various yarn ends on the roller and thereby produces a slightly sinuous wind on the beam core. However, in certain cases, comb guides may with a great deal of advantage be positioned between the roller guide and the beam core and/or the roller guide may be replaced with other suitable guides.

The resultant beamed package of sized, no-twist multifilament yarn is used directly as the yarn supply on a twisting machine without any substantial difficulty from tangling. The sized, no-twist yarn is twisted in one or two operations and is then suitably plied and twisted uniformly with one or more other similarly twisted yarn ends to form a strand or a tire cord, depending upon the denier of the yarn wound on the beam, and the denier of the tire cord desired.

One advantage of the present invention is that for a beam core of given dimensions a variable number of sized, no-twist yarn ends of the same yarn denier may be wound thereon into a well formed package substantially free from any entanglement of adjacent filaments and yarns. Such permits a great deal of flexibility, inasmuch as it is possible thereby to furnish the various tire cord manufacturers with the same dimension beam packages, but which have precisely the right number of yarn ends specified for the number of twisting positions on their particular twisting machines. That is to say, if fewer yarn ends are specified, the traverse of the comb guide is made greater to produce a more sinuous wind in the parallel winding of the yarn ends and thereby fill in the gaps which would otherwise exist between adjacent yarn ends and which would tend to promote slippage and tangling of the yarn ends; while if more yarn ends are specified, the traverse of the comb guide is made smaller, or even omitted, so that the sinuous wind is less.

Another outstanding advantage of the present invention is that the tire cord manufacturer is provided with a beam package of no-twist yarn. Such permits not only an economy in operations, but also permits the tire cord manufacturer to control completely the uniformity and amount of twist inserted in the yarn in making a tire cord. Thus, for example, the manufacturer formerly

could not double the yarns before twisting because of the twist already in them which twist would interfere with his desired cord construction. An economy in operations is effected by virtue of the fact that sizing the no-twist yarn permits the yarn to be handled without the necessity of its being slightly twisted. Formerly, for instance in the case of 1100 denier yarn, the rayon manufacturer inserted about 3 or 4 turns per inch of twist in one operation and in one or two additional operations, the manufacturer brought the total twist up to the desired amount, say, 15 turns per inch. In starting with a no-twist yarn, in contrast, the entire 15 turns per inch of twist can be inserted in simply one operation if desired. From a tire cord quality standpoint, the no-twist yarn is particularly advantageous in the case of a heavy denier yarn such as 1100, in which only two or three twisted yarn ends are plied and twisted to form the tire cord directly. For example, two of the sized 1100 denier yarn ends, each of which has been twisted 15 turns per inch, are plied together with 11 turns per inch of opposite twist to produce a tire cord possessing satisfactory balance and which still contains a great deal of the size applied to the no-twist yarn ends. With such heavy deniers, it is quite critical to have the right type and uniformity of twist in the single yarn end and, therefore, it is highly desirable that the manufacturer have absolute control of the entire twisting operations.

It has heretofore been considered that a sized, no-twist heavy denier yarn would fail to be amenable to yielding the requisite uniformity of twist so necessary in the production of a tire cord from a given yarn. On the contrary, however, in the present invention it has been found that the sized, no-twist heavy denier yarn, particularly if given a substantially circular cross-section, may actually be twisted and plied to produce a tire cord of remarkably good strength. The tire cords may, of course, be used as such, or in the form of a fabric, to reinforce the carcasses in making pneumatic rubber tires.

The invention is, of course, applicable to high tenacity, regenerated cellulose yarn, whether from the viscose process or cuprammonium process, or for that matter to yarn of any desired tenacity, as well as to other artificial yarns having similar properties; for instance, those made from lowly esterified cellulose esters or lowly etherified cellulose ethers.

Since it is obvious that many changes and modifications can be made in the details above described without departing from the nature and spirit of the invention, it is to be understood that the invention is not to be limited except as set forth in the appended claims.

We claim:

1. A beam package of rayon yarn, said package containing, wound in side-by-side relationship, a large number of separate, untwisted rayon yarns each of which is composed of a plurality of continuous filaments, said yarns having a substantially circular cross-section and containing a sizing composition in sufficient amount to hold the filaments together during winding and unwinding thereof but in insufficient amount to prevent free movement of said filaments relative to each other during twisting of the yarn.

2. In a process for the production of rayon cords suitable for use as reinforcement in tires, the steps comprising applying to multi-filament rayon yarns free from twist, a sizing composition in sufficient amount to hold the filaments together during the winding or unwinding thereof but in insufficient amount to prevent free movement of said filaments relative to each other during twisting of the yarn, drying said sized yarns while maintaining the yarns in substantially circular cross-section, simultaneously winding a plurality of said sized yarns in side-by-side relationship on to a beam core, simultaneously unwinding and twisting said yarns from said beam core, and plying said twisted yarns to form a cord.

3. In a process for the production of rayon cords suitable for use as reinforcement in tires, the steps comprising applying to multi-filament rayon yarns free from twist, a sizing composition in sufficient amount to hold the filaments together during the winding or unwinding thereof but in insufficient amount to prevent free movement of said filaments relative to each other during twisting of the yarn, drying said sized yarns to a moisture content of between 5% and 15%, while maintaining the same in substantially circular cross-section, simultaneously winding a plurality of said sized yarns in side-by-side relationship on to a beam core, simultaneously unwinding and twisting said yarns from said beam core, and plying the said twisted yarns to form a cord.

4. In a process of packaging multifilament rayon yarn, the steps comprising applying to multifilament rayon yarns free from twist, a sizing composition in sufficient amount to hold the filaments together during the winding or unwinding thereof but in insufficient amount to prevent free movement of said filaments relative to each other during twisting of the yarn, drying said sized yarns while maintaining them in substantially circular cross-section, and simultaneously winding a plurality of said sized yarns in side-by-side relationship on to a beam core.

5. In a process of packaging multifilament rayon yarn, the steps comprising applying to multifilament rayon yarns free from twist, a sizing composition in sufficient amount to hold the filaments together during the winding or unwinding thereof but in insufficient amount to prevent free movement of said filaments relative to each other during twisting of the yarn, drying said sized yarns to a moisture content of between 5% and 15% while maintaining the same in substantially circular cross-section, and simultaneously winding a plurality of said sized yarns in side-by-side relationship on to a beam core.

6. In an apparatus for beaming multifilament rayon yarns, means for applying size to said yarns, means for drying said yarns, grooved form means for maintaining said yarns in substantially circular cross-section during tne drying thereof and means for winding said yarns in side-by-side relationship on to a beam.

7. In an apparatus for beaming multifilament rayon yarns, means for applying size to said yarns, means for drying said yarns, grooved form means for maintaining said yarns in substantially circular cross-section during the drying thereof, means for simultaneously traversing said plurality of yarns, and means for winding said yarns in side-by-side relationship on to a beam.

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