Jan. 12, 1965 E. H. STRATFORD 3,164,948

CORDAGE AND METHODS OF MANUFACTURE THEREOF

Filed Feb. 28, 1963

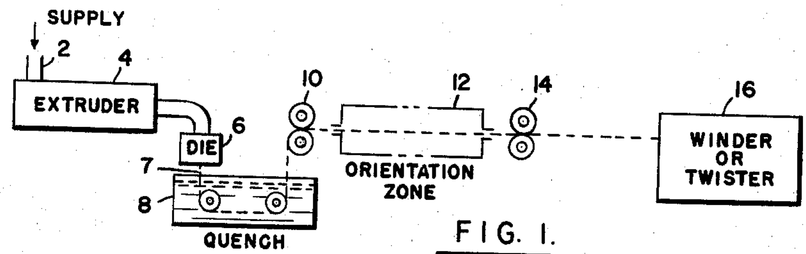


FIG. 1.

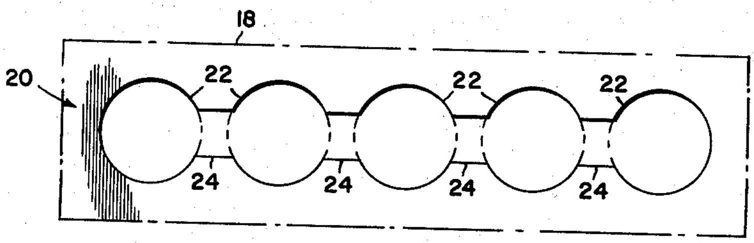


FIG. 2.

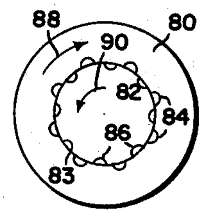
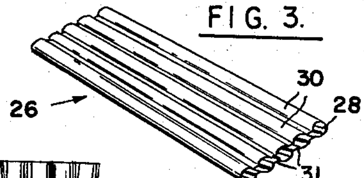


FIG. 9.

FIG. 3.



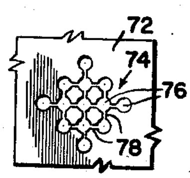


FIG. 8.

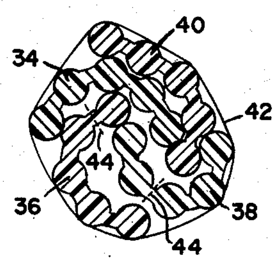


FIG. 5.

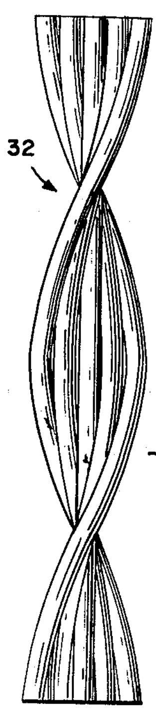


FIG. 4.

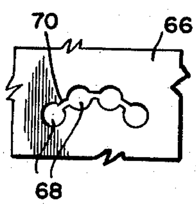


FIG. 7.

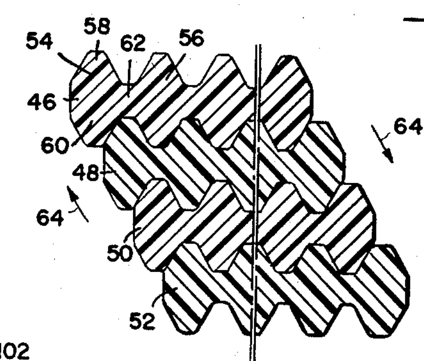


FIG. 6.

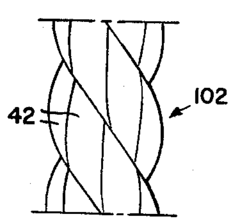


FIG. 10.

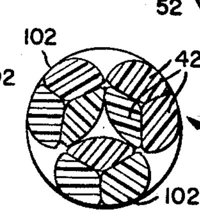


FIG. 11.

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CORDAGE AND METHODS OF MANUFACTURE THEREOF

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17 Claims. (Cl. 57—140)

This invention relates to cordage and methods of manufacture thereof and has particular reference to the manufacture of rope or other cordage from extruded plastics.

As will appear, the invention basically relates to yarn formation, and yarns provided in accordance therewith may be associated in various ways for the formation of cordage. For consistency of description, primary reference will be made to the formation of twisted rope as the end product. But it will become evident that the yarns produced in accordance with the invention are equally applicable to braided or plaited rope, cable or the like, and it will therefore be understood that the invention is not limited to twisted rope.

The conventional practice in the formation of twisted ropes from synthetic plastic material involves the drawing of filaments, the twisting of the filaments into yarns, commonly referred to as threads or singles yarns, the twisting of these yarns to form what are known as plied yarns, ply yarns, or, simply, plies, the formation of these plied yarns into strands, generally involving the formation of concentric twisted layers of the plied yarn, and finally the laying, with twisting, of the strands into rope. The ropes, in turn, may be laid together to form cables. Variants of the foregoing are made involving, for example, the twisting of plied yarns into cords which are in turn formed into strands; or yarns may be plaited to form strands; or plaited yarns may be formed into cords, in turn plaited or braided to form strands, or strands formed of twisted yarns may be plaited to form ropes, etc.

The major difficulties in the making of rope from synthetic plastic materials arise in the production and handling of the filaments. Extrusion of the conventional 6 and 12 mil monofilaments is a very critical process entailing precise equipment and controls and a great amount of skill. The fabrication of these monofilaments into plied yarn is expensive and involves low productivity because of the small deniers and the high twist necessarily involved.

In accordance with the present invention, ribbons, using this term in a broad sense as will hereafter appear, are extruded, the ribbons taking the form of filaments of different or similar shapes which are continuously or intermittently interconnected by reduced thickness bridges. Through the formation and use of these ribbons numerous advantages are obtained which may be briefly referred to as follows:

The sensitivity of the extrusion process is greatly reduced due to the fact that the cross-sectional areas of the extrusion openings in the dies are greatly enlarged avoiding difficulties of clogging and the like.

Another aspect of reduction of sensitivity of the extrusion process is involved in the possibility of drawing contaminated, substandard or reprocessed materials at draw ratios as great as 12 to 1 in spite of the presence of foreign particles creating points of stress concentration, the foregoing being due to the large deniers of the ribbons.

Plying operations are eliminated together with the overtwist involved in making yarn, thereby greatly reducing the throwing costs. In fact, the ribbons may be put directly into the strands of a rope, cable, braid or plait, totally eliminating yarn and ply making operations.

Universal winding of the ribbons may immediately follow the extrusion operation. The improvement in packaging thus achieved permits the maintenance of inventory between extrusion and yarn making.

The formed ribbons may be fully locking or semi-locking and have advantageous winding characteristics as contrasted with filaments of circular cross-sections.

The use of ribbons in accordance with the invention reduces yarn or strand twist, or both, depending on ribbon shape and the final desired rope. The advantage of reduction of twist will be evident when it is considered that for a given load applied to a final product, the rope, the existence of twist increases the lengthwise stress on the filaments as an increasing function of the amount of twist. Theoretically, for the attainment of maximum strength filaments should be extending in the direction of the applied force, i.e. they should be untwisted and should lie parallel to each other; but twist is necessary from a practical standpoint to form a compact structure which will withstand wear and prevent separation of the individual filaments which would cause them to be individually broken in use, permit snagging, and permit them to twist on themselves with resultant breakage. In accordance with the present invention, the amount of twist may be greatly reduced, thus providing a better approach to the theoretically desirable condition of filaments in respect to the direction of applied load.

Because of the formation of ribbons as hereafter more fully described, they exert wedge-like action in strands preventing relative movement and giving rise to high resistance to hockling.

The reduced thickness bridges of the ribbons provide excellent reservoirs to hold lubricants permitting relative movements of the components of the structure.

Because of the large deniers involved, yarns or strands may be twisted directly from the ribbons as they pass from the extruding devices, this being because of the low twist involved.

The general objects of the invention are concerned with the attainment of the foregoing and other advantageous results, and these objects and others will become more fully apparent from consideration of the following description, read in conjunction with the accompanying drawing, in which:

FIGURE 1 is a diagram illustrative of the extruding and associated operations which may be involved in accordance with the invention;

FIGURE 2 is a face view of a portion of a typical extrusion die;

FIGURE 3 is a perspective view showing the form of a ribbon produced by the type of die shown in FIGURE 2;

FIGURE 4 is an elevation showing the helicoidal form taken by the ribbon of FIGURE 3 when partially twisted, a single ribbon being shown for illustration though, as will appear, in general a plurality of ribbons will be twisted together;

FIGURE 5 is a cross-section of a yarn provided by the twisting of four ribbons of the type shown in FIGURE 3;

FIGURE 6 is a diagrammatic section of an alternative type of yarn provided by the association of four ribbons having special interlocking characteristics;

FIGURE 7 is a fragmentary view showing an alternative form of die in which a ribbon of curved cross-section is formed;

FIGURE 8 is a diagrammatic view of an alternative form of die which may be used in accordance with the invention for the formation of a ribbon;

FIGURE 9 is a view similar to FIGURE 8 but showing another form of die;

FIGURE 10 is a fragmentary elevation of a strand provided in accordance with the invention for the formation of a rope; and

FIGURE 11 is a transverse section of a rope formed from strands of the type illustrated in FIGURE 9.

The invention is generally applicable to the formation of cordage from a great variety of extrudable materials which may be handled, so far as extrusion is concerned, in accordance with the individual known procedures applicable to them. Such extrudable materials are polypropylenes, polyethylenes, polyamides, polyesters, polyvinyl chlorides, polyvinylidene chlorides, polyurethanes, polyallomers, polycarbonates, acetyl resins, Teflon or others. Any of these, including the various forms thereof, or mixtures thereof may be supplied in conventional fashion through a supply conduit 2 of a conventional extruder 4 which delivers them to a die indicated at 6. Generally speaking, such an extruder includes heating means and an advancing screw to provide the plastic to the die in molten condition. The invention is not concerned with the chemical aspects of the extruded plastic and it will be understood that, in general, any extrudable composition may be used which will produce satisfactory rope or other cordage for its intended purposes by reason of tensile and other properities.

Following the extrusion from the die 6, the plastic material is subjected to other conventional process. For example, the extruded ribbon or ribbons indicated at 7 pass with desired drawing while in molten or soft condition (which reduces cross-section) into a quench bath 8 wherein the molten or semi-molten plastic is cooled to effect solidification. While a gap is illustrated between the die and the surface of the liquid (usually water or oil) in the quench tank, it may be desirably in the case of various plastics to extrude directly into the quenching liquid. From the quench tank the ribbon or ribbons, now solidified pass through relatively slowly operating draw-off rollers 10 and thence through an orientation zone 12 and through faster operating rollers 14. The orientation zone is generally a heating zone involving infra-red, dielectric, microwave or induction heating or passage through an oil or similar heated bath. The bath may provide an external lubricant for the product. During this passage elongation is produced, suitable for the particular plastic in accordance with known procedures, by reason of the differential speed of the rollers at 10 and 14. As is known, this procedure increases the ultimate tensile strength of plastics of the type here involved. Following the rollers 14, the ribbon or ribbons pass to winding mechanism indicated at 16. In view of the fact that ribbons are produced, the winder may be of universal type to provide packages which may be stored as inventory.

Instead of a winder at 16, however, a twisting device may be provided for twisting a plurality of ribbons together to form a yarn or strand which may, in turn, be wound by universal winding to provide packaging. It may be noted that in contrast with procedure involving the winding of filaments on beams, twisting of the ribbons into yarns or strands may be directly effected as just indicated. This is made practical by the fact that while the ribbons emerge from the rollers 14 at a high linear rate, the twisting necessary to form yarns or strands is relatively small so that the twisting devices can be operated at practical speeds. Twisting of the usual monofilaments at this point is not practical because their linear speed of emergence is so high that the twisting devices, to secure the high amount of twist necessary would be obliged to operate at extreme and impractical speeds, or, alternatively, would require slowing down of the extrusion process.

Reference may now be made to FIGURE 2 which indicates at 18 the die plate of the die 6. As will be evident, this may contain a large number of openings to produce a number of ribbons corresponding thereto; but since these openings are duplicates of each other, only one

opening 20 in the die plate is illustrated in FIGURE 2. This opening, as shown, comprises what are essentially circular openings 22 joined by connecting slots 24. For convenience of reference, the portions of the plastic coming from the circular portions of the openings 22 (or other enlargements as described hereafter) will be referred to as filaments, while those portions extruded from the connecting slots 24 will be referred to as bridges. The number of filament-forming openings 22 may be of any desired number, and it has been found convenient to use arragements producing in a ribbon 4 to 11 or more filaments. The diameters of the circular openings 22 may, practically, range from about 0.010 inch to 0.050 inch, more or less. Draw ratios in the orientation zone which are practical may be around 9 to 1, meaning that the final cross-sectional area of the formed ribbon is correspondingly reduced from that approaching rollers 10, this being substantially less than the cross-section of the die opening. The draw ratio may, however, be as great as 12 or more, depending on the material. While the dimensions of the individual filament openings are not large, the complete cross-sectional area of the opening 20 is large, and consequently stoppage of flow and necessity of cleaning are much reduced. Even the constricted portions of the opening at 24 are effectively maintained clear by the abutting flow through the larger portion of the opening.

A portion of the ribbon formed by the use of the described die is illustrated in FIGURE 3 at 26. The cross-section 28 is geometrically similar to the die opening, but reduced in dimensions in view of the draw effected between the die and the first roller in the quench bath 8 (so that the cross-section of the ribbon as it solidifies may be considerably less than the cross-section of the opening in the die) and in view of the draw effected in the orientation zone 12 by the differential speed of the rollers 10 and 14. The filaments are indicated at 30 and the bridges at 31.

At this point consideration may be given to the significance of the ribbon. If individual filaments were drawn in accordance with conventional practice, a group of them would not be usable without their association or compacting into a singles yarn by twisting, the twisting being essential to hold them together to avoid snagging, disassociation, or individual breakage. Furthermore, a high twist of monofilaments would be required for this purpose. In the case of the ribbon 26, however, they are associated, and integrally so, as a group, and twisting of this group as such is unnecessary. A plurality of ribbons may, therefore, be twisted together to form what is the equivalent of a plied yarn. In that case the twist is very much less, and as noted above, the twisting together of ribbons may be effected at reasonable speeds as the ribbons emerge from the rollers 14.

FIGURE 4 shows, disassociated from other ribbons, the form taken by a single ribbon when twisted into a yarn, though curvature is here not indicated. The twisted ribbon, 32, has a generally helicoidal form. The illustration is primarily to explain how flexibility is secured. The ribbon in its original flat condition as illustrated in FIGURE 3 would, of course, have flexibility in a direction transverse to its width dimension comparable to the flexibility of its individual filaments, but would not be flexible at right angles to this direction. However, as will be evident from FIGURE 4, when twisted it has, from a macroscopic standpoint, flexibility in all directions. This flexibility is of the same order as that of a twisted singles yarn of the same number of filaments; but it may be made greater or less, depending upon the particular die design and resultant product cross-section by varying the width-to-thickness dimensions of the ribbon or the shapes and dimensions of the bridge and/or filament sections, resulting from the geometric configuration of the die opening. There is still another matter of significance evident from FIGURE 4: the filaments in the twisted ribbon have a lead which is substantially greater than they would have if adequately twisted into a singles yarn.

This represents better conformity to the desirable condition of extension of filaments as far as possible in the line of applied tension.

FIGURE 5 shows a cross-section of a yarn provided by the twisting together of four ribbons 34, 36, 38 and 40, each being of the type shown at 26 in FIGURE 3. In such twisting of the ribbons together to form the yarn 42, they will, in general, assume curved cross-sections as indicated. Even further curvature may be produced in the compacting resulting from twisting, FIGURE 5 being illustrative of the effect of twisting to a less than completely tight condition. As will be evident from this figure, the ribbons are to a considerable extent interlocked by entry of this various filaments into the hollows between other filaments. In other words, they are not free to slide laterally with respect to each other. This is a desirable condition which is effective in promotion of resistance to hockling.

Another situation of significance is also indicated in FIGURE 5. While the plastics suitable for rope making are more or less flexible and elastic, they do have a degree or rigidity which will, in some cases, particularly if polypropylene is used, and also in the case of polyethylene, cause the ribbons to resist transverse curvature to small radii. Accordingly, on twisting and compacting, some of the bridges between the filaments may be stressed to a condition producing breakage at surfaces such as indicated at 44. This, however, is not disadvantageous. Such breakages will only locally separate pairs of the filaments in the ribbon. They may thus become only intermittently conected, but since the breaks will be irregularly distributed throughout the ribbons, there will still remain the characteristic that the ribbons represent groups of filaments adequately connected to provide units which are equivalent to, but with their own advantages, twisted singles yarns. It will be readily seen that when breaks do occur locally, the groups of filaments on opposite sides of the breaks will generally have stresses relieved so that further breakages in a ribbon at a given cross-section are not likely to occur.

It may be noted that the filaments of a ribbon need not all be of the same size or shape; for example, large and small filaments may alternate across the width of a ribbon.

If it is desired to provide yarns by association of ribbon in a highly compact structure, the cross-sections of the ribbon may be desirably modified from that heretofore described by adopting the ribbons indicated, somewhat conventionalized, in FIGURE 6. In this figure the four associated ribbons are indicated at 46, 48, 50 and 52. Each filament here comprises the central rectangular portion 54 and trapezoidal portions 58 and 60 involving the 60 degree angular relationship illustrated. The bridges 62 are geometrically chosen so that, in the ideal condition, the ribbons may fit tightly together as illustrated. It will be evident that this represents in a minimum cross-sectional area a maximum amount of plastic, with substantial elimination of such inherent openings as must occur in a bundle of cylindrical elements. Rounding of corners will, of course, occur both in the extrusion from the die, the drawing before solidification, and later in the drawing of the ribbon. But there is a close and significant approach to what would be ideal: a yarn which had a solidly filled cross-section and nevertheless flexibility. Of course, the ideal exhibited in FIGURE 6 will not ordinarily be achievable since difficulty would be encountered in producing the complimentary interlockings as shown. But they will occur to a sufficient extent if the ribbons are fed parallel and in engagement with each other to produce considerable compacting of the yarn. The various ribbons are nevertheless free to move lengthwise with respect to each other, and when twisting occurs as indicated by the arrows 64, there will be achieved the flexibility of the generally helicoidal ribbon configuration as was described in reference to FIGURE 4.

The ribbons as formed need not be flat, and FIGURE 7 illustrates a die plate 66 provided with an extended opening in which circular openings arranged in an arc of a circle are interconnected by bridge passages 70. Returning to FIGURE 5, it will be evident that the curved ribbons produced by the die plate 66 could be associated and twisted without such stressing as might, in the case of a similar flat ribbon, result in breakage of the bridges. Many other ribbon configurations may obviously be adopted with substantially equivalent results. In fact, a ribbon might be extruded closed upon itself to form a tube of bridged filaments, which tube in use, and due to twisting, might be flattened to bring its opposite sides together with the filaments of the sides interlocking. Such a flattened tubular ribbon may, of course, be directly extruded.

There may also be extruded a ribbon having a cross-sectional area with a circumscribing outline of considerable extent in two dimensions as by the use of a die 72 having an opening 74 providing filament-forming openings 76 and bridge-forming openings 78, as shown in FIGURE 8. A ribbon thus formed will, on twisting, compact into a cross-section with abutting filaments.

It will now be understood that the term "ribbon" as used herein has a broad connotation of indicating filaments which are joined continuously or intermittently as exemplified by the foregoing and also by what will now be described with reference to FIGURE 9.

As described heretofore, the filaments of a ribbon were continuously connected along their lengths by bridges, at least as originally formed. It was also pointed out that under compacting stresses these bridges might be intermittently broken, nevertheless maintaining the assembly of filaments into ribbon units. It is, however, quite unnecessary to have the filaments connected to each other except at intermittent quite limited spots, so long as the connections are sufficient to prevent such substantial separations of the filaments as might lead to snagging. When the ribbons are twisted together in a yarn or strand, even though the twist is relatively loose, there is a further contribution to compacting, so that the connections between the ribbons may be relatively sparse. FIGURE 9 illustrates the formation of a ribbon in which filament interconnections are minimized.

The die illustrated in FIGURE 9 comprises outer and inner concentric members 80 and 82 having bearing surfaces at 83. The inner surface of the outer member is provided with outwardly extending openings 84 while the outer surface of the inner member is provided with inwardly extending openings 86. If the members are relatively rotated as indicated by the arrows 88 and 90, filaments will be extruded through the openings 84 and 86 which will meet or intersect intermittently to provide bridges. What is formed, of course, is initially a cylindrical mesh which, on being drawn, will collapse to a ribbon in which the component filaments will extend lengthwise. This mode of formation of a mesh is known, as shown in Mercer Patent 2,919,467.

The produced ribbon may be twisted after formation and drawing; but twist may also be effected by suitable relative and absolute rotations of the die members, for example, both may be rotated in the same direction but at different speeds so that relative rotation will determine, in connection with the linear rate of extrusion, the frequency of occurrence of bridges along the length of the ribbon while the mean rate of rotation will determine the twist.

The last described extrusion also exemplifies another procedure for extrusion which may be more generally followed: as the plastic material leaves a die it is liquid or semi-liquid and consequently if filaments are extruded through non-bridged openings and immediately brought together so as to touch each other they will cohere to produce the desired bridging.

Ribbons produced as described with reference to FIGURE 9 will obviously have high flexibility to provide curved cross-section and will also provide effective interlocking action.

Beginning with the yarns, the formation of the rope is conventional, and may be carried out as usual through twisting, braiding or plaiting operations.

As is usual, it is desirable to provide opposite twisting in the steps of forming yarn from the ribbon, strands from the yarns, and rope from the strands, though this alternation may be varied if desired. The various operations are carried out in conventional fashion. When flat ribbons are used, as shown in FIGURE 3, they may be untwisted when assembled and fed to the twister to form yarn, i.e., being untwisted prior to this yarn formation, the procedure differing, thus, from the twisting of filaments in the usual formation of singles yarns prior to assembly by reverse twisting into plied yarns. But if the ribbons are not flat (e.g., as produced by the dies of FIGURES 8 and 9), they may or may not be twisted in themselves before being twisted into yarns or strands.

One of the major advantages of the invention is that only very few ribbon extruding devices need be provided in a rope making plant to provide a great range of ropes. In fact, ribbons of only three different deniers need be provided for ropes ranging from 1/4 inch to 9 inches. For example, for ropes in the range from 1/4 inch to 7/8 inch in nominal diameter, only 9,000 denier ribbons need be produced. In this range the ribbons per yarn may range from 2 to 6, and the yarns per strand from 2 to 8 to make three strand rope. For the range of ropes from 3 inches to 6 inches (nominal circumference) ribbons of 27,000 denier may be provided. In this range the ribbons per yarn may be 7 to 9, while the yarns per strand may range from 3 to 9. For 6½ inch to 9 inch ropes, the extruded ribbons may have a denier of 52,000. The ribbons per yarn will then be 8 or 9, and the yarns per strand 6 to 10.

As specific examples for three strand ropes, the following may be cited:

For a 1/4 inch rope, two 9,000 denier ribbons may form each yarn, and two yarns may form each strand, the resulting strand having a denier of 36,000.

For a 3/8 inch rope, four ribbons, each of 9,000 denier, may form a yarn, three yarns may form a strand, and three strands a rope. FIGURES 3, 4, 5, 10 and 11 may be considered as illustrating specifically this rope and its components and steps in its formation.

For a 7/8 inch rope, six 9,000 denier ribbons may form each yarn, and eight yarns each strand.

For a 5 inch rope nine 27,000 denier ribbons may form each yarn, and six yarns may form each strand.

For a nine inch rope, nine 52,000 denier ribbons may form each yarn, and ten yarns may form each strand.

It is considered that for the practical attainment of the objectives of this invention the denier of ribbon used should not be less than 500, and desirably should be 3,000 or more, but may range upwardly to 60,000 or more, the upper limit depending upon the flexibility of the plastic used and the thickness of the ribbon; i.e., if the ribbon is thin, though wide, flexibility may be acceptable.

While the strands may be of layered formation, if desired, and are highly resistant to hockling because of the structural characteristics of the assembly as heretofore described, the additional complexities of forming layered strands may be avoided by twisting yarns of the type described into strands without layering. Also, ribbons may be twisted into strands without intermediate formation of yarns.

The elimination of layering has another very important advantage in that by this elimination there is greater translation of material and yarn strengths into finished rope strengths. As ordinarily practiced layering involves greatly different contributions of yarns in the various layers to rope strength, whereas if layering is not used more uniform contributions of the yarns to rope strength are attained.

For purposes of illustration, FIGURE 10 shows diagrammatically a strand 102 formed of twisted yarns 42, while FIGURE 11 shows a section of a rope 104 laid from the strands 102. The yarns 42 are, for illustration, shown in solid sections, but it will be understood they have component ribbons as shown in FIGURE 5.

While twisted ropes have been primarily considered in the foregoing, it is obvious that yarns or strands provided in accordance with the invention may be used to form braided or plaited ropes and cables, the constructions of which will be conventional except for their origin in ribbons.

It will also be evident that other light cordage may also be provided in accordance with the invention. It is accordingly to be understood that the invention is not to be regarded as limited except as required by the following claims.

What is claimed is:

1. The method including extruding and orienting plastic elements each of which comprises a plurality of continuous filaments at least intermittently integrally joined together, compactly twisting said elements together to form a unit, and twisting a plurality of said units together.

2. The method including extruding and orienting plastic elements each of which comprises a plurality of continuous filaments at least intermittently integrally joined together, compactly twisting said elements together to form a yarn, twisting a plurality of said yarns together to form a strand, and assembling a plurality of said strands to form a rope.

3. The method including extruding and orienting plastic elements each of which comprises a plurality of continuous filaments at least intermittently integrally joined together, compactly twisting said elements together to form a yarn, twisting a plurality of said yarns together to form a strand, and laying a plurality of said strands together to form a twisted rope.

4. Cordage comprising a plurality of strands compactly assembled with each other, each of said strands comprising a plurality of extruded and oriented plastic elements compactly assembled with each other, each of which elements comprises a plurality of continuous filaments at least intermittently integrally joined together with substantial freedom of said filaments for movements relatively to each other, said elements presenting externally to each other irregular surfaces impeding their relative lateral movements.

5. Cordage comprising a plurality of strands compactly assembled with each other, each of said strands comprising a plurality of extruded and oriented plastic elements compactly twisted together, each of which elements comprises a plurality of continuous filaments at least intermittently integrally joined together with substantial freedom of said filaments for movements relatively to each other, said elements presenting externally to each other irregular surfaces impeding their relative lateral movements.

6. Cordage comprising a plurality of strands compactly twisted together, each of said strands comprising a plurality of extruded and oriented plastic elements compactly twisted together, each of which elements comprises a plurality of continuous filaments at least intermittently intgrally joined together with substantial freedom of said filaments for movements relatively to each other, said elements presenting externally to each other irregular surfaces impeding their relative lateral movements.

7. Cordage comprising a plurality of strands compactly twisted together, each of said strands comprising a plurality of extruded and oriented plastic elements compactly assembled with each other, each of which elements comprises a plurality of continuous filaments at least intermittently integrally joined together with substantial freedom of said filaments for movements relatively to each other, said elements presenting externally to each other irregular surfaces impeding their relative lateral movements.

8. Cordage comprising a plurality of strands compactly assembled with each other, each of said strands comprising a plurality of yarns compactly assembled with each other, and each of said yarns comprising a plurality of extruded and oriented plastic elements compactly assembled with each other, each of which elements comprises a plurality of continuous filaments at least intermittently integrally joined together with substantial freedom of said filaments for movements relatively to each other, said elements presenting externally to each other irregular surfaces impeding their relative lateral movements.

9. Cordage comprising a plurality of strands compactly assembled with each other, each of said strands comprising a plurality of extruded and oriented plastic elements compactly assembled with each other, each of which elements comprises a plurality of continuous filaments at least intermittently integrally joined together by bridging portions of less thickness than the filaments, said elements presenting externally to each other irregular surfaces impeding their relative lateral movements.

10. Cordage comprising a plurality of strands compactly assembled with each other, each of said strands comprising a plurality of extruded and oriented plastic elements compactly assembled with each other, each of which elements comprises a plurality of continuous filaments at least intermittently integrally joined together with substantial freedom of said filaments for movements relatively to each other, said elements presenting externally to each other irregular surfaces impeding their relative lateral movements, said elements having individual deniers of at least 500.

11. Cordage comprising a plurality of strands compactly assembled with each other, each of said strands comprising a plurality of extruded and oriented plastic elements compactly assembled with each other, each of which elements comprises a plurality of continuous filaments at least intermittently integrally joined together by bridging portions of less thickness than the filaments, said elements presenting externally to each other irregular surfaces impeding their relative lateral movements, said elements having individual deniers of at least 500.

12. Cordage comprising a plurality of strands compactly assembled with each other, each of said strands comprising a plurality of extruded and oriented plastic elements compactly twisted together, each of which elements comprises a plurality of continuous filaments at least intermittently integrally joined together with substantial freedom of said filaments for movements relatively to each other, said elements presenting externally to each other irregular surfaces impeding their relative lateral movements, said elements having individual deniers of at least 500.

13. Cordage comprising a plurality of strands compactly assembled with each other, each of said strands comprising a plurality of extruded and oriented plastic elements compactly assembled with each other, each of said elements being in the form of a ribbon having a width multiple times its thickness and having a denier of at least 500.

14. Cordage comprising a plurality of strands compactly assembled with each other, each of said strands comprising a plurality of extruded and oriented plastic elements compactly twisted together, each of said elements being in the form of a ribbon having a width multiple times its thickness and having a denier of at least 500.

15. Cordage comprising a plurality of strands compactly assembled with each other, each of said strands comprising a plurality of extruded and oriented plastic elements compactly assembled with each other, each of said elements being in the form of a ribbon having a width multiple times its thickness and having a denier of at least the order of 9000.

16. Cordage comprising a plurality of strands compactly assembled with each other, each of said strands comprising a plurality of extruded and oriented plastic elements compactly twisted together, each of said elements being in the form of a ribbon having a width multiple times its thickness and having a denier of at least the order of 9000.

17. The method including extruding through a die and orienting plastic elements each of which as it leaves a single die opening comprises a plurality of continuous filaments at least intermittently integrally joined together, and compactly twisting said elements together.

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