

- [54] **COMPOSITE FALSE-TWIST YARNS,
METHODS AND APPARATUS**
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[58] Field of Search..... **57/34 B, 34 AT, 77.3,
57/140 BY, 157 F; 28/1.4, 72.12**

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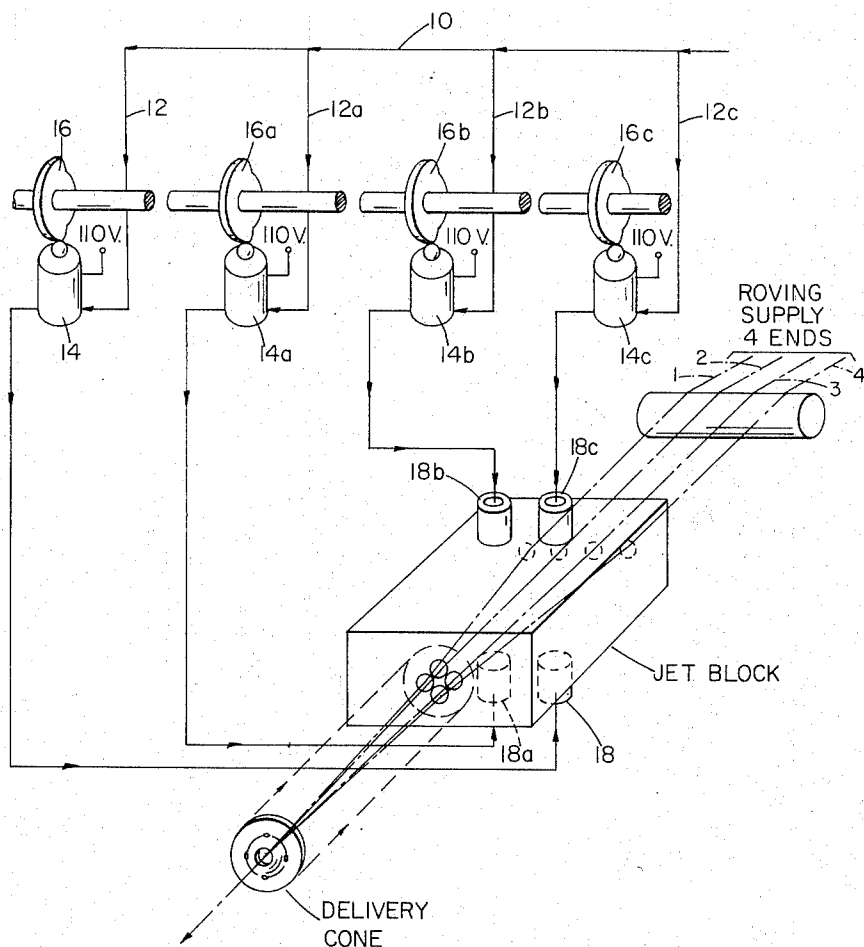
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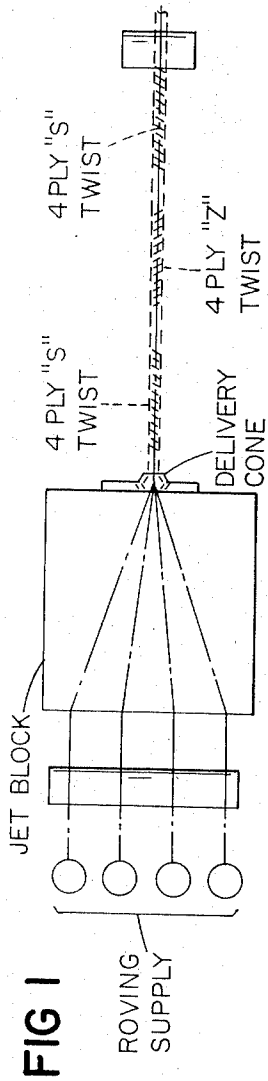
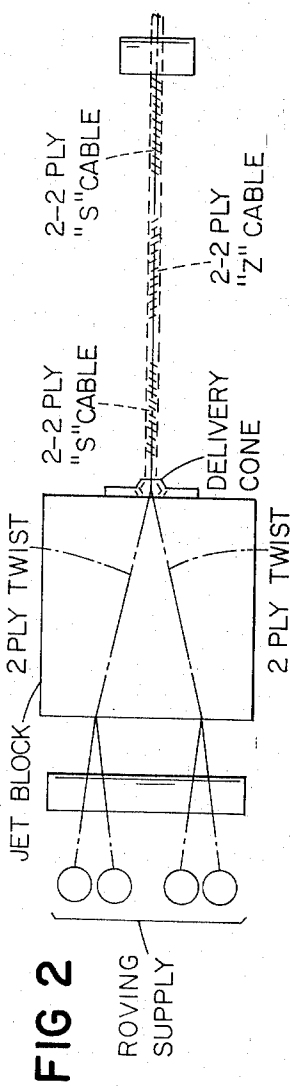
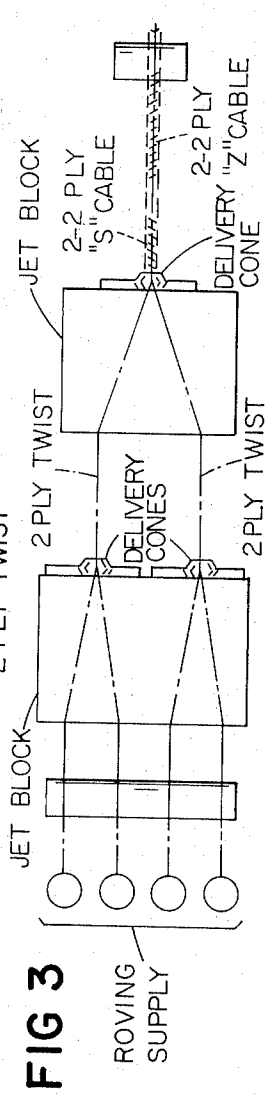
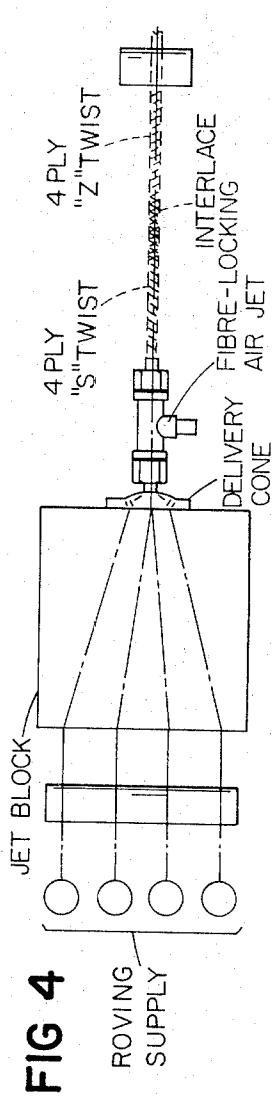
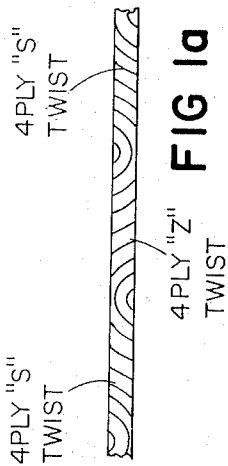
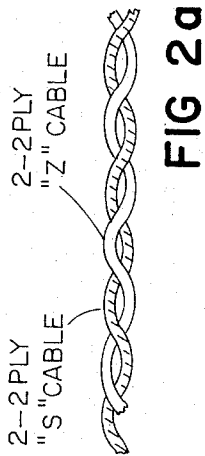
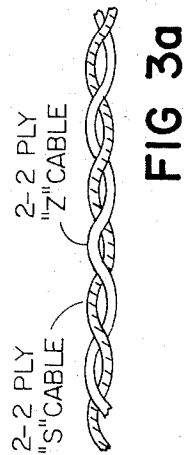
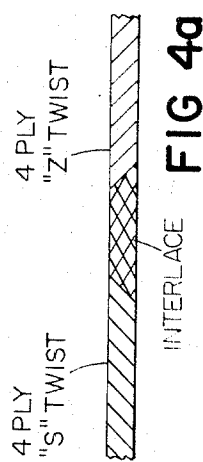
[57] **ABSTRACT**

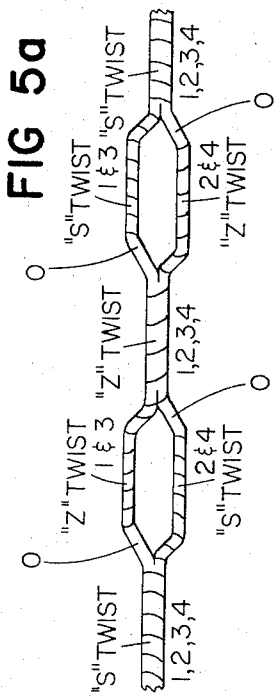
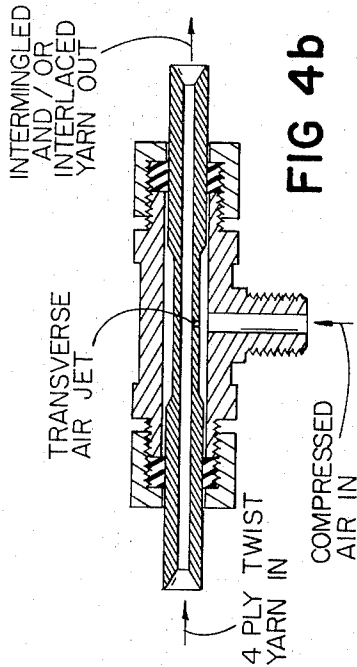
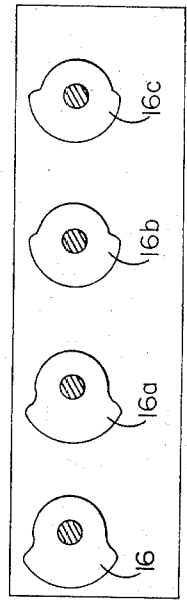
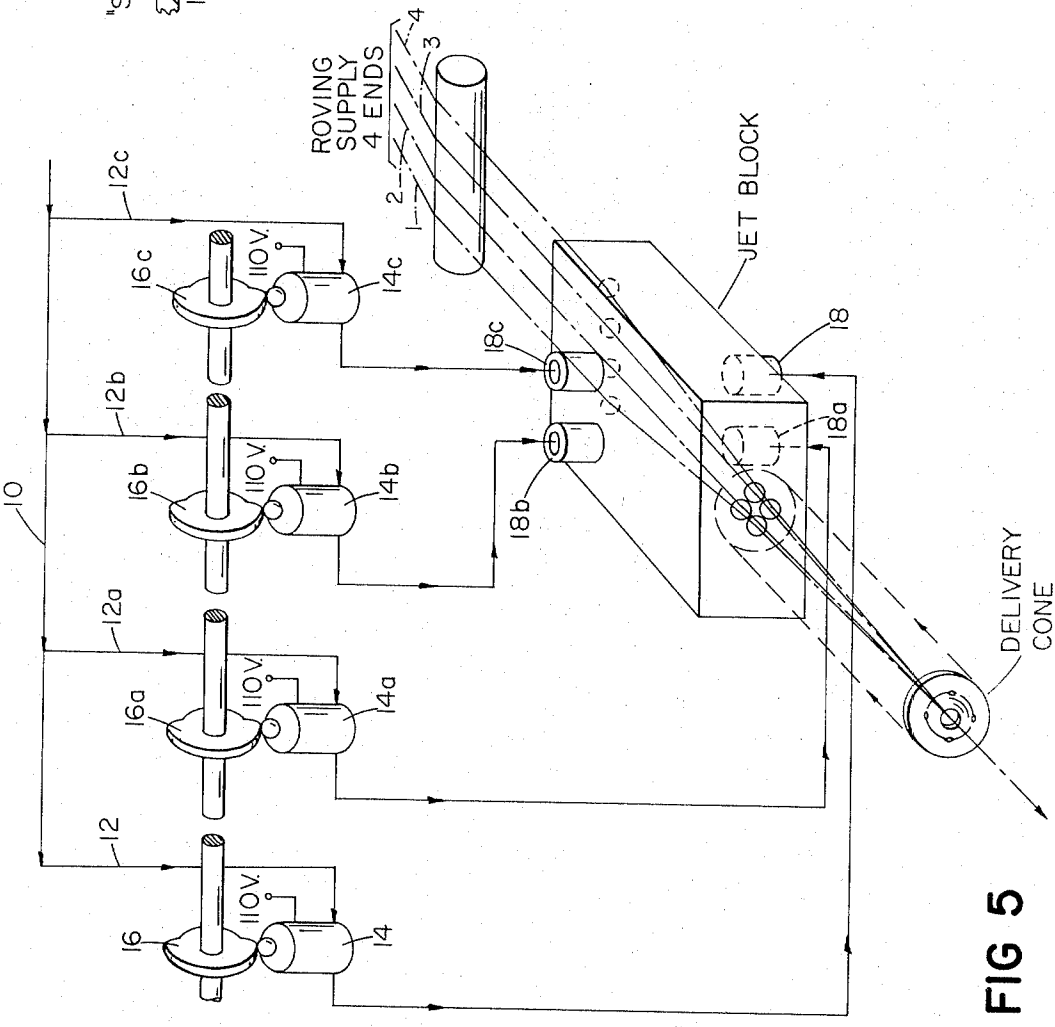
Composite false-twist yarns, method and apparatus,

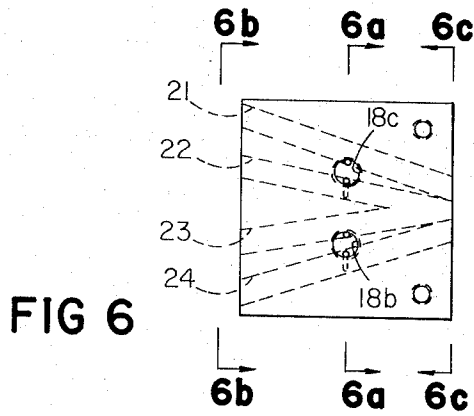
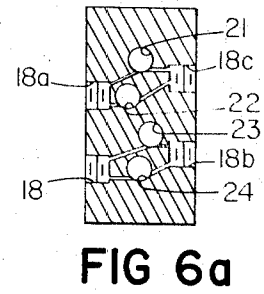
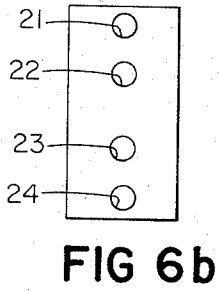
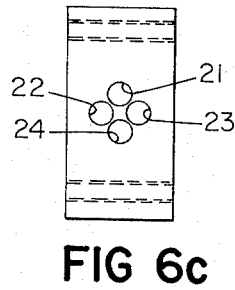
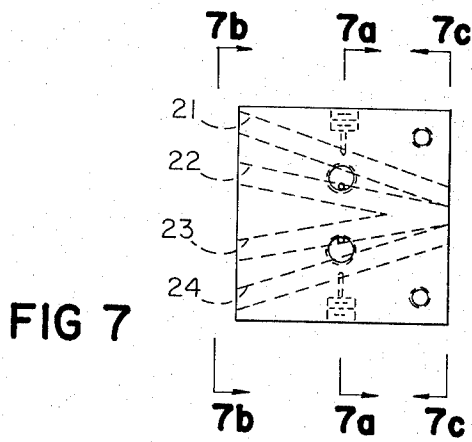
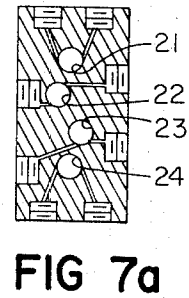
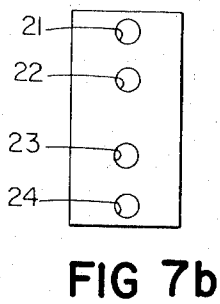
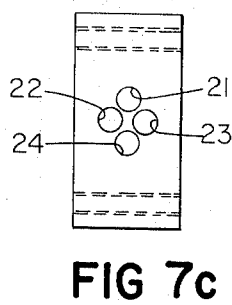
wherein continuous strand elements from their respective supply sources, for example, rovings, (at least three) and preferably four or more ends thereof while directly fed from their supply sources are air-jet spun and twisted simultaneously, whereby stable composite twisted yarns, with or without pairing and cabling, may be produced as end products, suitable, for example, for carpet and upholstery fabrics, the final yarn products being characterized by stabilized false twist zones, such stabilization being provided by interspersed or intermediate zones of opposite twist and, preferably, in addition, with intermingling (or interlacing) parts of (or whole) yarn elements including regular or irregular repeated interlacing of interchanged yarn elements to provide successively different pairing of said elements between (at least three) yarn elements, and preferably between pairs thereof; the apparatus for such operations including relatively high speed and high pressure air-jet means tangentially and successively applied to the individual yarn elements constantly and uniformly separately fed through converging air passages from their respective supply sources, with the converging passages terminating, for example, at a hollow truncated discharge cone, whereby the twisted yarn elements are assembled and combined to provide the final yarn products.

3 Claims, 20 Drawing Figures









COMPOSITE FALSE-TWIST YARNS, METHODS AND APPARATUS

This invention relates to novel stable composite false twist yarns that may be used to produce pile fabrics, for example, for carpets and upholstery, that are free from streaks, and to the methods and apparatus used for the manufacture of such yarns. However, the invention may be employed for the production of finer, more highly twisted yarns useful for other purposes.

Appearance in pile fabrics is of vital importance, whether for use in home, office, or elsewhere, and it has long been commercially difficult to produce pile fabrics of uniform appearance without a substantial, and expensive, percentage of seconds or rejects because of unsightly streaks and other visual defects in the finished goods. The composite yarns of this invention are stable, balanced, and do not snarl or kink; the twisted and/or cabled yarns can retain substantially all the characteristics of the component single yarn ends such as bulk, twist, etc.; the yarns are good for woven and tufted carpet processing since they are twist-stable; and, where desired, color combinations along the length and/or change in direction of twist along the length impart different visual characteristics to the yarns, as desired. These changes along the length, when used for carpet pile warps, break the normal yarn continuity which, in conventional yarns, tends to cause visual streaks. This result is accomplished without appreciably affecting the physical quality of the yarn structure either during fabrication or in pedestrian traffic areas. While the primary objective is to produce novel plied or cabled yarns, or both, that can be used to provide novel colorful and/or streak-free looped or cut pile carpet, such yarn can also be employed to impart these same desirable random moresque characteristics to fabrics for upholstery and other uses, whether later assembled by tufting, weaving knitting or other methods.

The composite yarns of this invention, to greater or lesser degree, all include false twist and, in making such yarns, a combined continuous air jet spinning and twisting process is used that greatly increases the rate and reduces the cost of yarn manufacture as compared with that of the prior art.

Also, as hereinafter described, rovings or other continuous strand elements, herein usually called yarn, are directly led from their respective supply sources and simultaneously spun and twisted in one single continuous operation, into usable plied cabled finished yarns, whereas the prior art has employed some two or three successive separate and independent spinning and twisting operations, usually with additional winding and packaging operations therebetween. The spinning and twisting operations described herein are simultaneously performed by air (or other gaseous fluid) jets, and these jets spin and twist the yarn elements into novel stable composite false-twisted plied carpet yarns, for example, yarns having zones of opposite twist along the length thereof with the yarn maintaining its twist-integrity in said zones, and within the confines of said zones. The yarn appears and behaves much like any normal balanced regularly twisted yarn with single and ply twist but unlike the simple opposite twisted yarn separated by lengthy zones of little or no twist of the prior art. Thus, though the false twist yarn of the invention can differ in its final forms, the yarn twist-integrity

characteristic is maintained to a very large degree along its length.

A unique feature of the yarns of this invention is the very substantial degree of twist retention therein maintained as compared to the low degree of twist retention of the prior art alternate false twist yarns. For example, such prior art alternate twist yarns, when held at two well separated points along their length, with at least one zone of "S" twist and one zone of "Z" twist separated by areas of no twist occurring between such two separated points, are tensioned, as by pulling the two separated holding points away from each other, it will be found that the areas of no twist become longer or greater and the areas of "S" twist and "Z" twist progressively become shorter or lesser. After tension is released, such prior art yarns do not materially tend to return to their original untensioned forms, and each succeeding application of tension normally results in still further untwisting of such prior art yarns, thus making them unsuitable for their intended use, and also creating handling problems because of their slack twist. When the alternate twist yarns of this invention are subjected to the same tensioning or pulling conditions, as outlined above with respect to prior art yarns, they will tend to untwist slightly but, upon release of tension, they return or twist back substantially to their original untensioned forms.

Referring to the diagrammatical drawings in which like numbers and designations and legends refer to like parts, and wherein, for example, the continuous yarn elements are rovings:

FIG. 1 is a diagram illustrating the manufacture from four rovings of a four-ply alternate twisted S and Z yarn;

FIG. 1a represents an enlarged typical example of a yarn that may be made by the method and apparatus illustrated in FIG. 1;

FIG. 2 is a diagram illustrating the manufacture from four rovings of a two-ply S and Z cabled yarn;

FIG. 2a represents an enlarged typical example of a yarn that may be made by the method and apparatus illustrated in FIG. 2;

FIG. 3 is a diagram illustrating the manufacture from four rovings of the same yarn as in FIG. 2 by the use of two separate and different jet twisting blocks;

FIG. 3a is a much enlarged representation of a typical example of a yarn that may be made by the method and apparatus illustrated in FIG. 3;

FIG. 4 is a diagram illustrating the manufacture from four rovings of a four-ply alternate twisted S and Z yarn with an interlace between such S and Z twists;

FIG. 4a represents an enlarged typical example of a yarn that may be made by the method and apparatus illustrated in FIG. 4;

FIG. 4b is a detail view showing, in longitudinal vertical cross-section, the construction of a suitable supplementary air jet, as shown in FIG. 4, providing fiber interlacing and twist stabilization;

FIG. 5 is another diagram illustrating the manufacture from four rovings of a four-ply alternate twisted S and Z yarn with an interlace between such S and Z twists;

FIG. 5a represents an enlarged typical example of a yarn that may be made by the method and apparatus illustrated in FIG. 5;

FIG. 5b represents typical cam profiles for the timed twisting sequence of the apparatus shown in FIG. 5.

FIG. 6 is a detail view in plan of an actual air jet twisting block with four air inlets that may be employed as shown in FIG. 1 (and FIG. 5);

FIG. 6a is a transverse cross-sectional view of the block taken on line A—A of FIG. 6, with FIG. 6b and FIG. 6c showing its roving inlet and yarn exit sides, respectively;

FIG. 7 is a detail view in plan of an actual air jet twisting block with eight air inlets that may be employed in lieu of the air jet block of FIGS. 6 and 6a;

FIG. 7a is a transverse cross-sectional view taken on line 7a—7a of FIG. 7;

FIG. 7b is an elevation of the roving inlet side of the jet twisting block of FIG. 7 looking on line 7b—7b thereof; and

FIG. 7c is an elevation of the outlet side of the jet twisting block of FIG. 7 (with exit cone removed) looking on line 7c—7c thereof.

In one preferred example, the yarn of this invention takes the form of a novel stable false twisted yarn preferably initially formed from a supply of continuous strand elements in at least four roving ends which constitute individual yarn elements of this invention, and of similar or different types, and/or sizes or colors (staple and/or continuous multi or mono filaments), having at least two separately twisted and cabled pairs. The final yarn product is characterized by fixed twist zones of substantial length between the zones where twist is changing direction, the twist-change zones separating zones of opposite twist. In addition, at every point along its length, except at the exact central point (i.e. short length) of reversal, the yarn has twists, both in its single ends and in its plied state, of opposing direction, sufficient to provide a stable balance between ply and single.

A second novel form of the yarn of the invention has an interlacing (regular or irregular) of the individual yarn elements between zones of opposite twist. This yarn will have at least three elements, portions or all of said elements depart from their relative positions in the ply yarn structure and assume, at least temporarily, other relative postures about the longitudinal axis of the plied yarn structure.

A third novel form of the yarn of this invention has yarn twist zones of substantial length between twist change points as in the preferred form of the invention, however; there is no cabling of the yarn and in the place of the zones of alternating twist separated by points (short lengths) of twist change there appear alternate zones along the length wherein all the yarn ends or elements have the same direction of twist, either all clockwise or all counterclockwise, and intermediate zones along its length wherein the yarn has two of its ends or yarn elements twisting or plying in one direction and two of its ends or elements twisting or plying in an opposite direction, the alternate and intermediate twist zones being separated by the points (short lengths) of twist change. If three elements are used the intermediate zones may have two elements that are plied or twisted in one direction as a sub-unit and the third element may be a sub-unit in itself that is twisted in an opposite direction.

Other variations of the above mentioned yarns may also be provided wherein each will have the same unique stable composite false twisted zones that maintain yarn integrity. For example, the interlacing or intermingling of the separately twisted pairs mentioned in

the preferred form may include an interchanging of yarn elements between pairs and have different elements forming the pairs in adjacent zones, that is, elements AB and elements CD would form plied pairs in one zone but elements AC and BD would form plied pairs in an adjacent zone. This locks the twist most securely in place for the elements will cross over one another at the twist change points as the pairing of elements is changed from twist zone to twist zone providing regular repeated interlacing with positive interlocking by reason of such interchanging. This changing of pairings may also be employed to produce a three element yarn by different pairings in adjacent zones with the third or odd yarn element twisted, wrapped or cabled about the two paired yarn elements thus, pair AB cabled with C; in next zone pair AC cabled with B, and in next zone pair CB cabled with A. Here, as in the four element two pair yarn, there will be a different pairing of two paired elements in adjacent zones.

Referring to the drawings in greater detail:

In the preferred method and apparatus illustrated in FIG. 1, four individual ends of roving are slackly fed (or even overfed at say +1 percent), respectively, at a typical rate of 400–500 ft/min. or somewhat faster, from four roving supply cheeses or jack spools through a pair of feed rolls or directly into the cylindrical passages of the tangential air jet spinning and twisting block. The four roving ends (yarn elements) are led, respectively, into four separate cylindrical passageways, say of $5/16$ inch $\pm$ $31/16$ inch diameter (whose centerlines only are indicated in dot and dash lines which also indicate the rovings) which passageways converge at or near the opposite yarn-exit side of the block. In actual practice, the converging passageways separately emerge from the exit or down-stream side of the air jet block, and from there the yarn elements preferably pass through a delivery zone which further converges and combines the twisted yarn elements delivered therefrom through its central axial hole by air flow, with excess air passing through freeing ports radially spaced from said axial hole as shown in the figure (see, too, FIG. 5). Each passageway has two small air inlet openings (later herein discussed) for delivery of an air stream under considerable pressure (for example of the order of 35–80 p.s.i.g., though preferably 40–65 p.s.i.g.) entering tangentially at high velocity, the flow of the compressed air from the air jets being automatically cyclically controlled to flow briefly first from one tangential air inlet and then briefly from the other or oppositely arranged tangential air inlet, as required for an opposite S or opposite Z twist, as the case may be. One air jet thus rotates and twists the roving in a counterclockwise, left or “Z” direction and the other air inlet rotates and twists the roving in a clockwise, right or “S” direction, an air valve being open to twist say for 0.01 to 0.5 seconds. Each single end of roving will thus be alternately false twisted in the “Z” direction and then false twisted in the “S” direction. When the four twisted yarn elements combine as they exit, from the delivery cone of the block, in convergence with the other three elements, and though each element may initially start to untwist, the four converging individually untwisting elements twist together to form a four-ply yarn, with the excess air flow dissipating from the delivery cone immediately upon contact and convergence of the yarn elements. At the point in the cycle, and yarn length, where the air jet direction of yarn rota-

tion is changed, there will be little, or zero twist. The yarn will therefore be composed of lengthwise zones of "Z" twist alternating with zones of "S" twist separated by points (short lengths) of little or no twist, as shown in enlarged FIG. 1a, this same figure serving to illustrate the method of making a simple three element yarn product. Typically, carpet yarns average 0.25 - 8 turns/inch and normal carpet yarns of the invention are within such range.

If desired, the yarn product can be paired and cabled, rather than simply twisted, by the tangential air jets into a four element yarn composed of two two-ply yarn elements. This may be accomplished by using three separate yarn element converging points in one jet block, as shown by dot and dash lines in FIG. 2, there being a separate converging point for each two yarn elements so that two yarn elements first converge as a pair and start twisting into a two-ply unit and the other two elements converge as a pair and start twisting into a two-ply unit. These two-ply units then converge at a third converging point at or about their exit from the block (in actual practise the converging two-ply units separately emerge from the exit or downstream side of the air jet block and from there preferably pass through a delivery cone as shown so the two two-ply units wrap or cable with each other to form the yarn of enlarged FIG. 2a.)

This cabling can also be accomplished as shown in FIG. 3, by using one block having two separate converging points shown by dashed lines for two yarn elements, but in this case the separate two-ply units will be kept separate and fed as units into a succeeding block having two passageways with tangential air jet inlets in each passageway for rotating and twisting the yarn elements in either a clockwise or a counterclockwise direction. The two two-ply sub-units will converge as they exit from this second block and twist or cable about each other. Suitable programming of the false twist air reversal timing controls (not shown) the pattern type of convergence, for example to provide the product of enlarged FIG. 3a. Air jet flow-timing and reversal means are not herein specifically shown and described since their construction and operation, as required to provide the objects of this application, are well within the skill and knowledge of the pneumatic art.

In a further and different novel example of the method and yarn of the invention, in FIG. 4 the individual yarn elements are twisted by the tangential air jets and then interlaced or intermingled between zones of opposite twist. The rovings are similarly fed from roving supply cheeses or jack spools through feed rolls to a tangential air jet block for alternate false twisting, as in the preferred method, and finally converged to form the twisted or cabled yarn of the invention. However, an additional or fiber-locking air jet, as above mentioned, is positioned to transversely direct a jet of air at the point after the elements converge as they exit from the downstream side of the jet block. This separating air jet directs a blast of air at an angle, oblique or substantially at a right angle (though preferably the latter) to the longitudinal centerline of the converged elements creating a random mixing of the fibers or group of fibers of the elements away from and toward said centerline so that they there interlace, intermingle, cross and/or wrap around each other in a random manner providing the interlocking which opposes untwist-

ing of the fibers and yarn elements of the final product. This additional locking jet preferably operates only during the short time in the cycle that the twist change zone of the yarn passes by. Thus, this combines and interlocks fibers, and groups of fibers, of the parent yarn elements in the repeatedly passing zones of little or no twist into a more cohesive grouping and prevents or minimizes possible bodily separation and untwisting of the four elements (though there may be three or more elements) in this zone into four separated elements that could create handling problems.

In the third mentioned novel form of the yarn product and the method of this invention, as illustrated in FIG. 5, the four yarn elements feed into the tangential air jet block, with four converging passageways as in the preferred method of FIG. 1, and in alternate periods each passageway will have its tangential jet stream directed or rotated at the same time as the other three passageways have their jet streams directed or rotated in this one and the same direction to twist the four end elements, as shown at the far left in the idealized yarn showing of FIG. 5a wherein, at two zones, the plied pairs, for purposes of illustration only, are shown as separated. However, at the intermediate periods one or more of the air jets (here two) will rotate its yarn elements (e.g. 1 and 3) in one direction, while the remaining (here two) jets will rotate their yarn elements (e.g. 2 and 4) in the opposite direction, second section or zone from the left as illustrated in FIG. 5a. The converged ends that are rotating in the one direction will twist about each other forming a plied yarn of ends 1 and 3 twisted in this one direction while the converged ends are rotating in the other direction will twist about each other forming a plied yarn of ends 2 and 4 twisted in this other direction. As certain of the elements will continue twisting in the twist change zones, there will be a discernible amount of twist, and even some cabling, in the twist change zones. As shown further in FIG. 5a, the resulting yarn will have alternate zones (first, third, and fifth), along its length wherein in each zone all four yarn elements are twisted in the same direction, four clockwise or four counterclockwise as shown; twist change zones (second and fourth) wherein two of the yarn elements are twisted in one direction and wherein two yarn elements are twisted in the other direction, with four short sections, O, as indicated on FIG. 5a, of zero twist.

As appears from the foregoing discussion, and particularly with respect to FIGS. 1, 2, 3 and 4 (except for the added separating interlocking air jet of the latter), it is evident that the active spinning and twisting operations of the respective tangential jets as described, requires and is dependent upon a programmed admission of compressed air thereto, together with related and correlated timing of the groups of jets in the operation thereof (and with respect to the rate of yarn element flow) required to produce the composite yarns of this invention, — all of which embody combining of at least three, and preferably four (or more), spun and twisted yarn elements, as twisted, plied, cabled, etc., by successive pulses from the tangential air jets. FIG. 5, as would be required in the earlier figures of the drawings, includes, in addition, a diagrammatic showing of typical suitable air jet controlling apparatus such as would be supplied by a man skilled in the art for the purpose of a programmed admitting and timing the required direction and duration of flow of air to such air jets, respec-

tively. Thus, referring to the apparatus of FIG. 5, from a main air-pressure supply line 10 as shown, are led four branch air conduits 12, 12a, 12b and 12c, each leading to its corresponding solenoid air-control valve of the series 14, 14a, 14b and 14c, respectively, so that the respective solenoids may be controlled as programmed by suitably-driven rotating cams 16, 16a, 16b and 16c, respectively. Typical cam profiles are shown in FIG. 5b, for the given timed twisting sequence correlated with, for example, the rate of yarn flow as previously indicated in connection with FIG. 5, to produce the yarn of FIG. 5a. Various other cam profiles may be supplied for other end-product yarns than that here shown in FIG. 5a, it simply being necessary to form and affix on a different given cam shaft the required series of different cam profiles and to bodily substitute any such required different cam shaft with its four different cam profiles. From each of the air valves is led a conduit to each of four air inlet ports 18, 18a, 18b and 18c of the FIG. 5 air jet block, such ports supplying, according to the desired selected timing, the tangential air jets, with each jet of the series spinning and twisting a single roving led from its roving supply to and through the jet block passage wherein it is spun and twisted. The twisted yarn elements then combine and pass through the delivery cone, herein shown in exploded position by which, in use, is attached to the exit side of this spinning block in position, as shown, e.g. in FIGS. 1 and 2.

The design and arrangement of an actual air jet block and individual tangential jets is more fully shown in FIGS. 6, 6a, 6b and 6c, such showings all being of a four yarn twisting passageways type of jet blocks of FIGS. 1 and 5, for example. However, if desired, only three of such passageways, with their jets, may be employed for a final product made up of but three yarn elements. Also, a jet block may incorporate additional passages and jets therefor to form a yarn product having more than four yarn elements.

FIG. 6 is a top plan view of a typical jet block having four passageways, 21, 22, 23 and 24 whose center lines, similarly numbered, show the convergence of the passageways from the yarn inlet side of the block of FIG. 6b to the yarn exit side of FIG. 6c (with exit cone removed). Each of said passageways is provided with two tangential, but oppositely disposed, air jet delivery outlets at the open ends of the small passages (shown in dotted lines in FIG. 6a) (for example about 0.052 inch diameter) leading, respectively, from the four aforementioned air inlet ports in the block with top inlet ports 18b and 18c supplying air to the clockwise tangentially directed air jet delivery outlets into each of the four yarn-twisting passageways 21, 22, 23 and 24 as shown in FIG. 6a, and with the bottom air inlet ports 18 and 18a supplying air to their oppositely directed small air passages (also shown in dotted lines in FIG. 6a) leading to their air jet delivery openings into the same four respective yarn-twisting passageways 21, 22, 23, 24.

The same general design and arrangement of the individual tangential jets, as in FIGS. 6 et seq., are shown in the four yarn-twisting passageway type figures, FIGS.

7, 7a, 7b and 7c. In the latter case, however, each one of the eight tangential jets is supplied with compressed air from its own separate block air inlet port via a single small air passage leading therefrom, eight of such small air passages being shown in dotted lines in FIG. 7c together with the eight separate ports, a detailed numbering and explanation of which is not necessary here in view of the showing of FIG. 7a, since the yarn spinning and twisting actions are the same as in FIG. 6 et seq. wherein two jets are siamesed from each of four block air inlet ports. The FIGS. 7 et seq. type, however, in use may be of considerable advantage in some cases wherein it is desired or necessary to have a more varied and variable individual control of the spinning and twisting of each individual yarn element without regard to any other element, according to the end product desired, though a more complicated system of individual cams, airvalves, and air "plumbing" is required as will be evident to those skilled in the art. Known commercial rotary air valve systems employed in other arts may be successfully used.

While it has been pointed out that the yarns of this invention are processed through a continuous spinning and twisting operation, that is, each of the initial yarn elements as herein described is a card roving by way of example, it is to be understood that when continuous filament elements are used the twisting or spinning operation as such may not be necessary or employed, at least to the degree for card roving; and also that single ends (yarn elements) of conventionally spun staple yarn may be employed and ply twisted in the same general manner.

I claim:

1. In an apparatus for making directly from yarn elements twist-stable composite false twisted yarns suitable for pile fabric manufacture, means characterized by a plurality of converging air spinning and twisting passages, each of said passages having a pair of air-jet openings transversely tangential to yarn elements fed through said passages, said openings being transversely tangential in opposite directions,

means for feeding yarn elements from their supply packages through said passages, respectively, compressed air supply means for said air-jet openings, and

means selectively intermittently controlling compressed air flow from said air supply means through said air-jet openings for spinning and twisting said yarn elements in accordance with a program to provide false twisted yarn elements, the apparatus also including means for converging and combining said false twisted yarn elements to provide a stable composite yarn product.

2. Apparatus as called for in claim 1 including two separate and successively operating means each characterized by a plurality of air spinning and twisting passages.

3. Apparatus as called for in claim 1 wherein said means for converging and combining is a truncated cone.

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