July 3, 1962 P. F. MARSHALL 3,041,812

PROCESS AND APPARATUS FOR MAKING NOVELTY YARN

Original Filed Dec. 10, 1959 7 Sheets-Sheet 1

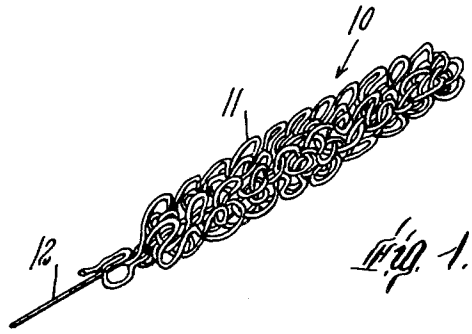


Fig. 1.

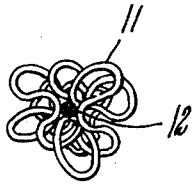


Fig. 2.

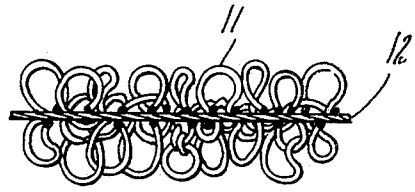


Fig. 3.

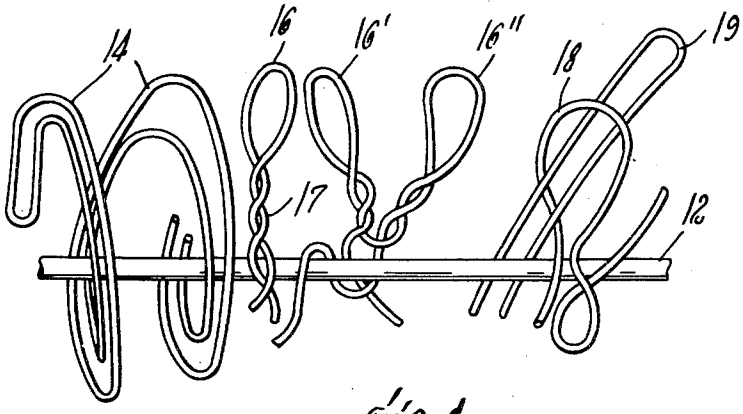


Fig. 4.

PROCESS AND APPARATUS FOR MAKING NOVELTY YARN

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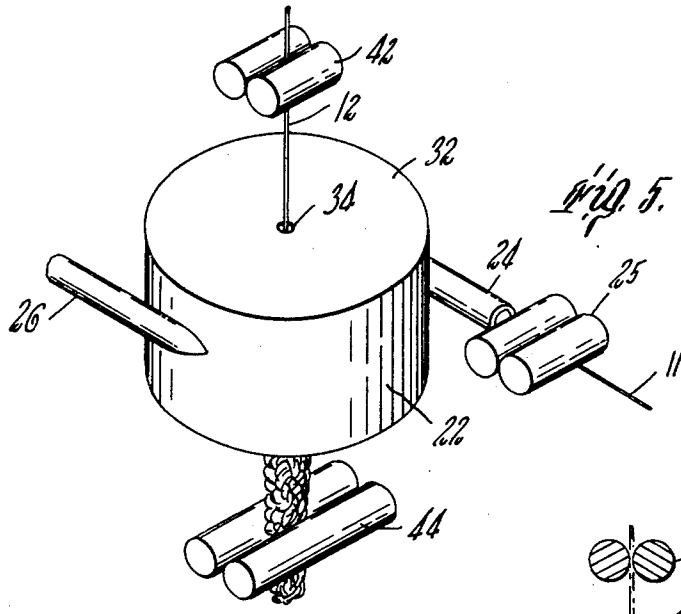


Fig. 5.

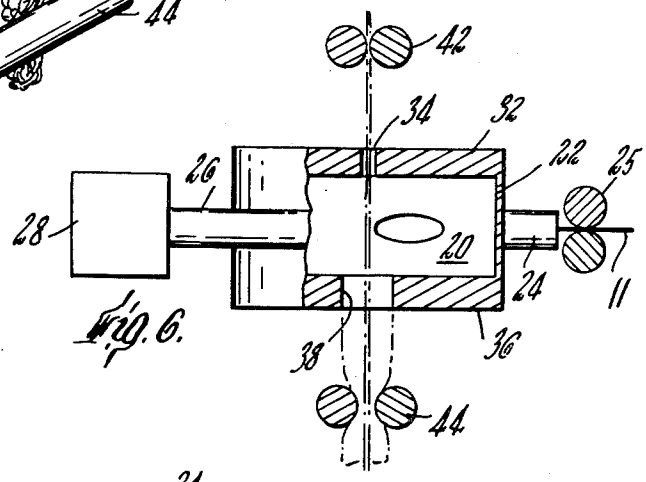


Fig. 6.

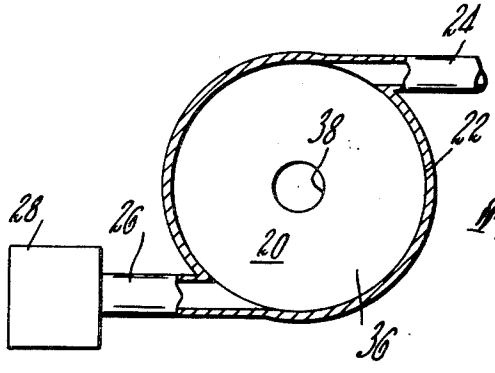


Fig. 7.

PROCESS AND APPARATUS FOR MAKING NOVELTY YARN

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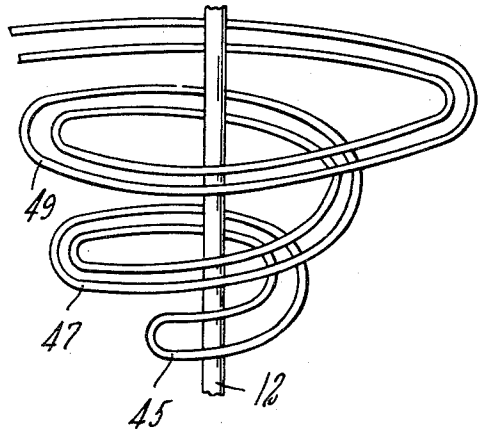


Fig. 8.

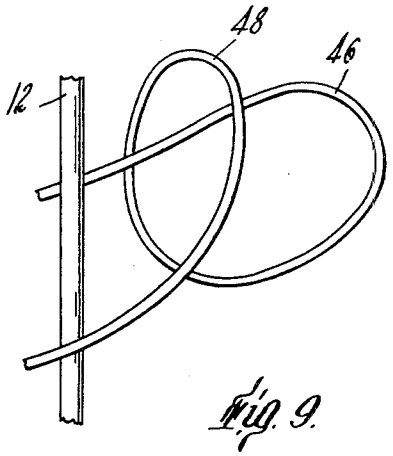


Fig. 9.

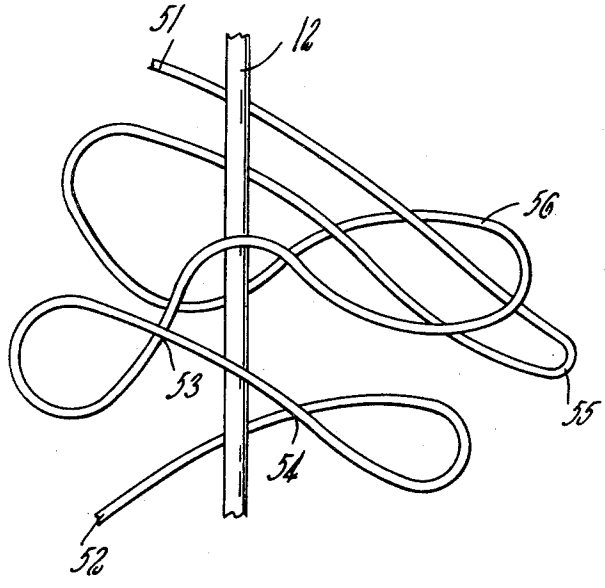


Fig. 10.

PROCESS AND APPARATUS FOR MAKING NOVELTY YARN

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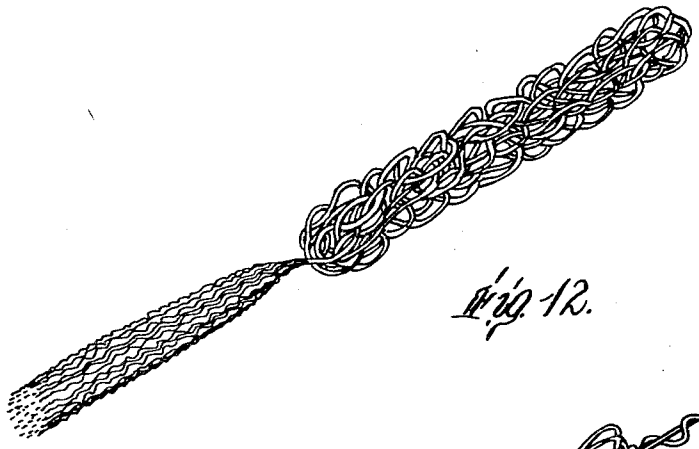


Fig. 12.

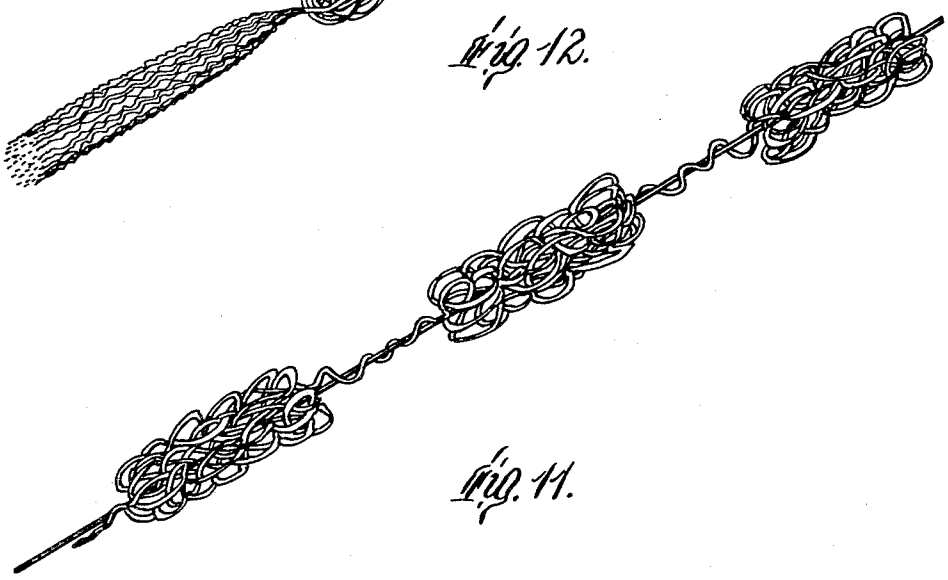


Fig. 11.

Fig. 13.

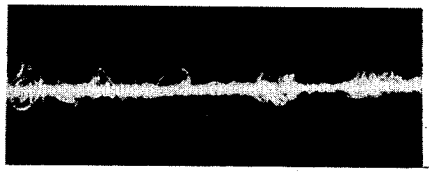


Fig. 14.

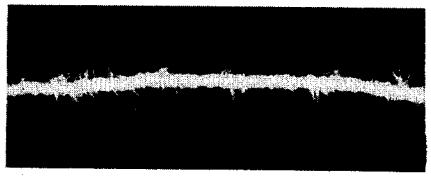


Fig. 15.

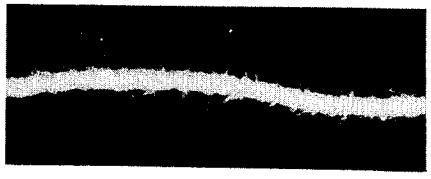
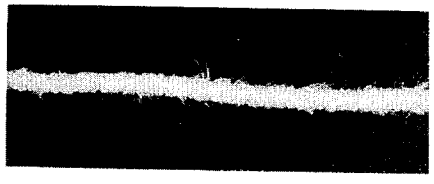


Fig. 16.



PROCESS AND APPARATUS FOR MAKING NOVELTY YARN

Original Filed Dec. 10, 1959

Fig. 17.

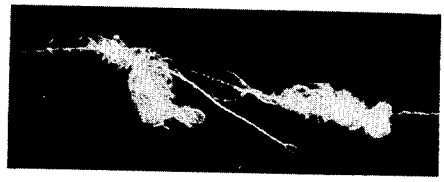


Fig. 18.

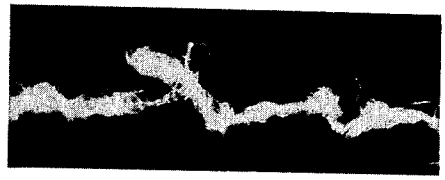


Fig. 19.



PROCESS AND APPARATUS FOR MAKING NOVELTY YARN

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Fig. 20.

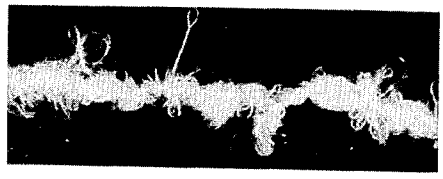


Fig. 21.

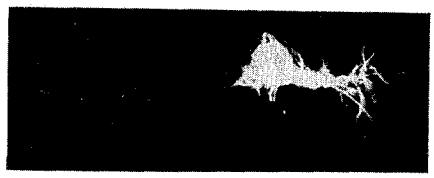
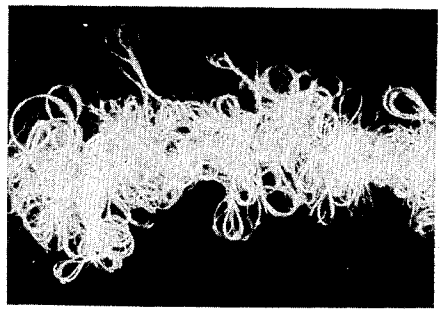


Fig. 22.



United States Patent Office

3,041,812

Patented July 3, 1962

3,041,812

PROCESS AND APPARATUS FOR MAKING NOVELTY YARN

Preston F. Marshall, Walpole, Mass., assignor to The Kendall Company, Boston, Mass., a corporation of Massachusetts

Original application Dec. 10, 1959, Ser. No. 858,694. Divided and this application Feb. 29, 1960, Ser. No. 15,017

11 Claims. (Cl. 57—6)

This invention relates to the production of a novelty yarn, particularly, it relates to a novelty core-constructed yarn prepared from a filamentary material wrapped in a series of looped configurations about the axis of said yarn and to a process and apparatus for producing said yarn without resorting to mechanical twisting devices. It is a division of my application Serial No. 858,694, filed December 10, 1959.

Novelty yarns, useful in the production of textured or "visual effect" fabrics or used in strand form alone for decorative ties, etc., are typified by products such as boucle yarns, slub yarns, loop yarns, and the like. In general they are prepared by feeding at different rates two yarns into a twisting device which wraps one yarn, which is overfed, around another yarn which is held under tension, or by overfeeding one yarn to form loops which are held between a pair of tensioned binder yarns twisted together. Core yarns are similarly prepared by wrapping a covering strand more or less completely around a core by means of a rotating hollow spindle.

All such yarns are prepared in a rotating or spinning device that wraps one type of filamentary material around another with a true wrap or twist. The process suffers from known limitations and deficiencies inherent in rotating mechanical devices, wherein problems of friction and lubrication become critical at high speeds, and constant maintenance and supervision are necessary. The yarns so prepared have taken many forms but in general have either had too low a bulk factor for many uses, have been too expensive to manufacture, were not attractive, or were subject to a combination of these and other factors.

Accordingly, it is a primary object of the invention to produce a novel and attractive yarn of the core-constructed type having unusually high bulk factor and low density if such be desired, yet economical to manufacture and of striking and attractive appearance. Following the principles of the invention, such yarns may be constructed from textile strand material, either of single or multiple strands of filaments, spun or unspun.

In general, the yarns of the invention are high-volume, low-density products, and preferably (though not necessarily) include a continuous core strand with one or more covering or wrapping strands wound, doubled, or looped thereabout. The wrapping yarn is generally deposited in a multi-layered, haphazard manner, which is commonly more closely packed adjacent to the yarn axis or core than it is around the periphery of the assembly. However, the presence of an actual core strand may be dispensed with in some instances. The covering or wrapping strand about the central axis of the yarn of the invention has a multiplicity of closely adjacent portions haphazardly doubled and twisted, and wound to a large extent as closed loops in doubled configuration, generally in the form of a closely spaced multi-layered and partially overlapping helix for a plurality of turns. A multiplicity of the loops of the wrapping yarn are twisted to form stems or pedicles and are frequently intertwisted with adjacent loop formations. Additionally, loop forms are often interlaced with other loops by passing therethrough. These loops extend generally perpendicular to and radially of the cental axis of the yarn and project outwardly therebeyond.

The novelty yarn of this invention, therefore, includes a wrapping of serially connected loops, said loops being disposed at various angles to each other but essentially with the loops lying in planes generally perpendicular to the main axis of the core yarn. Although the wrapped covering has been "false wrapped" around the core, so that it is essentially free from residual wrap, nevertheless the individual strand portions thereof are so entangled, snarled, and frictionally engaged with adjacent and contacting loop portions as to resist unwrapping thereof and provide a normally stable structure particularly where a central core strand is present. Although the preferred yarn according to the invention is generally uniformly wrapped throughout its length, it may also be intermittently wrapped with generally longitudinally extending strand portions alternating with wrapped portions.

It is another object of the invention to provide novel apparatus and methods for manufacturing the novel core-constructed yarn of the invention simply and at high speed by utilizing fluid, preferably gaseous, operating forces thereon. In this novel method, core-constructed yarns meeting the above objectives are generally produced preferably by simultaneously separately feeding a core strand and a wrapping strand into a fluid vortex in which a rapidly rotating air mass is localized. The core strand is preferably kept under tension but its rate of speed through the vortex may be varied periodically or irregularly. The wrapping strand is preferably fed in under little or no restraint, and usually its rate of feed is largely determined by the rate at which the air mass rotates in the vortex. If an especially uniform degree of wrapping is desired, the rate of feed of the wrapping yarn may be regulated to any predetermined rate.

More specifically, this may be accomplished by providing a generally cylindrical vortex chamber with a tangential fluid inlet thereto for pressurizing the chamber and creating a whirling body of fluid therein, the covering or wrapping strand preferably being introduced into said chamber through a tangential inlet thereto and passing from said chamber as the novel wrapped yarn of the invention through an axial outlet therefrom. The wrapping strand is drawn into the vortex chamber along the wall of the chamber. The core strand is preferably introduced through an axial inlet in the end of the chamber opposite to the outlet end. The covering or wrapping strand is continuously overfed into the chamber at a lineal rate greatly in excess of its bulked lineal withdrawal rate so that a portion thereof is continuously maintained in slack condition within the vortex chamber, wherein the whirling mass of fluid acts upon it to form randomly and haphazardly double-back loops and twisted pedicles. Simultaneously, the whirling fluid mass winds the loops into the form of a closely spaced and multi-layered and partially overlapping helix for a plurality of turns, and entangles, snarls, and interlaces the loops with one another. A central core strand or an equivalent thereof aids in this process.

The tendency of the wrapping yarn is to form a non-uniform series of variously sized loops, which spiral around the core strand generally radially to the yarn axis. As the core strand is advanced through the vortex, these loops form a series of collapsed bights, serially engaged with the core strand in the form of a constantly descending helix. Since there is no continuous unidirectional wrapping of the end of the wrapping strand around the core strand, the net unidirectional wrapping in the final product is mathematically zero. The looped and wound assembly is continuously removed from the vortex chamber opening, aided by the flow of fluid therethrough, preferably at a rate of the order of 1 percent to 20 percent of the rate of feed of the covering or wrapping strand into the chamber. The outfeeding assembly is at the same

time more restricted against movement in a lateral direction than the rotating wrapping strand in the vortex chamber, the amount of such restriction varying somewhat in accordance with a variety of factors such as strand size and weight, chamber size, degree of air pressurization, air flow speed, etc.

Various other objects and features of the invention will become apparent from the following description of preferred embodiments of the invention, taken with the accompanying drawings, wherein:

FIG. 1 is a diagrammatic perspective view, partially broken away, of a yarn of the present invention,

FIG. 2 is an enlarged cross section of the yarn of FIG. 1,

FIG. 3 is an enlarged longitudinal section of the yarn of FIG. 1,

FIG. 4 is a diagrammatic showing of certain aspects of the yarn of FIGS. 1–3,

FIG. 5 is a perspective view of the preferred apparatus of the invention,

FIG. 6 is a side elevation, partially in section, of apparatus according to the invention,

FIG. 7 is a sectional plan of the apparatus of FIG. 4,

FIGS. 8–10 are diagrammatic views illustrating the formation of the yarn of FIGS. 1–3,

FIG. 11 is a diagrammatic perspective view of a modification of the yarn of FIGS. 1–3,

FIG. 12 is a diagrammatic perspective view of another modification of the yarn of FIGS. 1–3, and

FIGS. 13–22 are photographs of yarns of the invention manufactured according to Examples 1–10 herein respectively.

Referring first to FIGS. 1 through 3, the core-constructed yarn **10** of the invention there shown includes a generally straight central core strand **12** having a wrapping strand **11** thereabout.

The strands themselves may be strands of a wide variety of textile fibers, or other strands, either staple or continuous, as is hereinafter more fully explained. For example, cotton, or wool yarns may be used in sizes from 10's to 200's cotton system, as may the synthetic fibers such as rayon, nylon, etc., either spun or continuous filament. Continuous strands of rayon, comprising a low twist bundle of filaments of size 1.5 to 20 denier per filament are especially useful in the invention because of the high bulking characteristic of such strands. Mixed fiber yarns may be used as well, and the physical and chemical characteristics of the central core strand **12** and the wrapping strand **11** may be quite different. It will be appreciated also that the invention is not confined to a cored yarn in the ordinary textile sense, but that the core may be of wire or other filamentary material, such as twisted paper, plastic monofilament, metallic ribbon, and the like. In this manner, a bulky novelty yarn may be produced which has exceptionally high tensile strength due to the nature of the core filament employed.

It is also within the scope of the invention to use two or more strands as a core. Exceptionally bulky products are obtained when the core consists of one or more strands of inexpensive material such as cotton roving, combined with a strand of glass or nylon serving to give high tensile strength.

As may be best seen in FIGS. 2 and 3, the wrapping strand **11** is wound double and deposited about the core strand **12** in a many-layered and haphazard manner. It is characterized by a multiplicity of closely adjacent portions haphazardly doubled back and wrapped in doubled configuration either with themselves, or with other such portions, generally in the form of a closely spaced, multilayered and partially overlapping helix. As may be seen at **14** in FIG. 4, a multiplicity of the doubled-back ends form loops **16** with twisted pedicles **17** which are frequently intertwisted with adjacent pedicled loops as at **16'** and **16''**. The loops **16**, **16'**, and **16''** etc., extend generally perpendicular to and radially of the central core strand **12** from the central axis of the yarn, and outwardly therebeyond. In the so-wound and twisted wrapping strand **11**, the individually looped strand portions are entangled, snarled, and interlocked with adjacent looped portions as shown at **18** and **19** in FIG. 4, so as to resist unwinding.

Apparatus suitable for manufacturing the yarn of FIGS. 1–4 is shown in FIGS. 5–7. Such apparatus may comprise a chamber **20** having a cylindrical wall **22** with a pair of tangential openings **24**, **26** thereinto and end walls **32**, **36**, having openings **34**, **38**. As a means for creating a longitudinally-extended whirling body of fluid in said chamber, tangential opening **26** is connected to a source of fluid pressure such as air pump **28**, while the wrapping strand **11** may be fed into the chamber **20** through tangential opening **24** by means of rolls **25**. The core strand **12** is fed into chamber **20** from tension device **42** through opening **32** in the upper end wall thereof, while the core-constructed wrapped yarn **10** is removed from the axially-extended opening **38** in the opposite end wall by means of a pair of rolls **44**.

In operation, to carry out the method of the invention, the core strand **12** is suppled from any suitable package, not shown, and is passed through guides or feed rolls **42** which, together with the take-up mechanism, insure that the core strand passes through the vortex chamber at a controlled velocity and under constant tension, so that it is essentially undistorted by the circulating air mass in the chamber. The core strand **12**, of whatever composition desired, is fed through the inlet **34**, passes through the vortex chamber, and is threaded through the outlet **38** to a pair of nip rolls **44**.

When the core strand is suitably tensioned between rolls **42** and **44**, compressed air is fed from pump **28** into the chamber through the tangentially-directed inlet **26** while the wrapping strand **11** is fed to the oppositely-disposed wrapping strand inlet **24**. The metering rolls **25**, feeding the wrapping strand **11**, are frequently omitted in the process, but may be used if a closely controlled but varying rate of input is desired, as for the production of sculptured yarns.

Air is fed into inlet **26** at from about 10 to 100 or more pounds pressure. The preferred tangential direction of the air stream, coupled with the generally cylindrical shape of the chamber, creates a miniature tornado in the vortex chamber, with a rapidly revolving stream of air circling around the walls. The end of wrapping strand **11**, drawn into the chamber through the inlet **24** by the rotating air mass, apparently either impinges on the core strand or else slows down due to wall friction within a fraction of a second after the process of feeding the wrapping strand is started. More wrapping strand is being drawn in, however, with the net result that the continually advancing wrapping strand passes the leading end, and a loop or bight is formed.

Under hypothetical ideal conditions, as shown in FIG. 8, the advancing end **45** of a loop thus formed would wrap spirally in the form of doubled loops **47** and **49** around the core strand **12**. One feature of the product of this invention, therefore, is the presence in the wrapping layer of incrementally doubled looped windings, generally perpendicular to the core strand axis.

Due probably to the presence of some turbulence and pulsing in the air flow, however, and to slight irregularities in the core strand and wrapping strand, the idealized type of wrapping shown in FIG. 8 is apparently not often realized. A loop of wrapping strand in the vortex chamber is subject to air forces which tend to twist it on itself, as well as to rotate it around the chamber.

Such a twisting action means that numerous loops or loop segments will be given a half turn or more of twist around their own bifilar axes, as shown in FIGS. 9 and 4. Such a secondary action interrupts the smooth advance-

ment of the strand, with the result that the infeeding end of the strand **46** will be propelled beyond the twisted portion **48**, to form another loop of different configuration. In this way, the continuous propagation of doubled loops is constantly being interrupted by inertial forces, by twisting of a part of the loop, or by engagement with a previously twisted loop segment.

Still a fourth cause of entanglement is the fact that a loop may be thrust through another loop, as illustrated in FIGS. 10 and 4. In FIG. 10, the strand ends **51** and **52** are the end portions of the compound loop which lies between them. This compound loop contains two places, **53** and **54**, where a half-twist bight has been formed, and another region where a newly formed loop **55** has passed through the eye of a previously formed loop **56**.

Such compounded entanglement and frictional engagement of the wrapping strand doublings gives considerable structural strength and coherence to the product of this invention.

Nevertheless, inspection of FIG. 10 will show that if the ends **51** and **52** are pulled to the left, the whole compound loop is freed from the core yarn **12**, and no wrapping is left. Thus, there is no true winding of the wrapping end around the core yarn as in prior art cored yarns. Hence, the type of wrapping effected herein is referred to as "false wrapping," as mentioned above. The doubled and compounded loops are wrapped around the core, with frequent reversals of direction, in a random and haphazard manner, depending on the instantaneous state of strand aggregation just ahead of the wrapping loop as it whirls around in the vortex chamber.

The continuous downward movement of the core strand **12** has the effect of continuously transporting these radially-disposed, compounded, and entangled loops out of the vortex chamber and to the winding mechanism as an integrated wrap. The term "radially-disposed" means that if a cut is made through the cored yarn of my invention, I may get three or four very short pieces of wrapping strand, a fraction of an inch in length, due to cutting through the tips of loops which are not perfectly perpendicular to the core yarn axis. In general, however, cutting through the cored yarn of this invention gives two pieces of wrapping strand, indicating that the compound loops radiate out from the core and are not substantially laterally disposed to it.

The descending spiral of interacting incremental doublings has been described above as it is collapsed onto a constantly progressing core strand. By proper selection of yarn size and air pressure, however, the wrapping strand may be made to entangle upon itself and serve as its own core to produce a "self-cored" core-constructed strand according to the invention, as described more specifically in Examples 5, 6, 8, 9, and 10 below.

In such cases, the explanation is probably as follows: The spiraling doubled strands are constantly moving down through the vortex chamber, due to gravity and to the tendency of the air to be exhausted through the exit tube. At a point near the bottom of the chamber, the entangled wrapping strand becomes so bulky and so dense that a following loop wraps around this nucleus, much as if it were a core strand. If this wrapped nucleus is then withdrawn from the vortex chamber and wound up at an appropriate rate, it is found that the doubling and wrapping will continue to propagate a bulky voluminous product without the need for providing a core for the wrapping strand to wrap around. It is important, of course, that this voluminous coreless yarn be removed from the vortex chamber as fast as it is formed, or else it will quickly plug the chamber and the process will stop.

Motion pictures taken at 8,000 frames per second indicate that in producing a coreless novelty yarn of this type, the real yarn formation takes place at or near the bottom of the vortex chamber **20**, that is, near the lower tip of the descending, narrowing spiral. The initiation may be due to any momentary irregularity in mass density, but once begun, the self-wrapping continues so long as the input and windup are adjusted so as to maintain a steady equilibrium state.

In this process, it is obviously not necessary to have separate inlets for core and wrapping strands. A chamber such as shown in FIGS. 5–7 may be used to advantage, but with the opening **34** omitted or with the wrapping strand fed through opening **34** and air introduced through both side openings **24** and **26**. As is true of this invention in general, more than one strand at a time can be fed into the chamber. Two ends of yarn of different color may be combined, for example, to give a bulky decorative structure useful as a Christmas tree trim, or decorator's material.

To some extent the size of the loop formation will depend on the density of the material of which the yarn is composed. Even more important is the modulus of rigidity of the yarn composition, nylon differing from viscose, which in turn differs from acetate. In addition, the resistance to bending, which governs the size and shape of the loops formed, can be varied widely in any one type of yarn by varying the denier or weight per unit length of the filaments chosen. For example, in a 260 denier-17 filament nylon yarn, the individual filaments are about 15 denier. Such a yarn tends to form springy, resilient bows which radiate clearly from the center of the assembly and have quick recovery from deformation. In a 70 denier-34 filament nylon yarn, however, a softer and more compliant product is obtained.

By proper choice of the above variables, a wide variety of structures may be produced in which various components are stratified in the surface or at the center of the assembly, as desired.

Another useful modification of the invention, resembling a slubbed yarn, is shown in FIG. 11. Such a yarn is produced when the withdrawal of the core strand is slightly in excess of the speed of wrapping that takes place in the vortex chamber. This can be brought about either by speeding up the windup, or by decreasing the air pressure so that less rotational energy is imparted to the wrapping yarn. Specific illustrations are given in Examples 5 and 9, below.

As above set forth, if the rate of wrapping in the lower part of the chamber is balanced against the rate of withdrawal, a continuous even wrapping is obtained, with no plugging of the exit tube and no backward propagation which would plug the chamber.

However, if the yarn is withdrawn at a rate too fast to allow uniform wrapping, the wrapping does not become thinner and uniformly attenuated, as might be expected, but instead, it is suddenly converted to a series of slubs, separated by unwrapped areas, as shown in FIG. 11. The exact reason for this is not understood, but apparently the excess take-up speed of the winder, coupled with the air stream issuing from the exit tube, creates a pulsing action in the process which leads to the intermittent wrappings appearing like beads on a string. The periodicity is quite regular, and by manipulation may be varied over a substantial range. Such slubbed products can be made either with or without a core strand, as desired.

Among the major advantages of this invention are the simplicity, speed, and economy with which a wide variety of useful and novel yarnlike arrays may be produced. A thick and quite inexpensive paper core yarn may be smoothly wrapped with a thin layer of fine viscose rayon, to simulate a textile yarn, at speed which cannot be matched by conventional wrapping or braiding techniques. A cotton core yarn wrapped with coarse nylon combines strength with bulky resilience, for use as a rug yarn. If a tensioned rubber core is wrapped with rayon or nylon, an inexpensive elastic yarn is produced. Wires may be quickly wrapped with any desired electrically insulating strands. Although the invention has been described chiefly in terms of textile yarns or wire, it is equally applicable

to any filamentary material that can be fed continuously into the vortex chamber, such as slit Mylar film, plain or metalized, and similar materials.

I have also found that the product of this invention is useful as a starting material for the production of "bulked yarns" or "textured yarns," such as are known to the textile trade as Taslan, Ban-Lon, or Agilon. Such yarns, made from continuous filaments, are characterized by having the individual filaments in the bundle crimped or looped or otherwise dispersed so that they tend to stand apart from each other in the filamentary bundle, thus providing a feeling of bulk, softness, and warmth that is lacking in regular untextured continuous filament yarn.

By the incremental doubling and looping process of this invention, continuous filament yarn may be compacted into a tight, false-wrapped yarn. This wrapping may be around a true core strand, or it may be around its own bulk as described above, where a "self-cored" yarn is described. I have found that if a yarn of this latter type is subsequently drawn out, so that the wrapping is attenuated to approximately its original length, the redrawn yarn is markedly different from the yarn originally fed to the vortex tube, as shown in FIG. 12. This represents a multifilament strand compacted on itself according to the invention, and subsequently drawn out to about 95% of its original length, by conventional drawing means.

Such a process is to be contrasted with certain conventional "bulk-yarn" processes which have the disadvantage of needing to combine a dispersing or crimping process with a heat-setting process. That is, unless the filaments are heat-set, the bulkiness and loft that have been applied to the yarn are of a temporary nature, and will not resist subsequent processing into fabrics. Hence, it is common practice to apply heat to the yarn at or just prior to the point at which the individual filaments are to be separated and dispersed.

In the product of my invention, however, the individual filaments in the wrapping yarn are not dispersed or blown apart in the vortex tube, but the relatively intact filament is wrapped into a series of doubled loops radiating out from the central axis, as described above. This creates a stable product which may be wound up in a conventional package and stored indefinitely. Any subsequent desired treatment, such as dry heating, steaming, impregnating, or treatment with resin solutions, may be carried out on the individual packages at any time and in any equipment, that is suitable. Since the compacted yarn has no true wrapping, as explained above, it can be drawn out by conventional methods. I have found that due apparently to the tight doubling that the yarn has undergone, the individual filaments in the yarn tend to spring apart in a series of irregular waves, as shown in FIG. 12. Such a drafted product has many of the properties of "textured yarns," but is much more economical to produce.

The product of the invention will now be illustrated by the following examples, which are shown in FIGURES 13 to 22, respectively.

Example 1, FIG. 13

A vortex chamber similar to that shown in FIGS. 5 to 7 was used to wrap a 70 denier-34 filament nylon strand around a 260 denier-17 filament core. The brass chamber was ¼ inch in diameter, ⅛ inch high, with a core strand inlet of 1/16 inch diameter and an outlet of ⅛ inch diameter. The air inlet and wrapping strand inlet were each 0.040 inch in diameter.

Using an air pressure of 60 lbs. per square inch and a windup speed of 20 yards per minute, the product of FIG. 13 was obtained. The final denier of this nylon wrap on nylon core was 4,200. Subtracting the uncontracted core yarn denier of 260 shows that the wrapping yarn is now 3,940 denier. This indicates that approximately 56 yards of the 70 denier wrapping strand are wrapped around each yard of product.

Example 2, FIG. 14

The same chamber was used as in Example 1. The wrapping strand was again 70 denier-34 filament nylon, and the air pressure 60 lbs. Three parallel core strands were used, one of 260 denier-17 filament Estron and two strands of 900 denier-230 filament nylon, to provide a high-tensile strand. The takeup speed was 80 feet or 26.7 yards per minute.

The total denier of the product, shown in FIG. 14, was 5,550. Subtracting the 2060 core denier indicates that the wrapping was 3,490 denier, showing that about 50 yards of wrapping strand were wrapped around each yard of product.

Example 3, FIG. 15

The same chamber, wrapping strand, and air pressure were used as in Examples 1 and 2. The core was of two strands, 260 denier-17 filament nylon and 4,400 denier-3,000 filament viscose. Take-up was 53 feet or 17.7 yards per minute.

The product of FIG. 15 weighed 10,600 denier, of which 4,660 was core and 5,940 was wrapping. This indicates that about 85 yards of 70 denier nylon are wrapped around each yard of final product.

Example 4, FIG. 16

Using the same chamber, wrapping strand, air pressure, and take-up speed as in Example 3, the 70 denier nylon was wrapped around a compound core made of one strand of soft steel wire, 9,600 denier, and one strand of 4,400 denier-3,000 filament viscose tow.

The product of Example 4 weighed 22,800 denier, of which 8,800 denier was wrapping. This indicates that about 126 yards of 70 denier nylon is wrapped around each yard of product.

Example 5, FIG. 17

Using the same chamber as in previous examples, a 70 denier-34 filament nylon strand was fed into the side opening 24, with no yarn being fed in as a core strand. At an air pressure of 40 pounds per square inch and a take-up speed of 134 feet or 44.7 yards per minute, the product of FIG. 17 was obtained.

The product consists of a series of slubs, about 5/16 inch in diameter, spaced about 1 inch apart on the 70 denier nylon strand. The denier of the product is 1,000, indicating that about 14 yards of 70 denier nylon has been intermittently wrapped upon itself to form 1 yard of product. This product can be made equally well with chamber opening 34 open or closed.

Example 6, FIG. 18

This was an exact duplicate of Example 5 except that the take-up speed was decreased to 32 feet or 10.7 yards per minute. As seen in FIG. 18, the slubs are thereby run so closely together that the product has the appearance of a more or less continuous yarn. The denier of the product was 2,850, indicating that over 40 yards of 70 denier nylon has been used to form one yard of product.

Example 7, FIG. 19

Using the same chamber as in the above examples, a 260 denier-17 filament nylon strand was wrapped around another 260 denier-17 filament nylon strand as a core. Air pressure was 60 pounds, take-up speed 17.7 yards per minute.

The increased resilience of a large-denier nylon wrap is seen by comparing Example 7, FIG. 19, with Example 1, FIG. 13. The wrapping component was 7,840 denier, indicating that about 30 yards of wrapping strand are wrapped around each yard of core strand of the same composition.

Example 8, FIG. 20

Using the same chamber as in the above examples, an air pressure of 30 pounds, and a take-up speed of 10 feet per minute, a 70 denier-34 filament nylon strand was fed into the core strand inlet **34** under no tension. No wrapping strand was used, and the wrapping strand inlet **24** was left open.

The denier of the product was 5100, indicating that 130 yards of 70 denier of nylon had been wrapped on itself to form one yard of product.

Example 9, FIG. 21

Using the same chamber and the same 70 denier nylon strand as in Example 8, the air pressure was increased to 40 pounds and the take-up speed to 80 feet per minute. Under these conditions, the product of FIG. 21 was obtained. Each slub is about ¼ inch long, and they are spaced about 2 inches apart. The final product is 600 denier, indicating that about 9 yards of 70 denier yarn are consumed for each yard of product.

Example 10, FIG. 22

A chamber similar to FIG. 5–7 was used, with an inside diameter of ½ inch, a height of ¼ inch, core strand inlet of 1/16 inch, an an outlet of ¼ inch diameter. Air at 20 pounds pressure was blown in through both side openings **24** and **26**, which were 0.094 inch in diameter.

Two strands of Fiberglas yarn, type G150–1/9-1Z were fed in through the opening **34**. The take-up rate was 45 feet or 15 yards per minute.

The product shown in FIG. 22, weighed 4 grams per yard. The two initial strands weighed 7,315 yards per pound, or 0.062 gram per yard. The contraction factor was therefore 64.5 yards of input material for each yard of product.

It will be clear to those skilled in the art that there may be a variety of modifications, not disclosed herein, of the products, processes, and apparatus of the invention within the spirit thereof and the scope of the appended claims.

I claim:

1. A method of making a core-constructed yarn comprising continuously overfeeding a continuous strand into a generally cylindrical body of fluid whirling about a central axis, continuously maintaining an overfed portion of said strand within said body in slack condition, randomly forming doubled-backed loops in said strand, and winding said loops in doubled configuration in the form of a close spaced and partially overlapping helix for a plurality of turns and entangling and snarling said loops with one another by the whirling motion of said fluid body.

2. A method as claimed in claim 1 wherein said feeding is at a variable rate.

3. A method as claimed in claim 1 wherein said feeding is at a uniform rate.

4. A method as claimed in claim 1 further including the step of attenuating said looped and wound strand to provide a bulked yarn.

5. A method of making a core-constructed yarn comprising continuously overfeeding a continuous strand into a generally cylindrical body of fluid whirling about a central axis, continuously maintaining an overfed portion of said strand within said body in slack condition, randomly forming doubled-backed loops in said strand, winding said loops in doubled configuration in the form of a close-spaced and partially overlapping helix for a plurality of turns and entangling and snarling said loops with one another by the whirling motion of said fluid body, and continuously removing the looped and wound strand from said fluid body at a rate not greater than 20% of the rate of feed of said strand into said whirling body.

6. A method as claimed in claim 5 wherein said removal is carried out while restricting said looped and wound strand in a transverse direction.

7. A method of making a core-constructed yarn comprising continuously passing a straight tensioned continuous core strand axially through a generally cylindrical body of fluid whirling about a central axis, continuously overfeeding a continuous wrapping strand into said generally cylindrical body of fluid whirling about a central axis generally tangentially thereof, continuously maintaining an overfed portion of said wrapping strand within said body in slack condition, randomly forming doubled-backed loops in said wrapping strand, winding said loops in doubled configuration in the form of a close-spaced and partially overlapping helix for a plurality of turns about said core strand and entangling and snarling said loops with one another and with said core strand by the whirling motion of said fluid body, and continuously removing the looped and wound bulked core-constructed yarn from said fluid body.

8. A method as claimed in claim 7 wherein said yarn is removed at a rate equal to the rate of feed of said core strand into said fluid body and not more than 20% of the rate of feed of said wrapping strand into said whirling fluid body.

9. Apparatus for manufacturing a core-constructed yarn comprising a generally cylindrical chamber, means for creating a whirling body of fluid in said chamber including a tangential opening in said chamber and means for applying a pressurized fluid to said opening, means for feeding a wrapping strand into said chamber including an opening in a side wall of said chamber, means for feeding a core strand into said chamber including an opening in an end wall of said chamber, and means for removing said core-constructed yarn from said chamber including an opening in the end wall of said chamber opposite from the wall having said core strand inlet opening.

10. The apparatus according to claim 9 wherein the opening for feeding the wrapping strand is tangential to the chamber.

11. The apparatus according to claim 10 wherein the tangential opening for applying a pressurized fluid and the tangential opening for feeding a wrapping strand are substantially oppositely disposed on the walls of the generally cylindrical chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

2,852,906	Breen	Sept. 23, 1958
2,869,967	Breen	Jan. 20, 1959

FOREIGN PATENTS

1,177,428	France	Dec. 1, 1958
1,178,980	France	Dec. 15, 1958
776,410	Great Britain	June 5, 1957
799,185	Great Britain	Aug. 6, 1958

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,041,812 July 3, 1962

Preston F. Marshall

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, lines 36 and 53, for "FIG. 11, each occurrence, read -- FIG. 12 --; column 7, lines 23 and 54, for "FIG. 12", each occurrence, read -- FIG. 11 --.

Signed and sealed this 31st day of December 1963.

(SEAL)
Attest:
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Acting Commissioner of Patents