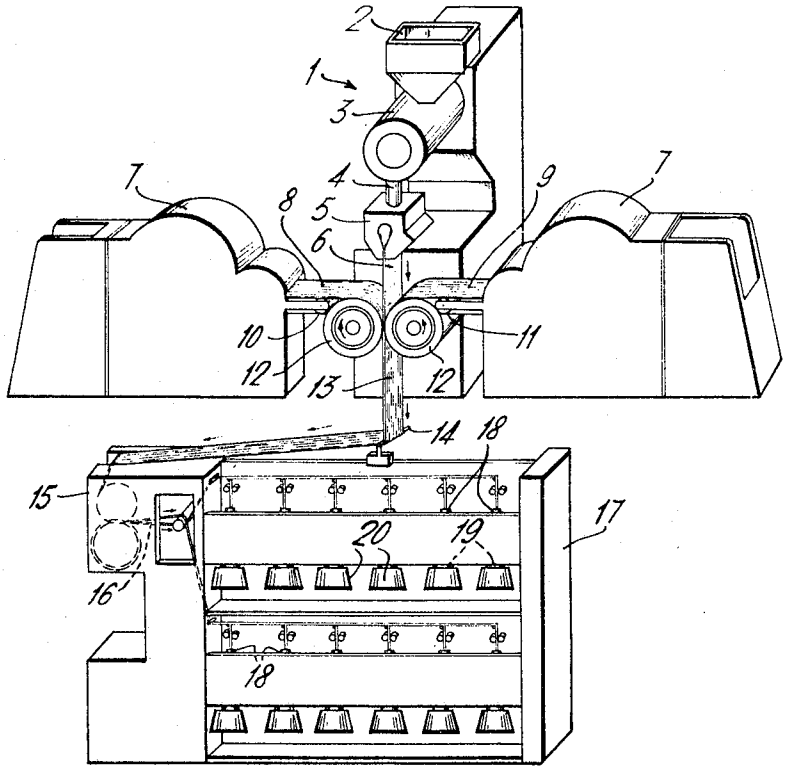
Dec. 2, 1969 E. BOBKOWICZ ET AL 3,481,132

TEXTURED FILAMENT YARNS

Original Filed May 27, 1963 2 Sheets-Sheet 1

FIG. 1



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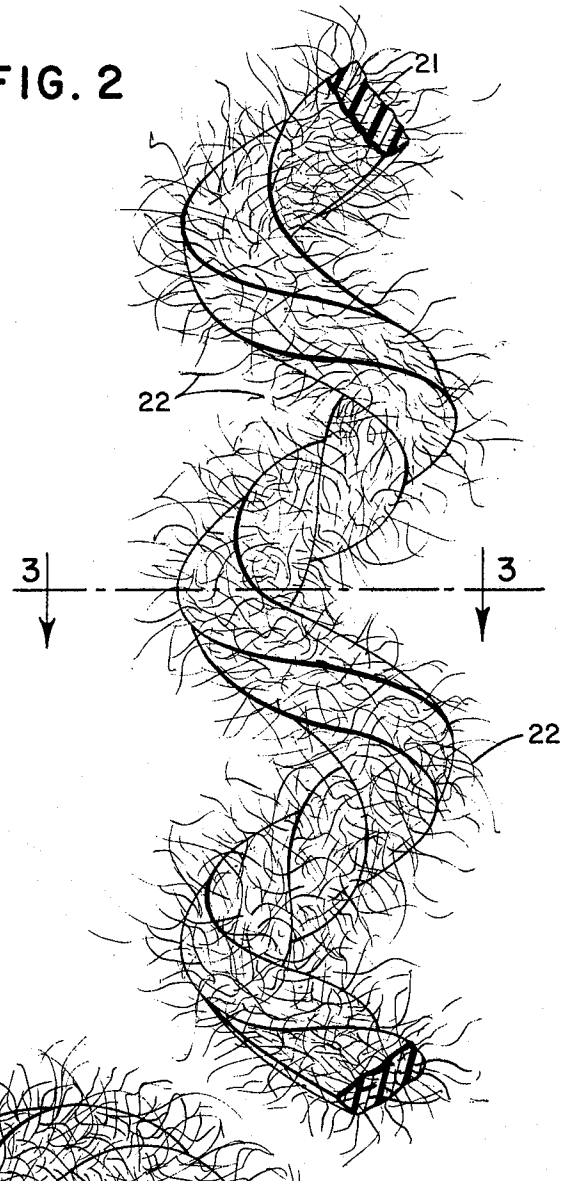
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TEXTURED FILAMENT YARNS

Original Filed May 27, 1963 2 Sheets-Sheet 2

FIG. 2



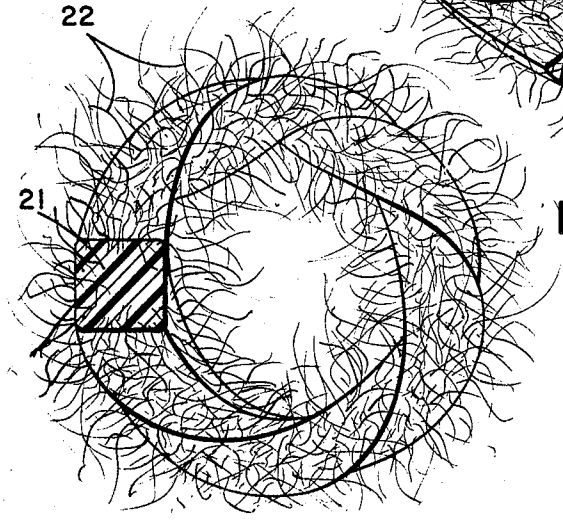


FIG. 3

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3,481,132

TEXTURED FILAMENT YARNS

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Original application May 27, 1963, Ser. No. 283,389, now Patent No. 3,347,727. Divided and this application June 9, 1967, Ser. No. 662,220

Claims priority, application Great Britain, May 29, 1962, 20,617/62

Int. Cl. D02g 3/02, 3/36

U.S. Cl. 57—140 8 Claims

ABSTRACT OF THE DISCLOSURE

Composite textured yarns having a central continuous core of synthetic resin, such as nylon, polyester, polypropylene, and polyacrylate and an outer surface of natural fibrous material such as cotton or wool. This yarn has substantially the appearance, feel and other physical properties, characteristic of the outer fibers. If desired, the outer fibers can be staple fibers of synthetic resin which is the same as or different from the resin of the central core. For special purposes, the outer fibers may be composed of metal, asbestos or other inorganic substances.

This application is a division of co-pending application, Ser. No. 283,389, filed May 27, 1963, now Patent No. 3,347,722.

This invention relates to a novel yarn from staple fibers without the necessity for any roving or drafting operations of the type utilized in conventional yarn making methods.

To understand better the difference between the product of this invention and conventional yarns it is necessary to consider the basic process of making yarn.

Ever since spinning began the spinner's art in essence has consisted in making use of the slight adherence and surface grip between fibers to hold them together until they have been twisted sufficiently to grip each other tightly and form a strong yarn. The cohesion forces on which the spinner depends are slight; the fibers must therefore be carried gradually through many stages of carding, drawing, roving, drafting and twisting on many different machines to evolve the final yarn. The inherent cohesion properties vary with various staple fibers; this necessitates in conventional yarn making the use of different processing means adapted to each type of staple fibers and these processing means are all exclusively based on the utilization of the cohesion forces to make yarn.

This new yarn is not characterized solely by natural cohesion forces between the fibers but relies on adhesion forces derived from a resinous bonding agent introduced for the purpose of adhering the fibers to one another to form a yarn having a permanent twist.

The preparation of this new yarn avoids the complex and necessarily slow roving and drafting stages of the conventional method and in most cases the drawing stage thereby making feasible much higher yarn making speeds as well as automation of the entire processing of staple fibers in one continuous sequence of steps from fiber webs to yarn.

With this simplification of textile procedures and consequent increase in processing speeds this new yarn can be produced more economically.

In addition enabling a more economical production of yarns the present invention includes filament yarns which have advantages over known types of filament yarn.

In the textile art the term filament is defined as an individual strand that is infinite in length. Man-made filaments are infinite in length and may attain a total length of several miles. A filament yarn may comprise mono- or multi-filaments without or with twist, which when present is usually slight. A textured filament yarn is a generic term for any filament yarn modified in such a way that its original physical and surface properties have been changed. The term implies that a different texture has been imposed on the extruded shape of the filament.

To better understand this aspect of the invention it is useful to briefly recapitulate the basic facts of all hitherto known methods of filament yarn production.

There are three basic techniques by which man-made filament yarns can be produced:

(1) The solvent method.
(2) The wet method.
(3) The melt method.

All three methods are variations of a single technique using a spinneret which has many fine holes through which a man-made liquid substance is forced and right after extrusion is solidified into continuous multi- or mono-filaments, the yarns of which are straight and due to the extrusion technique have a highly smooth surface and shape.

Ever since man-made filament yarns began to be produced in continuous filament form the disadvantage of its straight shape and smooth surface for many uses became apparent for the following basic reasons:

(a) Low resilience and abrasion resistance
(b) Lack of warmth and insulation properties which are inherent in most natural fibers because of the air retained among the crimped fibers.
(c) Low moisture absorbence properties and low water repellence.
(d) Lack of comfort in wear, because laying flat they are unable, like crimped fibers do, to segregate sweat droplets and maintain adequate porosity.

To overcome these main, though not the only disadvantages of straight continuous man-made filaments two basic techniques, different in approach, of yarn making have been developed.

In the first method the filaments are either chopped or broken up into staple fibers corresponding to natural fiber length, so that the staple fibers obtained of the filaments can again be processed on existing conventional machinery and by the complex and costly conventional yarn making methods into continuous yarns and textures similar to the conventional yarns made of natural fibers. To further neutralize previously said disadvantages of man-made fibers they are often blended with various natural fibers.

In the second method various mechanical means and methods are used to change the physical appearance and shape of the filament by imposing on the yarn a different texture. Such textured yarns are either crimped, coiled, curled, or looped. Although the usual process of texturizing of filaments comprises continuous high speed operations the costs involved considerably increase the price of the final product, the textured yarn, because it has to pass through five phases of processing, as is for instance the case in the production of nylon textured yarns, as follows:

PHASE ONE

The filament yarn has to be removed from the bobbin.

PHASE TWO

The individual filaments of the yarn are displaced from their natural and relatively close packed position either by mechanical distortion (for example twisting) or by other means.

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PHASE THREE

The displaced filaments comprising the yarn are made to assume a permanent configuration, as by heat-setting.

PHASE FOUR

The forces which caused the filament displacement in phase two are removed (by untwisting, if the filaments have been displaced by twisting) so that the yarns assume permanent bulk and/or stretch characteristics, particularly after relaxation.

PHASE FIVE

In this phase the textured yarn is wound into a suitable package.

The production of textured yarns thus involves the making of a filament, then its reprocessing on complex and costly machines into textured filament yarns by passing through the above five stages of processing. For these reasons textured filament yarns are among the most expensive yarns on the market. Staple fiber yarns made from man-made fibers (or their blends with natural fibers) necessitate also first of all, the making of a filament, which after processing into staple fibers and blending with other fibers must pass through many costly stages of conventional yarn production, such as opening, blending, picking, carding, drafting, roving, twisting and winding before the final yarn evolves. In both cases, thus, the production involves two distinct, different, separate and discontinuous stages of processing and different equipment.

This invention provides a composite filament yarn with a texture which will eliminate all the disadvantages previously mentioned of a conventional smooth and straight filament yarn in which yarn, if and when desired or preferred, any positive normal or heat-set twist of heat-set false twist can be imparted to increase its textured and/or stretch yarn character. According to the invention such textured filament yarns can be produce from any extrudable thermoplastic materials such as nylon, polypropylene, acryonitrile, polyethylene, rubber compounds, etc., or their blends (which may include some thermosetting agents), with the aid of any type of short or long staple fibers in loose or preformed fiber webs, of random or parallel arranged fibers or in the form of pulp, paper, etc., in one continuous sequence of operations from a suitable raw material to ready filament yarn package.

By way of illustration and without limitation the invention will be described with reference to the accompanying drawings, FIGURE 1 of which shows one preferred arrangement for carrying out the method for producing the novel composite yarns. FIGURES 2 and 3 are enlarged views of such yarns.

In FIGURE 1, the apparatus illustrated includes an extruder **1** comprising a hopper **2**, and a heating chamber **3**. Synthetic resin is fed into the hopper **2**, from which it passes into the heating chamber **3** to be melted. The molten resin passes through a connection **4** to an extrusion head **5** from which the resin is extruded in the form of a layer **6** consisting of a continuous still plastic film or a plurality of continuous filaments parallel with one another.

On each side of the layer **6** there is disposed a carding or garnetting or other device **7** well known in the art for producing an aligned fiber web. The devices **7** are utilized for the purpose of forming fibrous webs **8** and **9** from staple fibers, each of the webs having the fibers thereof substantially arranged parallel to the longitudinal extent of the web. The webs **8** and **9** are fed by way of guide rolls **10** and **11** towards opposite sides of the resinous layer **6**. The sandwich thereby formed from the resinous layer **6** and the webs **8** and **9** is then fed between a pair of cooled rolls **12** which are driven at such a speed that they take up the layer **6** at a greater rate than it is extruded from the head **5**, thereby maintaining the layer **6** under tension.

In addition to exerting tension on the layer **6**, the cooled rolls **12** serve other purposes. In the first place they exert pressure which causes flow of the resinous material into the webs **8** and **9**. In the second place they exert a cooling action on the resinous material which causes it to coagulate. The net effect is to produce a composite web **13** wherein the fibers of the webs **8** and **9** are securely bonded to the resinous layer **6** at the points of contact with same.

The composite web **13** is passed around a guide **14** and fed to a slitter device **15** where it is slit into a plurality of ribbons **16**.

From the slitter device **15** the ribbons **16** are fed to a twisting machine **17** comprising a plurality of spindles **18** which need not be described in detail because they are of the kind described and illustrated in United States Patent No. 2,900,782 issued on Aug. 25, 1959. The spindles **18** deposit packages **19** in pots **20**. If desired the spindles **18** could be replaced by conventional ring spindles.

The spacing between the cooled rolls **12** is so adjusted as to exert a firm gripping pressure on the sandwich of the webs **8** and **9** and the resinous layer **6** and the rate of extrusion from the extrusion head **5** so controlled as to keep the resinous layer **6** under tension. This arrangement provides a means of controlling the thickness of the resinous layer **6** and hence the ratio of resin to fiber in the final product. Moreover the tension on the resinous layer **6** is sufficient to ensure a desirable stretching action so that by the time the resinous layer **6** reaches the nip of the rolls **12** orientation of the resin molecules in the hot sheet has been effected. It is well known that films or filaments of many synthetic resins can be considerably strengthened if they are subjected to stretching action great enough to cause orientation of the resin molecules in the direction of the longitudinal extent of the film or filament. This increase of strength is accompanied by an increase in length of the film or filament. Therefore, the resinous layer **6** which is delivered to the nip of the cooled roll **12** has considerable strength due to the stretching which has been exerted on it. The cooling action exerted on the resinous layer **6** by the rolls **12** serves to set the molecules of the resinous layer **6** in their oriented positions so that the composite web **13** is bonded together by a resinous layer of considerable strength. This is in contrast to the situation which would prevail if instead of introducing between the webs **8** and **9** a directly extruded resinous layer **6** the latter layer was substituted by prefabricated film or filament of the resin. In the latter case, for the purpose of achieving satisfactory adhesion of the fibrous webs **8** and **9** to the film of filament the cooled rolls **12** would have to be replaced by heated rolls so as to soften the surface of the prefabricated film or filament. Such application of heat would impair the orientation of the molecules in the prefabricated filament or film with consequent loss of strength. Composite webs derived from such a method would therefore not be as strong as the web **13** of the present invention. Also, the strength of yarns formed from such a web would be inferior to the yarns formed from the web **13**.

In a specific example using the apparatus shown in FIG. 1, two webs **8** and **9** of staple cotton fiber were applied to opposite sides of a layer **6** of polypropylene which was 0.001 inch in thickness. The temperature of the extrusion head **5** was about 550° F. The webs **8** and **9** contacted the layer **6** at a distance of about 3 inches below the head **5** where the temperature of the layer **6** had dropped to about 350° to 400° F. The rate of extrusion of the resin from the head **5** was such as to give the layer **6** a linear speed of about 10 feet per minute while the rolls **12** were rotated at such a speed as to take up the layer **6** at about 100 feet per minute, thereby exerting tension on the layer **6** between the head **5** and the rolls **12**. The composite web **13** obtained in this way was split into ribbons and the ribbons were twisted into yarns. The yarns so produced had the feel and appearance of a conventional cotton yarn while having a strength much great-

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er than that of conventional cotton yarn. Microscopic examination revealed that the yarns had a continuous core of polypropylene surrounded by a sheath of cotton fibers some portions of which were embedded in the polypropylene core and some resin-free portions of which extended therefrom. It was further noted that the core had a helical configuration due to the twisting operation and that parts of the resin-free portions of the cotton fibers were held between adjacent helices of the core.

This novel yarn is shown in enlarged scale in FIGURE 2, wherein **21** represents the twisted helical core of continuous synthetic resin and **22, 22** represent the staple fibers partly imbedded in the resin core forming a sheath about the same, with parts of the resin-free staple fibers held between adjacent helices of the core. FIGURE 3 represents a transverse view of such a yarn along the line **3—3** of FIGURE 2.

Quite apart from the improved strength of the webs and yarns of the present invention, the use of a resinous layer which is produced by direct extrusion techniques provides other advantages over the use of a prefabricated film or filament. In the formation of films and filaments for conventional purposes considerable effort has to be expended in order to obtain a commercially satisfactory product. The criteria for whether the product in question is satisfactory or not are based on a variety of considerations most of which are quite irrelevant when the film or filament is desired for use in the production of resin bonded yarns. For example, when producing a film for sale as such, careful attention must be given to the production of a smooth surface. This is commonly achieved by a calendering operation which requires careful control. When producing filaments on the other hand, it is normally an important requirement that the filament should be of uniform cross section within quite small tolerances. It is a natural consequence of the degree of care that has to be exercised in producing films or filaments for normal commercial use that the cost of these films and filaments is relatively high by comparison with the films or filaments that can be produced by direct extrusion as in the method of the present invention. These directly extruded films or filaments are required to have acceptable physical properties and uniformity of manufacture but appearance is of little consequence. Accordingly, by adopting the technique of directly extruding the resinous bonding agent between the fibrous webs considerable economy is achieved without sacrificing any quality.

Another advantage of the method of the present invention by comparison with a generally similar technique in which a prefabricated film or filament is used instead of a directly extruded material is that the nature of the resin can be readily adjusted to meet the prevailing requirements. Commercially available films and filaments contain in many cases ingredients which are important for one reason or another in the products which are to be used in that form. Such ingredients include for example delustering agents, components having an affinity for dyestuffs and so on. Such materials are of no particular value when forming a resin-bonded yarn and may even be deleterious. According to the present invention the resin used for bonding the fibers together can without any difficulty be given a composition which is thought to be most appropriate for the particular material being produced. Unnecessary ingredients can be left out. More important, ingredients useful in resin-bonded textile materials which are however undesirable in most commercially available films, or filaments can be included. For example, the inclusion of a thermosetting resin in the resinous mixture offers no difficulty. Indeed it is possible to utilize a resin mixture consisting entirely of a thermosetting resin. Films and filaments of thermosetting resins such as phenol formaldehyde resins and urea formaldehyde resins are not commercially available. The addition of such resins may be desired for the purpose of increasing the strength and stiffness of the resin-bonded fibrous product. Furthermore, it may be desirable to operate with a higher content of plasticiser than is commonly used in films or filaments. This can be achieved without difficulty in the method of the present invention.

Another important advantage in the method of the invention is that use can be made of resins or resin mixtures which have a high melting point without impairing the qualities of the fibers in the fibrous webs. At the moment that the resin comes into contact with the fibrous webs the sandwich thereby formed is immediately subjected to the cooling action of the rolls **12**. The fibers in the webs **8** and **9** are therefore not subjected to temperatures which could impair their properties. In a method where the directly extruded resinous layer **6** is replaced by a layer of prefabricated films or filaments and the cooling rolls **12** replaced by heated rolls damaging of the fibers in the webs is likely to occur if the resinous material involved has a high melting point. This is because in order to bring the resinous layer to a state of softness such that adequate adhesion between the resin and the fibrous webs can be achieved the temperature of the resinous layer must obviously be brought above the softening point of the resin. In order to do this heat has to be transmitted from the heated rolls through the fibrous webs to the resinous layer. It follows that the fibrous webs are brought to a temperature higher than the softening point of the resin. Many resins, for example nylon, have such high softening points that there are few fibrous materials which can withstand being brought to the temperatures necessary in order to effect satisfactory bonding between the resin and the fibers. In the method of the present invention degradation of the fibers can occur, if at all, only at the parts of the fibrous web immediately adjacent the fibrous layer, the bulk of the web being maintained at a lower temperature due to the action of the cooled rolls **12**. Because of this feature of the invention of achieving satisfactory bonding between the fibers and the resinous material without exposing the fibers to unduly high temperatures it is possible to make resin bonded fibrous products from combinations of fibers and resins that could not be successfully treated if the resins were supplied in the form of a prefabricated film or filament.

It will be appreciated that the process illustrated in the drawing can be modified in many ways within the scope of the invention. The process of the invention essentially comprises forming a directly extruded layer of a resinous material and a fibrous web in which the fibers have preferably been brought into substantially parallel relationship with one another in the longitudinal extent of the web, bringing the resinous layer and the fibrous web together, subjecting them to cooling and pressure to form a composite web in which the fibers are bonded to one another by means of the resinous material. If desired, two identical fibrous webs may be used to form the composite web as illustrated in the accompanying drawing. However, a single fibrous web is sufficient. Also, one of the fibrous webs **8** and **9** could be replaced by a layer of paper or pulp or metallic foil. The production of yarns from such a web could be effected by twisting the ribbons cut from the web in such a manner as to dispose the paper or pulp in the interior of the yarn. In this manner there can be economically produced a bulky yarn. Similar results could be achieved by using in place of paper or pulp a randomly arranged fibrous web, for example, a web of linters. Also, both of the fibrous webs **8** and **9** could be replaced by paper or paper pulp.

Other arrangements are also clearly feasible. For example, it will be possible to produce one composite web by extruding a resin layer between a layer of paper and a web of staple fibers which had been brought into parallel relationship with one another and then to extrude a second resin layer between this first composite web and a second web of staple fibers arranged in parallel relationship

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with one another so as to produce a second composite web having fibers on both sides thereof and an interior composed of paper sandwiched between two resinous layers.

The invention is primarily concerned with the production of resin-bonded yarn. However, it will be appreciated that the composite webs produced according to the invention are useful in themselves as wrapping and covering materials. In particular, they can be used as imitation leather.

It has been observed that the bonding of the fibrous webs together can be achieved by means of a resinous layer which may be a continuous film or may be made up of a plurality of continuous filaments. The nature of resin employed is not critical. For example, the resin may be a polyamide, polyacrylate, a cellulose ester, especially cellulose acetate, a regenerated cellulose, polyethylene, polypropylene, a polyester and so on. As indicated above thermosetting resins may be used if desired.

The nature of the fibers from which the fibrous webs are made is also capable of much variation. Thus, the fibers may be animal fibers, such as wool; vegetable fibers such as cotton; bast fibers such as ramie, jute flax, hemp or kenaf; hard fibers such as sisal, sansiveria or agave; glass fibers; mineral fibers such as asbestos; and man-made fibers such as polyamide, polyester, polyacrylonitrile and so on.

The formation of the fibrous webs can be effected by any of the various fiber aligning and parallelising devices which are well known in the art, for example using cards, garnets, drawing frames, gills, paper machines, and so on. Furthermore, where the staple fibers are too short to be formed into self-supporting webs, the fibers may be dispersed in an air current and blown on to the tacky surface of the resin layer by suitable blower means so that a web of the fibers is formed on the surface of the resin layer.

The method of the invention makes possible the production of yarns which possess the strength of a conventional filament yarn in that they have a continuous core of synthetic resin and at the same time have the surface characteristics of a textured yarn due to the presence of an outer sheath of staple fibers. This is in contrast to yarns produced by impregnating staple fibers with resin; in such yarns the resin is diffused through the fiber mass so that a harder yarn is obtained. Also, the yarns of the present invention can readily be produced with a high degree of evenness whereas with yarns produced by conventional textile methods this is more difficult since each of the series of steps involved in a conventional method of yarn production is capable of causing unevenness in the yarn.

The method of the invention thus yields novel yarns comprising a continuous core of a resin and fibrous material anchored to said core in that portions of the fibrous material are embedded in said core while other portions of the fibrous material, which are substantially free from said resin, extend from the core to provide a sheath having the normal surface characteristics of said fibrous material. Preferably, the anchoring of the fibrous material to the core is enhanced by the imparting of a twist to the yarn which gives said core a helical form and serves to trap portions of the resin-free fiber between adjacent coils of the helical core thus formed.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A textured filament yarn comprising a continuous helical core of resin with longitudinally oriented molecules and fibrous material having portions thereof embedded within said core and other portions extending out of said core and being substantially free from resin, forming a sheath about said core and providing a yarn with a fibrous texture having the normal surface characteristics of said fibrous material as well as improved strength and softness, due to the longitudinal molecular orientation of the said resin and the protrusion of the fibrous material about said helical core.

2. A yarn according to claim **1**, wherein said fibrous material consists of staple textile fibers.

3. A yarn according to claim **1**, wherein said resin is a thermoplastic resin selected from the group consisting of nylon, polypropylene, acrylonitrile, polyethylene and rubber compounds.

4. A yarn according to claim **3**, wherein said thermoplastic resin is blended with a thermosetting resin selected from the group consisting of phenol formaldehyde resins and urea formaldehyde resins.

5. A yarn according to claim **1**, wherein said fibrous material is linters.

6. A yarn according to claim **1**, wherein said fibrous material is paper fiber.

7. A yarn according to claim **3**, wherein portions of said fibrous material protrude inwardly of said helical core andother portions protrude outwardly thereof.

8. A yarn according to claim **1**, wherein the resin is a thermosetting resin selected from the group consisting of phenol formaldehyde resins and urea formaldehyde resins.

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