Oct. 22, 1929. P. D. CANNON 1,732,593

PRODUCTION OF COMPOSITE YARNS AND YARN OF SAID CHARACTER

Filed June 22, 1928

Fig. 1

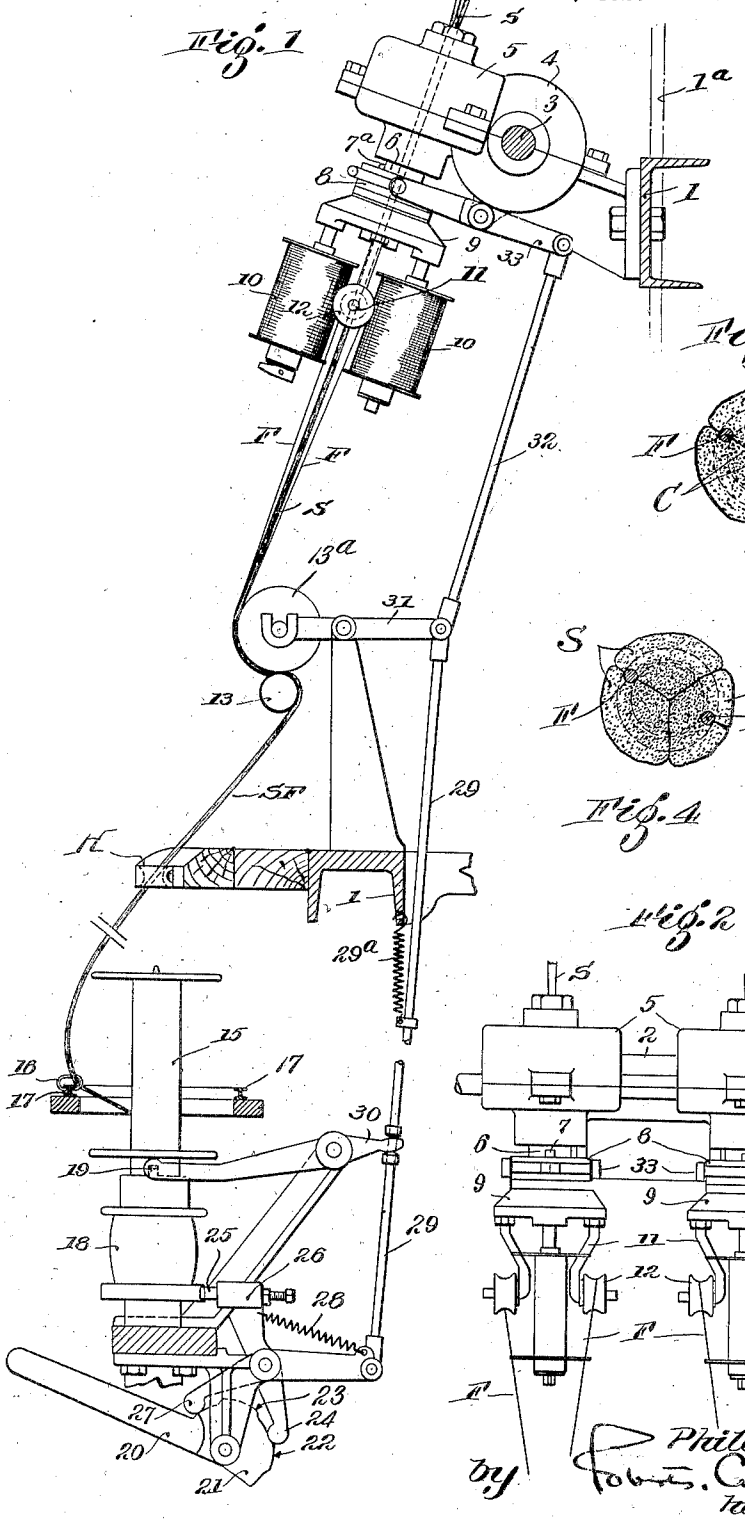


Fig. 3

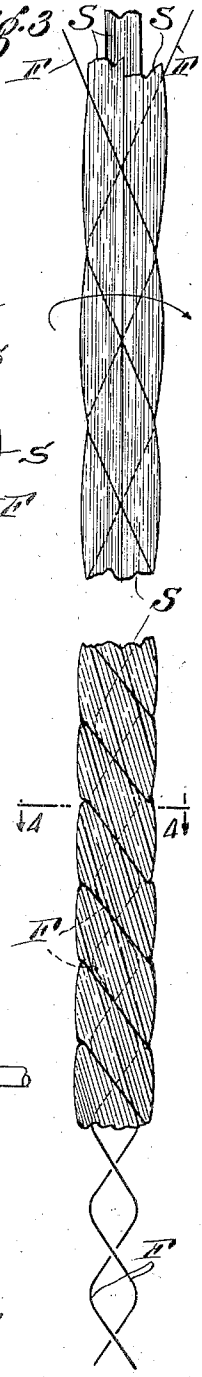


Fig. 5

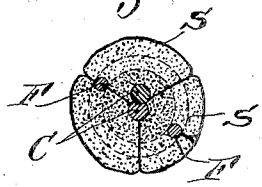


Fig. 4

Fig. 2

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UNITED STATES PATENT OFFICE

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PRODUCTION OF COMPOSITE YARNS AND YARN OF SAID CHARACTER

Application filed June 22, 1928. Serial No. 287,464.

This invention relates to the production of yarn or strands of composite structure comprising textile fibers, and has for a characteristic if not principal object the construction of a strong yarn or strand composed chiefly of fibers which, by reason of their short length, their relative stiffness, or their inferior coefficient of surface friction, or for other reasons, are ill adapted to the formation of a strand, yarn or the like by the usual processes of spinning. In particular, the invention is addressed to the problem of yarn construction in which short asbestos fibers form the chief staple, these being not only short, but less supple, and less tenacious of frictional engagement with each other than other textile fibers.

As is well known, a mixture with asbestos fibers of other textile fibers such as cotton is advisable and in many instances practically necessary, if asbestos yarn is to possess sufficient consistency, tensile strength, and suppleness to be amenable to weaving, braiding, or other textile operations.

And further, there are sundry uses for yarns in which asbestos is the chief staple, which demand even more tensile strength (especially during the fabrication of fabrics made of them) than mere addition of other textile fibers can impart, and for such uses the fibrous components are often reinforced by fine wires, usually brass or bronze, which are spun into the yarn along with the textile fibers. But, even with such reinforcing components as have been used, there has been a distinct limit of asbestos fiber length, below which it has been impracticable to attempt to spin a yarn containing a large enough proportion of asbestos to provide the heat and fire resistant properties in the degree required. Asbestos fiber of adequate length for spinning is relatively scarce and therefore expensive; hence the more or less recent endeavors to utilize short fiber asbestos in paper-strip form for the production of yarn or twine, reinforced if need be with filaments of stronger textile material, or with wires.

Asbestos fiber so short that it baffles any attempt to spin it, either with or without a permissible proportion of stronger fibers, as cotton, or with or without reinforcing filaments or wires, is nevertheless fully amenable to carding operations and will form carded fleeces, or rovings, or condensed slubbings (hereinafter referred to as rovings) having ample self-sustaining consistency to be handled as rovings, especially if reinforced with a permissible proportion of cotton fiber mixed with it, say about ten per cent on the weight of the asbestos fiber, and condensed. The predominant parallelism of the fibers in such a roving, which enables the asbestos fibers to lie in contact with each other and with the intermixed cotton fibers through practically their entire length, is responsible in large measure for the consistency and manipulability of the roving as a whole; whereas the attempt to spin such rovings in the usual manner will fail because the asbestos fibers refuse to maintain their contacts with each other, or with the cotton fibers, spring apart, and defeat the object of the spinning twist.

My invention herein described comprises a method of yarn or strand formation, and the product of that method. For elucidation of the method, a mechanism will be described, which is described and claimed in an application for United States Letters Patent, filed concurrently herewith and serially numbered 287,463, and is not herein claimed.

The cardinal features of my yarn-making method are as follows: A carded roving, composed of predominantly parallel fibers, has applied to it an external spiral wrapping of relatively strong filaments, such as threads or wires, the fibers of the roving maintaining their mutual longitudinal contacts, as established by their carded predominant parallelism, during the wrapping. Preferably, the carded roving will be first condensed as by rubbing-belts, or by trumpets, in a well known manner, which without sensibly altering the general parallelism of the fibers, increases the intimacy of their mutual contacts and bundles together a longitudinal section of the thin flat fleece into a substantially round roving. A single roving of sufficient substance per unit length to provide the desired body of

fibers for the yarn to be made may be employed, or several rovings may be assembled in parallel relation and wrapped together if a larger body be required. Preferably two or more wrapping filaments are used, forming a plural winding or wrapping which exerts a binding or compacting pressure on the roving fibers. Then the wrapped roving is subjected to a spinning twist, for example on any appropriate kind of spinning frame, such as a ring-spinner, and spun so as to give the roving fibers a twist, preferably in the same rotative direction or aspect as the helix or helices of the wrapping filaments, and thus also to tighten the wrapping filaments beyond the tightness of their primary lay by increasing their number of turns or spins per unit length in the strand. The wrapping helix already having a twisted relation to the roving as a consequence of wrapping, the resulting yarn shows a wrapping filament twisted to a greater degree than the twist in the wrapped roving. Since, however, the purpose of these steps is to provide a yarn in which tensile elongation of a fibrous element is resisted by causing the component fibers of the fibrous element to be bound and held as a consequence of its elongation under tensile stress in increasingly effective frictional contact, by forces acting transversely of its length, any relation of binder to roving which will result on pulling on the roving in tightening a cincture about it of a binder is contemplated by this invention. The binder may therefore be laid upon the roving, in relation to subsequent spinning twist, in any way, so long as the subsequent spinning twist leaves the binder in spiral relation to the fibrous element, without depriving the combination of its effect to increase the tensile strength of the yarn as a consequence of lengthwise strain by an increasingly tight binding of the bundle of fibers of which it consists. Although the operation of spinning is usually understood to involve drawing as well as twisting, and although the twisting of the wrapped roving strand herein described may involve very slight drawing, or perhaps none at all, nevertheless, since the twisting of the said wrapped or fasciated strand is shown as, and will usually be done by, a ring-spinning apparatus, and would naturally be called spinning, we apply that term herein to the operation shown as performed by a ring spinning apparatus, whether drawing be an accompaniment of twisting or not.

By performing the two steps of wrapping and spinning in succession, the textile fibers are fasciated by the wrapping filament or filaments, and held in their original relation with each other and with closer intimacy than at first, so that even though these fibers be so short, smooth, or otherwise ill adapted for spinning that spinning under the ordinary conditions would be impracticable, being held bound as in an elongated fagot by the tightening wrappings, they are compelled to respond to the spinning operation without loosening or separation, as well as if they were inherently capable of assuming on spinning twisting an increased mutual interlocking engagement, which they are not alone capable of doing. Instead of directly furnishing practically all of the tensile resistance of the composite yarn, the binder or wrapping is thus induced to cause the wrapped bundle of fibers to be more effective to resist tensile stresses, because better held together in frictional contact.

The wrappings of filamentous material are preferably so laid upon the parallel strands of roving that the lineal distance from turn to turn along the wrapped strand shall be not substantially greater than the length of the longer fibers in the strand itself, and, preferably, this distance is of the same dimensional order as or less than the average or mean fiber length, with a further possible preference for a shorter spacing.

The tendency of the wrapper filaments is to sink into the fiber-aggregate a little during the wrapping, and, by the preferred steps, still more during the spinning, when the filament helix is tightened on the fibrous core. The inner core of fibrous material is thus tightly bound, while the ends of outer fibers are tied in and restrained from standing radially out from the spun yarn to form a fuzz. But whatever the relation of wrapping to spinning, by performing the spinning twist (inevitably accompanied by a longitudinal stress on the rovings) on a fasciated bundle, instead of twisting together severally parallel roving and binding elements, the well known tendency of the firmer and less extensible binders of a series led together to a spinning device to twist about each other to form a central core of a spun yarn merely covered by the roving element, is excluded. Everywhere the binding elements hold between them substantially all of the intervening substance of the roving element, although the binding is buried by the extrusion of parts of the fibrous roving. This relation prevents slippage or "skinning" of the roving element in respect to the hard cordage or wire element, a grave defect when the yarn is to be woven.

The fasciation of the roving-fibers should be accomplished while their predominant parallelism with the length of the roving and their close mutual longitudinal contacts persist. Preferably, therefore, the roving should not be subjected to any twist, as by spinning, or substantial longitudinal stress, until the fasciation of fibers by the wrapping filaments is complete and secure. This condition will be substantially, though not literally, observed, if a slight initial twist be given to the roving at the point where the wrapping fila-

ments are engaged with it; though in all cases the roving should not be given sufficient twist to displace seriously the fibers, one from another.

While the advantages of the method which forms one aspect of this invention will be more pronounced when fibers inherently ill-adapted to spinning are employed, they will nevertheless be secured in sensible degree when longer or inherently spinnable fibers compose the roving, as for instance long-fiber asbestos.

The efficacy of the method above briefly outlined has been demonstrated, for one instance, by forming asbestos yarn, using asbestos fibers heretofore incapable of being spun satisfactorily (and therefore of the kind heretofore utilized in large part for making asbestos paper) together with about ten per cent of short staple cotton, employing fine brass wire as the wrapping material, laid in a double spiral of which each single pitch is from three to four turns to the inch, making the lineal spacing from turn to turn about one-sixth to one-eighth inch, and thereafter spinning from two to three or more turns to the inch into the fasciated fiber core, correspondingly tightening the twist of the wrapping filaments. Composite yarn thus constructed has by test demonstrated that, weight for weight, it is about twenty-five per cent stronger to resist breakage than previously used standard composite yarn of substantially the same size, made of strands of long fiber asbestos with ten or twelve per centum of cotton fiber, spun with two reinforcing wires of the same material and fineness as wrapping wires used in constructing the new yarn. This wrapped and spun roving yarn weaves well both as warp and filling, braids evenly and satisfactorily, and is in all respects equal, and in important qualities superior to, the long fiber yarn heretofore employed, and made by first spinning the asbestos fiber into component yarns and then spinning several such components with reinforcing filaments such as fine wires. The asbestos component of the standard yarns can be skinned on their wire core, whereas yarns made in the new way can not be skinned in respect to their binding element.

In the drawings hereto annexed, which illustrate wrapping and spinning devices as one instance of apparatus for the performance of the method and manufacture of the product herein claimed.

Fig. 1 is a vertical section of a spinning machine showing in side elevation one wrapping head and spinning devices;

Fig. 2, shows, in front elevation, two adjacent wrapping heads;

Fig. 3 is an elevation, partly broken away, showing a yarn in different stages of formation;

Fig. 4 is a section on line 4—4 of Fig. 3; and

Fig. 5 is a section similar to Fig. 4 of a modified product.

Referring to Figs. 1 and 2, the spinning frame shown may have any usual supporting members 1, having an upward extension at 1ª on studs, spindles or cradles on which are mounted for unwinding the cops or cheeses of carded and condensed, but usually untwisted roving which constitutes the material on which the combined wrapping and spinning mechanism operates. The wrapping mechanism shown in Fig. 1 and also in Fig. 2 comprises a frame or bracket on which are mounted the driving gear housings 4 and 5; a bearing for the drive shaft 3 being provided in the housing 4. The hollow wrapping-head shaft at 6 is provided with a spline 7 which turns the driving member of a clutch 8, at the same time allowing for movement of member 8 along the shaft 6 to engage or disengage member 8 with a rotary wrapping head 9 loosely mounted on the shaft 6 to rotate with it when the clutch 8 is brought into driving engagement, in which position it is shown in Fig. 1. The wrapping head 9 carries spools 10, usually two spools, on which are wound the supplies of the wrapping filament, which may be a strong cordage or thread or fine wire. Studs 11 carry porcelain rolls 12 over which the filaments are led, these filaments being shown at F, F.

The winding head drive mechanism including the shaft 6 is centrally bored so that a strand or strands of roving S taken from the cops or cheeses (not shown) may pass centrally and axially of the wrapping mechanism to be conducted to the draw-off rolls 13, 13ª. If for any reason desirable, a textile cordage or wire core C, comprising a single or multiple strand may, see Fig. 5, be fed to accompany the rovings F.

From the lower roll 13 the compound strand SF composed of the rovings S and the wrapping filaments F is led in the usual manner to the pot eye H and to the traveler 16 on the spinning ring 17, which is arranged in the usual relation with the spindle spool or quill 15 on a ring rail having the usual winding builder or vertical traverse motions. The traveler 16 has sufficient weight and resistance on its ring 17 to provide at least a bobbin-winding degree of tension on the spinning run of the yarn. The spindle bobbin or spool has a releasable drive connection with the whorl 18, at 19. The spindle 15 and drive shaft of the wrapping mechanism are driven simultaneously and with a fixed ratio of rotative speeds; for example, 90 to 100 rotations of wrapping to 1500 R. P. M. of the spindle.

The operation of the typical mechanism described, which may be any suitable mechanism, is as follows: The strand S composed of one or more condensed rovings (and a core

or cores C, if desired) passing axially through the wrapping mechanism to the guide roll 13 usually under insufficient tension for drawing or elongation is there engaged, as shown, at the point where the rovings are supported on top roll 13ª by the wrapping filaments F, F, which are wrapped in open double helix upon the roving, fasciating the fibers thereof as the roving is drawn by the spinning mechanism between the rolls 13, 13ª and through the pot eye H. The spindle motion spins the twist into the fasciated fibers of the roving in the same rotative direction as that in which the wrapping filaments are wound on the roving so that as it is twisted by spinning the wrapping filaments are tightened on the roving, holding the fibers thereof securely in their mutual longitudinal engagement. The spinning twist will be thrown into the roving as far back as the roll 13, but no farther, so that at the point where the wrapping filaments F, F are helically wound upon the roving, the latter (and its core C, if any, Fig. 5) is in the same condition as the fiber is when drawn from the supply. It will be found feasible, though not desirable, when the bobbin-winding drag on the spinning yarn is sufficiently positive to draw off the wrapped roving, to substitute a pot eye like that at H for the rolls 13, 13ª, placing it at such a distance from the wrapping head as to determine properly the point of wrapping engagement of filaments F, F with this roving S. With such an arrangement the spinning twist will be thrown back to some extent to the point where the wrapping filaments engage the roving, but will not be sufficiently pronounced to disarrange seriously the mutual contact relation of the roving fibers, so that the latter will be secured in their proper contact relation by the wrapping filaments, and the positive limitation of advance or pay off by operated rolls is preferred. If, however, the fibers of the roving S, or a large proportion of them, are of very short length, and therefore lacking in suppleness, effective and positive means, such as engaging rolls 13, 13ª for preventing the spinning twist from affecting the roving until after its fibers have been fasciated, and for regularly and evenly drawing off and feeding forward the roving, will be found practically necessary. Such means, moreover, I believe to be highly desirable if the full advantage of my invention is to be secured, particularly in respect to regularization of the number of twists of the finished yarn per unit length, which is a function of the linear rate of pay-off and the revolutions of the traveler 16, as distinguished from those of the spindle.

Reverting again to the drawings, the means for temporarily throwing out and rendering inoperative the above described wrapping and spinning mechanism are indicated as a train of mechanism operated by the throw-out handle 20 to which is attached a cam disk 21 provided with projecting cam surfaces 22, 23. Whenever occasion arises for stopping the train of mechanism, depression of the throw-out handle 20 will first, by engagement of the cam surface 22 with the lever 24, apply the brake 25, through a resilient connection 26, to the spindle whorl 18, checking the latter. Further movement of the handle 20 brings the cam projection 23 to bear upon the lever 27 which, through the tension rod 29 articulated therewith, rocks the lever 30 to lift the spool 15 out of engagement with the clutch face of the whorl at 19, and when this has been accomplished the cam projection 22 passing from under the lever 24 allows the spring 28 to release the brake shoe 25. By means of the rod 29 the rocking lever 31 is oscillated to lift the top roll 13ª off the driven roll 13 and at the same time the extension rod 32 (Fig. 1) rocks a clutch lever 33, lifting the clutch 8 and releasing the wrapping head 9 from the rotative drive of the shaft 6. The movement of the rod 29 above described elongates the tension spring 29ª (Fig. 2) which, when the wrapping and spinning mechanism is to resume operation, restores, through the rods 29, 32, the clutch 8, the roll 12 and the spool 15, to their normal operating condition. During this movement of restoration which takes place when the throw-out handle 20 is raised by the operator, the spindle brake 25 is momentarily applied, slowing the whorl 18 so as to facilitate reengagement of the spool step with the driving key at 19.

It will be understood that, in a roving made from a bundle of carded fleece the fibers are to some extent crossed with each other, though their lay is predominantly parallel with the length of the roving. The condensation of each strip of such roving, by a trumpet or condenser rolls or belts assembles the component fibers in closer frictional and longitudinal mutual engagement with each other, while hardly if at all altering their predominant parallelism with the length of the roving. The condensation imparts desirable consistency to the roving for purposes of subsequent handling. Since the carded fleece varies slightly in density from place to place, so that there is a limit to the uniformity of the sliver or roving into which a strip of it can be condensed, it will usually be found desirable to assemble two or more such condensed rovings to average their deviations from uniformity of density and pass them together through the wrapping head, wherein the fasciation of the several rovings into a single yarn core will form them into substantially a cylindrical strand (Fig. 4). If relatively fine yarns are to be produced, a single condensed roving may be treated in the same manner as the as-

sembled rovings in the instance above described. For metal wire filaments there may be substituted cotton, linen, or other textile threads, in cases where the physical qualities of metal are not necessary or desirable. Since the above illustrated and described fasciation of fibers, in themselves ill-adapted to sustain a spinning operation, is a step preparatory to spinning in that it enforces retention of mutual longitudinal contacts between the fasciated fibers, any fibers which are susceptible of forming a condensible carded fleece and of sustaining the stresses of mere translation to and through a wrapping head may, by the method above described, be assembled into a spun yarn which possesses the tensile strength due to conservation of the frictional contacts between adjacent fibers and to the increased intimacy of such contacts produced by the initial fasciation and the subsequent tightening of the helically wrapped filament or filaments upon the fiber core. Within limits, however, any lay of the fasciating elements F inducing the fasciating element to bind and hold an included fibrous element more strongly as a consequence of endwise stress on, or elongation of, the composite strand during or after making will serve to secure some at least of the advantages of this invention, by causing a pull on the composite strand to result in binding it together more tightly, and thus permitting an inherently weak bundle of fibers to be so held as materially, if not predominantly, to contribute to a high resistance to breakage under tensile stress. For this reason the preferred relation of binder helix to roving twist may be departed from, so long as the ultimate result is to secure a binding which will react on the roving bundle on elongation of the roving bundle to tighten the bundle and cause it to resist further elongation.

When the composite yarn is called upon to resist stresses greater than the improved resistance given by the described wrapped fibrous elements, wire or cordage core elements C, Fig. 5, may be included in it, these twisting together in the center, as in ordinary asbestos yarns, as a consequence of spinning.

I claim:

1. Method of yarn manufacture comprising as steps: fasciating roving composed of fibers with helically wrapped filament and spinning a twist in said wrapped roving in the same rotative direction as that of the helical wrapping.

2. Method of manufacturing yarn of fibers inherently ill-adapted to ordinary spinning operations, comprising as steps: placing about a roving comprising such fibers a helically wrapped filament, and spinning a twist in said roving and its wrapping in the same rotative direction as that of the helical wrapping.

3. Method of manufacturing yarn from short asbestos fibers inherently ill-adapted to ordinary spinning operations, comprising as steps: laying about a running roving comprising such fibers a helically wrapped filament, and spinning a twist in said wrapped roving in the same rotative direction as that of the helical wrapping.

4. Method of manufacturing yarn from short fibers inherently ill-adapted to ordinary spinning operations, comprising as steps: laying about a running roving comprising such fibers a helically wrapped filament, and spinning a twist in said wrapped roving whereby stresses tending to elongate the wrapped roving tighten the wrapping and increase the resistance of the spun roving to further elongation.

5. Method of yarn manufacture comprising as steps: fasciating roving composed of fibers with filament helically wrapped thereon, the successive turns of filament spaced apart by a distance not substantially greater than the length of the longer fibers of said roving, and spinning a twist in said wrapped roving in the same rotative direction as that of the helical wrapping.

6. Method of manufacturing yarn of fibers inherently ill-adapted to ordinary spinning operations, comprising as steps: fasciating a roving comprising such fibers with filament, helically wrapped thereon under relatively light tension, the successive turns of filament spaced apart by a distance not substantially greater than the length of the longer fibers of said roving, and increasing the radial tension of the wrapping by spinning a twist in said wrapped roving in the same rotative direction as that of the helical wrapping.

7. Method of manufacturing yarn from short asbestos fibers inherently ill-adapted to ordinary spinning operations, comprising as steps: fasciating a roving comprising such fibers with filament helically wrapped thereon, the successive turns of filament spaced apart by a distance not substantially greater than the mean length of the fibers of said roving, twisting the wrapped roving and concurrently subjecting the yarn to longitudinal tension tending to tighten the wrapping on the fibrous roving.

8. Method of yarn manufacture comprising as steps: fasciating roving composed of fibers with a plurality of helically wrapped filaments and spinning a twist in said wrapped roving in the same rotative direction as that of the helical wrapping.

9. Method of manufacturing yarn from short asbestos fibers inherently ill-adapted to ordinary spinning operations, comprising as steps: fasciating a roving comprising such fibers with a plurality of helically wrapped filaments, and spinning a twist in said wrapped roving in the same rotative direction as that of the helical wrapping.

10. Method of yarn manufacture comprising as steps: fasciating roving composed of fibers with a plurality of filaments helically wrapped thereon, the successive turns of filament spaced apart by a distance not substantially greater than the length of the longer fibers of said roving, and spinning a twist in said wrapped roving in the same rotative direction as that of the helical wrapping.

11. Method of manufacturing yarn of fibers inherently ill-adapted to ordinary spinning operations, comprising as steps: fasciating a roving comprising such fibers with a plurality of filaments helically wrapped thereon, the successive turns of filament spaced apart by a distance not substantially greater than the length of the longer fibers of said roving and spinning a twist in said wrapped roving in the same rotative direction as that of the helical wrapping.

12. Method of manufacturing yarn from short asbestos fibers inherently ill-adapted to ordinary spinning operations, comprising as steps: fasciating a roving comprising such fibers with a plurality of filaments helically wrapped thereon, the successive turns of filament spaced apart by a distance not substantially greater than the length of the longer fibers of said roving, and tightening the wrapping on the roving by spinning a twist in said wrapped roving in the same rotative direction as that of the helical wrapping.

13. Yarn, comprising a core of fiber roving, filament wrapped in open helix upon said core and fasciating the fibers thereof, the core and filament twisted in the same rotative direction.

14. Yarn, comprising a core of twisted roving compressively held by a wrapping helically surrounding and partly enclosing the core.

15. Yarn, comprising a core of roving composed in large part of fibers inherently ill-adapted to ordinary spinning operations, filament wrapped in open helix upon said core and fasciating the fibers thereof, the core and filament twisted in the same rotative direction.

16. Yarn, comprising a core of twisted roving composed in large part of fibers inherently ill-adapted to ordinary spinning operations, filament wrapped in open helix upon said core and fasciating the fibers thereof, the filament being thereby adapted to tighten on the fibrous core on elongating stress on the yarn.

17. Yarn, comprising a core of twisted roving compressively held by a wrapping helically surrounding and partly enclosing the core, the pitch of the spiral wrapping having more turns per inch than the pitch of the twisted core.

18. Yarn, comprising a core of twisted fibrous roving and a twisted wire compressively held by a wrapping helically surrounding and partly enclosing the core, the pitch of the spiral wrapping having more turns per inch than the pitch of the twisted core.

19. Yarn, comprising a core roving in large part composed of asbestos fibers inherently ill-adapted to ordinary spinning operations, filament helically wrapped about said core and fasciating the fibers thereof, the core and filament being twisted in the same rotative direction to different extents.

20. Yarn, comprising a core of twisted roving compressively held by a wrapping helically surrounding and partly enclosing the core, and buried by tension beneath the ultimate cylindroid surface by extruded parts of the roving core.

21. Yarn, comprising a core of fiber roving filament wrapped in open helix upon said core and fasciating the fibers thereof, the successive turns of said filament spaced apart by a distance not substantially greater than the mean length of the fibers of said core, the core and filament twisted in the same rotative direction.

22. Yarn, comprising a core roving composed in large part of fibers inherently ill-adapted to ordinary spinning operations, filament wrapped in open helix upon said core and fasciating the fibers thereof, the successive turns of said filament spaced apart by a distance not substantially greater than the length of the longer fibers of said core, the core and filament twisted in the same rotative direction.

23. Yarn, comprising a core roving composed in large part of asbestos fibers inherently ill-adapted to ordinary spinning operations, filament wrapped in open helix upon said core and fasciating the fibers thereof, the successive turns of said filament spaced apart by a distance not substantially greater than the length of the longer fibers of said core, the core and filament twisted in the same rotative direction.

24. Yarn, comprising a core of fiber roving, a plurality of filaments wrapped in open helix upon said core and fasciating the fibers thereof, the core and filament twisted in the same rotative direction.

25. Yarn, comprising a core roving composed in large part of fibers inherently ill-adapted to ordinary spinning operations, a plurality of filaments wrapped in spaced open helices upon said core and fasciating the fibers thereof, the core and filament twisted in the same rotative direction.

26. Yarn, comprising a core roving in large part composed of asbestos fibers inherently ill-adapted to ordinary spinning

operations, a plurality of filaments wrapped in open helices upon said core and fasciating the fibers thereof, the core and filament twisted in the same rotative direction.

27. Yarn, comprising a core of fiber roving, a plurality of filaments wrapped in open helices upon said core and fasciating the fibers thereof, the successive turns of said filament wrapping spaced apart by a distance substantially less than the distance between successive turns of a longitudinal element of said core, the core and filament being twisted in the same rotative direction.

28. Spun yarn composed of a roving element relatively weak in resistance to tensile stresses and wrapping element, the wrapping element tensely surrounding at least a substantial part of the roving element and adapted to react to compress that part of the roving in response to tensile stress longitudinally of the yarn, whereby the component fibers of the roving are held in compressive contact to contribute a greater part to resistance to tensile elongation than the normal resistance of the roving to tensile elongation.

29. Yarn, comprising a core roving composed in large part of asbestos fibers inherently ill-adapted to ordinary spinning operations, a plurality of filaments wrapped in open helices upon said core and fasciating the fibers thereof, the successive turns of said filament wrapping being spaced apart and having been tightened upon the core as the result of twisting the core and filament in the same rotative direction.

30. Yarn composed of a roving element of carded asbestos and a modicum of a longer fiber and relatively weak in resistance to tensile stresses, and a wrapping element, the wrapping element tensely surrounding a moiety of the roving element and adapted to react to compress the roving in response to tensile stress longitudinally of the yarn, whereby the component fibers of the roving are held by the tight wrapping in compressive contact to contribute a major part to resistance to tensile elongation.

Signed by me at Manville, N. J., this 18th day of June, 1928.

PHILLIP D. CANNON.