Sept. 30, 1958 L. M. KEELER ET AL 2,853,847

METHOD OF AND APPARATUS FOR INTERTWINING FIBERS TO FORM ROVING OR YARN

Filed May 8, 1957 4 Sheets-Sheet 1

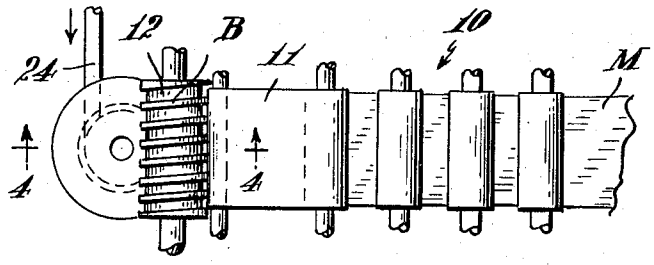

Fig. 2

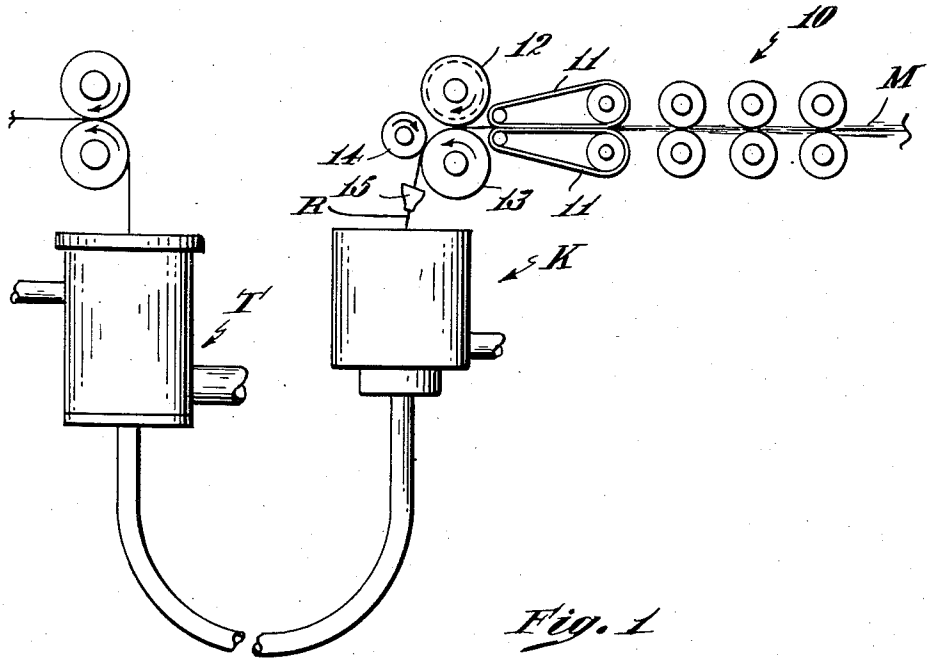

Fig. 1

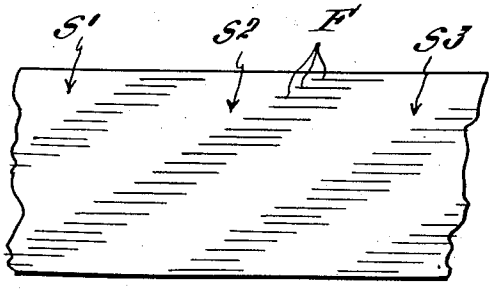

Fig. 3

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Filed May 8, 1957 4 Sheets-Sheet 2

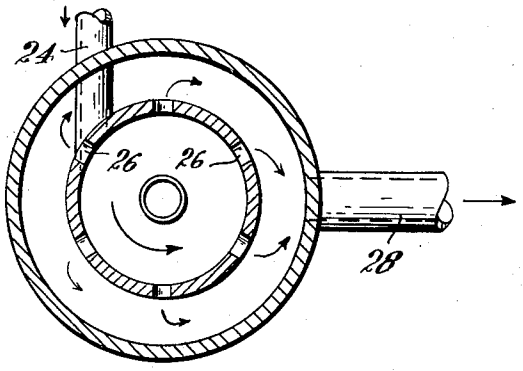

Fig. 5

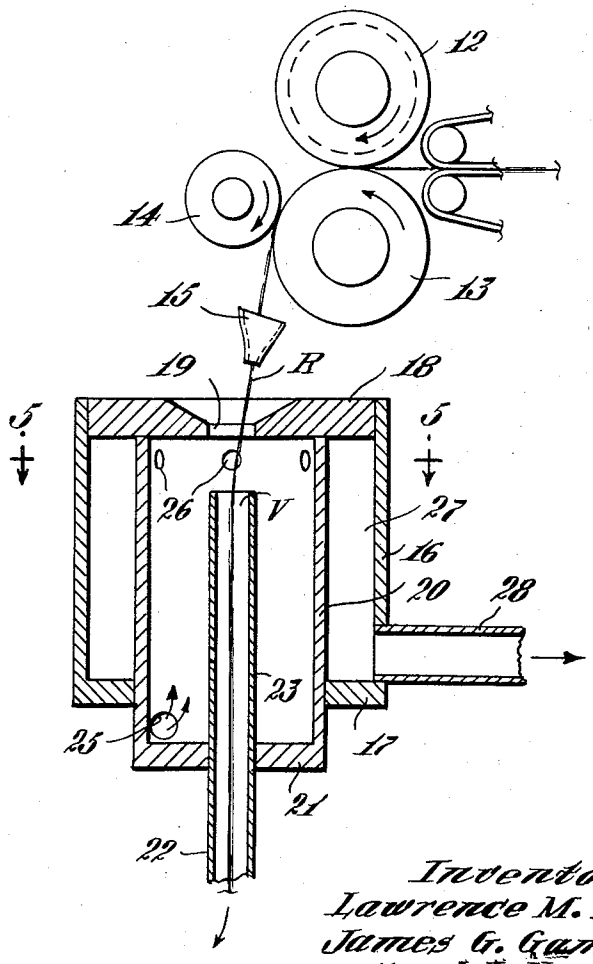

Fig. 4

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Filed May 8, 1957

4 Sheets-Sheet 3

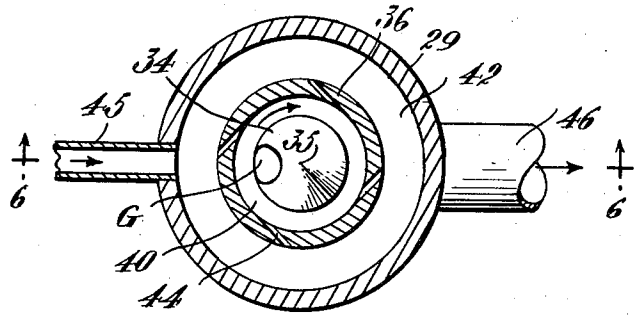

Fig. 7

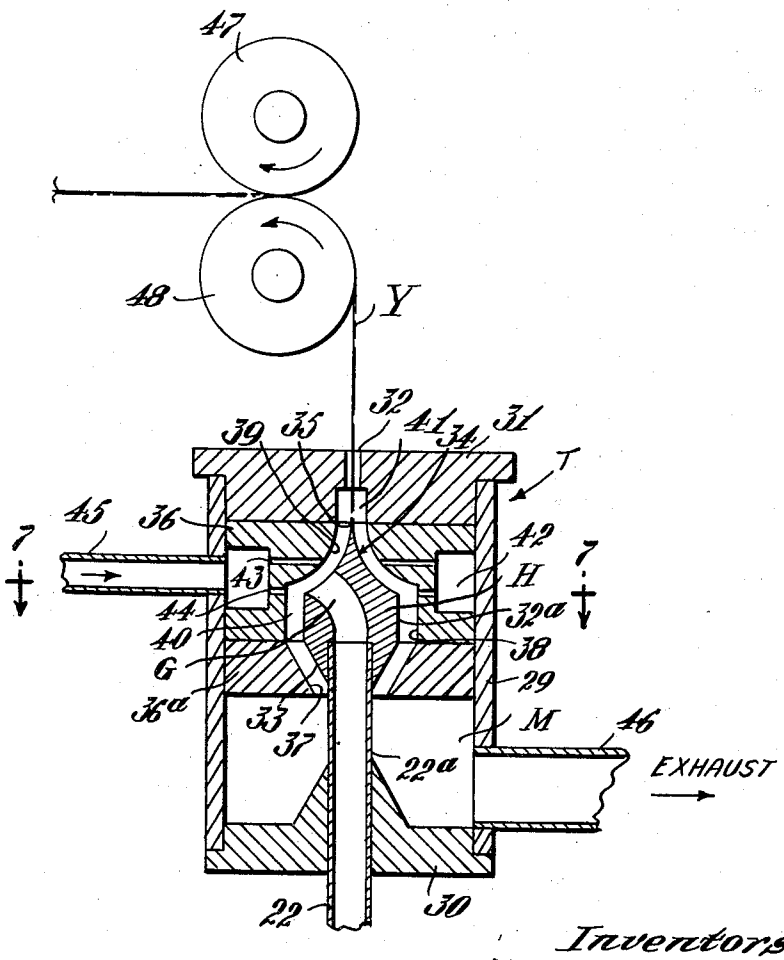

Fig. 6

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METHOD OF AND APPARATUS FOR INTERTWINING FIBERS TO FORM ROVING OR YARN

Filed May 8, 1957 4 Sheets-Sheet 4

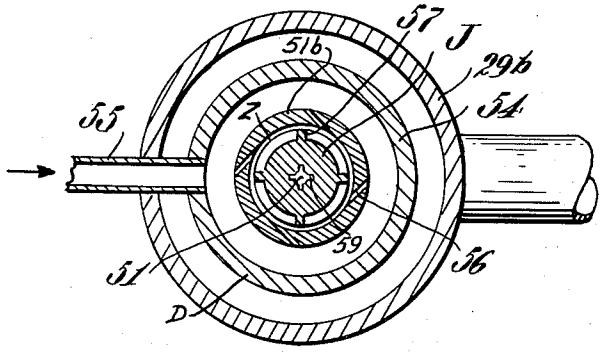

Fig. 9

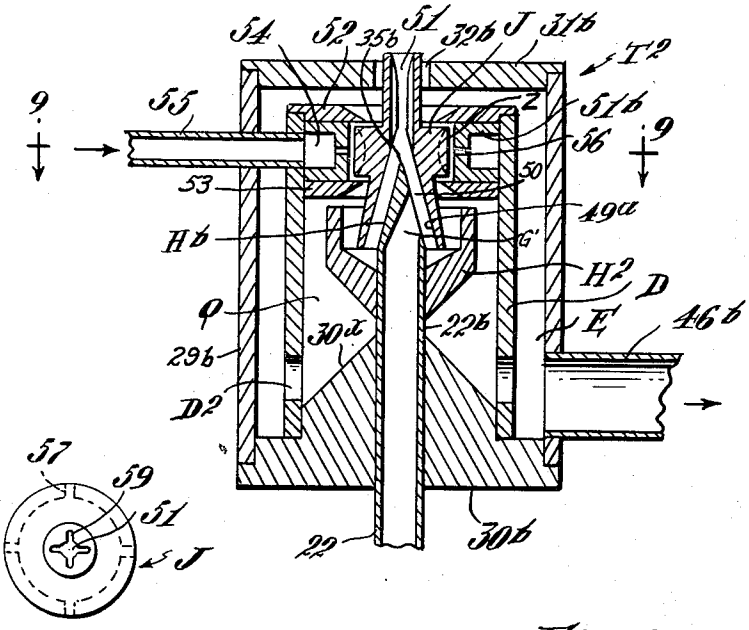

Fig. 8

Fig. 11

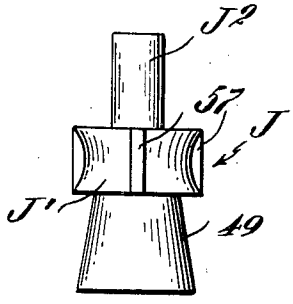

Fig. 10

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United States Patent Office 2,853,847
Patented Sept. 30, 1958

2,853,847

METHOD OF AND APPARATUS FOR INTERTWINING FIBERS TO FORM ROVING OR YARN

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Application May 8, 1957, Serial No. 657,961

30 Claims. (Cl. 57—51)

This invention pertains to textile manufacture and, more especially, to a novel method of and apparatus for use in assembling and intertwining fiber of textile length to provide roving or spun yarn.

It has heretofore been proposed to spin fibers by hydraulic action by first suspending the fibers, as discrete particles, in a stream of water and then concatenating the fibers to form a spun strand by imparting a swirling motion in the water. In accordance with the aforesaid method, the fibers are first assembled to form a strand while suspended in the liquid; but, for certain purposes and in dealing with some types of fiber, it has been found advantageous to subject the fibers to a more or less conventional mechanical carding and drafting before imparting twist by hydraulic means.

The present invention has for a principal object the provision of a novel method of and apparatus for use in the practice of said method wherein the fibers are first assembled to form a substantially continuous but untwisted strand which is then delivered into the field of action of a rapidly rotating body of liquid whereby twisting is imparted to the fibers comprising the strand. A further object is to provide mechanical means operative to impart a positive twist to the strand.

A further object is to provide a novel method of and apparatus for use in drafting the strand and imparting false twist to the strand as the latter is advanced toward the twisting zone.

A further object is to provide a novel method of and means for disposing the fibers in overlapping relation thereby to provide better coherence in the untwisted strand than is the result of conventional drafting methods.

A further object is to provide a novel method in which the untwisted strand, as it enters the zone where false twist is imparted, is substantially equal in weight to the final yarn count.

Other and further objects and advantages of the invention will be pointed out in the following and more detailed description and by reference to the accompanying drawings.

Fig. 1 is a diagrammatic elevation illustrating apparatus embodying the present invention;

Fig. 2 is a fragmentary plan view of the right-hand portion only of the apparatus of Fig. 1, showing the drafting means;

Fig. 3 is a diagrammatic view illustrating the arrangement of the fibers resulting from the action of the drafting means shown in Figs. 1 and 2;

Fig. 4 is a fragmentary vertical section, showing the interior of the false twist-applying device, to larger scale than Fig. 1, and on the line 4—4 of Fig. 2;

Fig. 5 is a fragmentary horizontal section on the line 5—5 of Fig. 4;

Fig. 6 is a fragmentary vertical section on the line 6—6 of Fig. 7, to larger scale than Fig. 1, showing the interior of the twisting device;

Fig. 7 is a fragmentary horizontal section on the line 7—7 of Fig. 6;

Fig. 8 is a view generally similar to Fig. 6, but illustrating a modification;

Fig. 9 is a fragmentary horizontal section on the line 9—9 of Fig. 8;

Fig. 10 is a side elevation to larger scale than Fig. 8, showing a rotor embodied in the structure of Fig. 8; and,

Fig. 11 is a plan view of the rotor of Fig. 10.

Referring to the drawings, the numeral 10 designates a set of drafting rolls such as are customarily employed in the preparation of fibers for spinning, these rolls being shown as receiving the fibrous material M in the form of a sliver (for instance a 70 grain sliver) and delivering it to the aprons 11 which, in turn, deliver the fibrous material to the nip of a pair of high-draft rolls 12 and 13, turning in opposite directions, the aprons and high-draft rolls being of a generally customary type and functioning in generally customary manner except that, whereas the bottom roll 13 is of the usual smooth cylindrical shape, the upper roll 12 has a peripheral, helical rib B which presses the fibrous material against the cylindrical surface of the roll 13. Cooperating with the rolls 12 and 13, there is a customary doffer roll 14 which strips the fibrous material from the surface of the roll 13 and guides it downwardly toward any suitable condensing means, such for example as the trumpet guide 15.

The action of the ribbed top roll 12, as contrasted with that of the customary cylindrical top roll, is indicated diagrammatically in Fig. 3. In this view, the fibers F are shown as arranged in diagonally extending, overlapping series S′, S^2 and S^3, etc., in each of which the individual fibers, although approximately parallel, are arranged in echelon. The result of this action is to condense the fibers and cause them to cohere more firmly than results from the customary drafting action wherein the fibers are delivered in the form of a fine, thin and delicate web. The untwisted fibrous strand which emerges from the lower end of the trumpet guide 15 is of a weight equivalent to that of the final yarn count.

The device K (hereinafter referred to as a false-twist inserter) delivers the strand from guide 15 into a stream of liquid whereby the strand is advanced at the proper rate toward the twisting apparatus T. The false-twist inserter K (Figs. 4 and 5) comprises an outer, hollow shell 16 having the bottom wall 17 and the top wall 18, the latter being provided with the central aperture 19 through which the untwisted strand R progresses downwardly. Within the shell 16, there is arranged a cylindrical casing 20, having the bottom wall 21. The side wall of this casing extends up into contact with the member 18 which thus forms a cover or top wall for the casing 20. A conduit 22 extends up through a central opening in the bottom wall 21 of the casing 20. That portion of this conduit which is within the casing 20 is vertical as shown at 23 and constitutes a stand-pipe, open at its top. A pipe 24 (Figs. 2 and 5) receives liquid from a suitable source and delivers it through an opening 25 (Fig. 4) in the side wall of the casing 20 into the lower end of the casing at a point outside of the standpipe 23. The opening 25 is so arranged (Fig. 5) that the liquid entering from the pipe 24 is delivered in a tangential direction so that, as it rises within the casing 20, it follows a spiral course about the stand-pipe 23. The side wall of casing 20 is provided, at a level above the upper end of the stand-pipe but below the cover member 18, with one or more overflow openings 26 through which liquid may flow outwardly and into the chamber 27 between the shell 16 and the casing 20 and thence escape through a delivery pipe 28. By the provision of the overflow openings 26, a definite pressure head is maintained in the casing 20 above the upper end of the stand-pipe 23 so that liquid from the opening 25 will always enter the upper end of

the stand-pipe at a constant predetermined velocity. As this liquid enters the upper end of the stand-pipe **23**, it forms a vortex at the point V in accordance with well-known principles. Assuming that the untwisted strand R is being delivered downwardly through the opening **19** so that its lower part is caught within the vortex V, the rotation of the downwardly moving stream of liquid tends to impart twist to this strand, the twist extending upwardly toward the nip of the rolls **12** and **13** and downwardly into the conduit **22**. The twist so imparted to the strand is a false twist such as is customarily produced by the action of the twister head of a wool ring-spinning frame. This false twist consolidates the constituent fibers of the strand in a continuous and uniform manner, thus insuring continuity of the strand as it progresses onwardly through the conduit **22** toward the twisting apparatus T (Fig. 1). However, it should be noted that because of friction between the fluid flowing downwardly through the stand-pipe **23** and through the conduit **22**, the rotation of the fluid is gradually retarded until eventually its motion of rotation is reduced to zero. At this time, the strand of fibers, of course, also cease to rotate, the effect being to cancel out the false twist which was imparted to the strand during the earlier part of its progress through the stand-pipe **23**.

The conduit **22** leads to the twisting apparatus T, the latter (Figs. 6 and 7) comprising the outer casing **29** (here shown as cylindrical) having the bottom or floor **30** and the top or cover **31**, the latter having the central discharge port **32**. The conduit **22** enters the casing **29** through an opening in the floor **30**, the terminal part 22^a of this conduit being vertical. To the upper end of this portion 22^a of the conduit, there is secured means for preventing back-twist in the strand as the latter moves upwardly through the delivery portion 22^a of the conduit **22**. The back-twist preventer comprises the head H which is fixed to the upper end of the conduit and which is externally contoured to provide a cylindrical central portion 32^a, the downwardly tapering lower portion **33** and the upper portion **34** which is of a generally conical shape although having a concave, peripheral surface. This conical portion terminates at a point **35** which is coaxial with the discharge port **32** in the cover. The head H is provided with an internal passage G whose lower end registers with the upper end of the conduit 22^a and which diverges outwardly and upwardly so that its discharge end is within the conical surface **34** of the head.

A fixed horizontal septum comprising superposed parts **36** and 36^a is arranged within the casing **29** just below the cover **31**. The part 36^a has a downwardly tapering surface **37** parallel with the surface **33** of the head. The part **36** has the cylindrical surface **38** parallel with the surface 32^a of the head and an upwardly converging surface **39** parallel with the surface **34** of the head. These spaced opposed surfaces of the head and septum define an annular chamber **40** whose upper portion converges upwardly and merges with a cylindrical portion **41** above the point **35**, the part **41** being axially aligned with the discharge port **32**. The septum members **36** and 36^a are so shaped as to provide an annular plenum chamber **42** from which jet nozzles **43** and **44** lead inwardly to the annular chamber **40**, these jet nozzles being so arranged as to enter the chamber **40** in tangential relation. A pipe **45** supplies fluid under pressure, preferably a liquid, from a suitable source, such fluid being delivered by the jet nozzles **43** and **44** into the chamber **40** and thus creating a rotating body of liquid within the upper part of the chamber **40** within the zone into which the advancing end of the fibrous strand is delivered by the stream of liquid flowing upwardly through the part 22^a of the conduit. The lower part of the annular chamber **40** opens into a chamber M in the lower part of the casing **29**, and from this chamber, a pipe **46** leads away the liquid which collects in the chamber to a suitable point of discharge.

Above the casing **29**, drawing-off rolls **47** and **48** are arranged in such a position that the twisted strand Y, as it is drawn off by these rolls, moves vertically up through the discharge port **32** without contacting the walls of the discharge port.

In Figs. 8 and 9, there is illustrated a modified form T^2 of the twisting apparatus. This modified arrangement comprises the casing 29^b having the bottom wall or floor 30^b and the top wall or cover 31^b, the latter having the central aperture 32^b. The delivery portion 22^b of the conduit **22** extends up leak-tight through an opening in the floor 30^b of the casing. A cylindrical shroud D, of lesser diameter than the casing 29^b is arranged within and coaxial with the casing 29^b, with its lower end fixed to the floor 30^b of the casing. Preferably the floor 30^b slopes downwardly and outwardly as shown at 30^x toward openings D^2 to conduct fluid from the space Q within the shroud to the space E between the shroud and casing and thence to discharge pipe 46^b. This delivery portion is vertical and, in this instance, terminates in a conical part H^b having its apex 35^b axially aligned with the opening 32^b. Within this conical portion H^b, there is a passage G' forming a continuation of the interior of the conduit 22^b and which extends to the periphery of the surface of the conical portion of the conduit. A cup-like receptacle H^2 is fixed to the vertical part 22^b of the conduit at a point just below the conical upper portion H^b of the conduit, and a rotor J is arranged above the member H^2. This rotor J (Fig. 10) comprises a central, cylindrical body portion J' and a downwardly flaring skirt **49** whose inner surfaces 49^a (Fig. 8) is substantially parallel with the peripheral surface of the conical upper portion H^b of the conduit 22^b and spaced therefrom so as to define the annular chamber **50**. This chamber extends upwardly above the tip or point 35^b of the conduit and merges with a cylindrical bore **51** in the upper cylindrical part J^2 of the rotor, such upper part being located within the opening 32^b in the cover 31^b. The body portion J' of the rotor J is arranged within a central, cylindrical chamber Z in a part 51^b fixed within the upper part of the shroud. The rotor is confined within this chamber Z by upper and lower guard members **52** and **53**, respectively, which are fixed to the shroud D. The upper guard **52** has a central aperture through which the upper part J^2 of the rotor passes freely. The rotor is of such dimensions that it is free to turn within the chamber Z in the part 51^b and, in normal operation, as will be pointed out hereafter, it does not contact any of the surrounding parts.

The part 51^b is provided with a circumferential channel **54** into which leads a supply pipe **55** designed to receive fluid, preferably liquid, under pressure from a suitable source and to deliver it into channel **54**. Jet nozzles **56** extend inwardly from channel **54** into the chamber Z, entering the latter tangentially. The body portion J' of the rotor J is provided with blades **57** which are impinged by the fluid delivered by the jet nozzles **56**, the blades being so shaped that the force of the fluid turns the rotor at high speed. Preferably, the upper part J^2 of the rotor is provided with radial grooves **59** extending outwardly from the central passage **51**, thus, to provide a positive contact with the strand as the latter is delivered upwardly through the passage **51**, it being understood that the strand will be drawn off from the passage **51** by means equivalent to the rolls **47** and **48** shown in Fig. 1.

In the operation of the device and referring first to Figs. 1 to 7, inclusively, liquid from the supply pipe **24** enters the chamber in the casing **20** and sets up an upward spiral flow therein, the supply pressure being so adjusted that a fraction of the water which enters the chamber in the casing **20** will always overflow through the openings **26**, thus maintaining a constant head above the upper end of the stand-pipe **23**. As above noted, the flow of liquid from the chamber in the casing **20**, downwardly into the upper end of the stand-pipe, creates a vortex at the point V and, assuming that the untwisted

strand R is being delivered at the proper rate downwardly from the drafting rolls **12** and **13**, the advancing end of the strand will be caught in the downwardly flowing stream of water in the stand-pipe **23**. On the assumption that the strand of material will be delivered at the same linear velocity as the downward flow of the fluid in the stand-pipe, the strand, in continuous form, will move down with the liquid stream and will be condensed by the false twist imparted during the earlier stages of its movement through the conduit **22**. After the rotation of the fluid in the conduit ceases, the strand of condensed fibers continues on with the stream of water and now, substantially devoid of twist, enters the passage G (Fig. 6) in the head H of the twisting apparatus. The eccentric arrangement of the delivery end of the passage G acts to prevent twist from moving backwardly down into the upper part **22a** of the conduit. The liquid within the conduit **22a** discharges from the upper end of the passage G into the annular chamber **40** and, with it, the advancing end of the strand of fibrous material enters the annular chamber 40. High-pressure liquid from the pipe **45**, entering the plenum chamber **42**, is discharged by the tangential jet nozzles **43** and **44** into the annular chamber **40**. Due to the high velocity and direction of flow of the liquid, an inverted vortex is created within the upper part of the annular chamber 40, conforming to the shape of the annular chamber above the central portion of the head H. The pressure within the rotating body of water thus created will be much greater at the outer periphery of the chamber **40** than nearer its center. The fibrous material discharged from the upper end of the passage G is caught by the inverted vortex and is caused to revolve around the tapering upper portion of the head H. If, at the start of the operation, a device, such for example as an ordinary pipe cleaner, be projected down through the passage **32**, the revolving fibers will cling to the pipe cleaner and, if the pipe cleaner be carefully withdrawn from the passage **32**, the fibers, in the form of a twisted strand, will be withdrawn through the port **32** and may be entered into the nip of the rolls **47** and **48**. Assuming that these rolls are driven at the proper peripheral speed, the continued operation of the apparatus will result in the delivery of a continuous twisted strand of fibers. The liquid which discharges through the upper end of the passage G and also that which forms the jets delivered by the nozzles **43** and **44** flows downwardly through the lower part of the annular chamber **40** and into the chamber M in the lower part of the casing and thence out through the delivery pipe **46**.

The arrangement of modified twister T^2 of Figs. 8 to 11, inclusive, is, in general, similar to that of Figs. 6 and 7, it being understood that the conduit **22** is supplied with liquid carrying the untwisted strand in the same way as in the arrangement of Fig. 6. The delivery of pressure fluid through the pipe **55** into the chamber **54** drives the rotor J at high speed, while the liquid emerging from the passage G' carries with it the advancing end of the untwisted strand so that the latter enters the annular chamber **50**. The fluid which is discharged from the jet nozzles **56** and that which is discharged from the passage G' surrounds the body portion of the rotor so that the rotor, in effect, floats in a body of water without contact with any fixed part so that there is no necessity to provide bearings for the rotor and the latter may rotate at exceedingly high speed without developing frictional difficulties. The fluid and fibrous strand delivered through the passage G' enter the chamber **50** and the rotation of the lower part of the rotor causes the fluid and fiber to rotate about the conical tip **35b** of the conduit. When, at the initiation of the operation, a pipe cleaner is inserted downwardly through the bore **51**, it picks up the rotating fibrous material in the chamber **50** and when drawn upwardly brings with it the twisted strand which may then be caught in the nip of the drawing-off rolls, and thus initiating the continuous formation of a twisted roving or spun yarn.

Desirably, in order to insure a uniform twist, the grooves **59**, above described, are provided in the wall of the passage **51**, the result being that the twisted material will be caught in one of these grooves so that the twist insertion becomes positive, with one turn of twist introduced into the material for each revolution of the rotor.

While certain desirable embodiments of the invention have herein been disclosed by way of example, it is to be understood that the invention is broadly inclusive of any modifications falling within the scope of the appended claims.

We claim:

1. That method of forming a twisted strand textile sliver which comprises as steps drafting the fibers constituting the sliver and delivering them as an untwisted but continuous strand into a vortex at the upper end of a downwardly flowing stream of liquid, conveying the strand by means of said stream to a twisting zone, delivering the advancing end of the strand axially into an annular chamber in which a body of liquid is rapidly rotating thereby imparting twist to the fibers comprised in the strand, and drawing the resultant twisted strand upwardly and axially from said chamber.

2. The method, according to claim 1, wherein the rotational velocity of the downwardly flowing stream of liquid is gradually reduced substantially to zero before the strand reaches the twisting zone.

3. The method, according to claim 1, wherein false twist is imparted to the strand by the rotating stream as the strand enters the latter and, as the strand is carried along by the stream, gradually reducing the rotational velocity of the stream substantially to zero before the strand reaches the twisting zone thereby cancelling out the false twist.

4. The method, according to claim 1, wherein, during drafting, motion, transversely of the general direction of travel of the sliver, is imparted to its constituent fibers thereby compacting the fibers and making them strongly coherent.

5. The method, according to claim 1, wherein, in drafting the sliver, its constituent fibers are disposed in overlapping series in each of which the fibers are arranged in echelon.

6. The method, according to claim 1, wherein, in drafting the sliver, a high draft is imparted by means of a pair of rolls, one of which has a spiral rib which presses the fibers against the periphery of the other roll and thereby tends to impart lateral motion to the fibers.

7. The method, according to claim 1, wherein, in drafting the sliver, its constituent fibers are subjected to the action of a drafting roll having an helical, peripheral rib cooperating with a smooth-faced, cylindrical roll whereby the constituent fibers, as they are drafted, are arranged in a series of overlapping series thereby providing an untwisted strand whose fibers are strongly coherent.

8. That method of forming a twisted strand of textile fibers which comprises as steps conveying an untwisted fibrous strand, by means of a stream of liquid, into a twisting zone, delivering the advancing end of the untwisted strand into an annular chamber having an axial outlet, discharging tangential jets of high-pressure fluid into said annular chamber thereby to impart twist to the fibers comprised in said strand, discharging the liquid from said chamber, and drawing the resultant swisted strand through the axial outlet.

9. The method, according to claim 8, which comprises preventing the formation of back-twist in the advancing strand as the latter enters the twisting zone.

10. The method, according to claim 8, which comprises creating an inverted vortex in a body of liquid at the twisting zone, and delivering the advancing end of the untwisted strand eccentrically into said vortex.

11. That method of forming a twisted strand of textile fibers which comprises as steps conveying an untwisted fibrous strand, by means of a stream of liquid, into a twisting zone, delivering the advancing end of the strand eccentrically together with the liquid which conveys it, into an upwardly tapered chamber, said chamber having an upwardly extending axial outlet, separating the liquid from the fiber, and drawing off the resultant twisted strand through said outlet.

12. Apparatus for use in forming a twisted strand from textile fiber comprising means for drafting fiber to form an untwisted strand in which the fibers are generally parallel, means for creating a downwardly flowing stream of liquid having a vortex in its upper end, means for guiding the advancing end of the untwisted strand into said vortex whereby false twist is imparted to said advancing end, and a conduit for conducting the stream, with the entrained strand, toward a twisting apparatus, the parts being so constructed and arranged as to reduce the rotational velocity of the stream substantially to zero as it approaches the twisting apparatus thereby cancelling out the false twist in the strand.

13. Apparatus, according to claim 12, wherein the twisting apparatus comprises a casing having therein an annular chamber provided with an axial outlet, means for guiding the stream with the advancing end of the strand into said chamber near one side of the latter, means for creating a rotating body of liquid in said chamber thereby to impart twist to the fibers comprised in the strand as said fibers enter said chamber, and means for withdrawing the resultant twisted strand from the chamber through said outlet.

14. In apparatus of the class described, in combination, means for imparting false twist to an untwisted fibrous strand thereby to consolidate it and insure its continuity, said twisting means comprising a hollow casing having an opening in its floor through which a conduit extends upwardly to form a vertical stand-pipe within the casing, said stand-pipe being open at its upper end, means providing a cover for the casing spaced from the upper end of the stand-pipe and having an entrance port coaxial with the stand-pipe, means cooperating with the casing wall and cover to provide an annular collecting chamber exterior to the casing and having a discharge opening near its bottom, means for delivering liquid under pressure into the lower part of the casing at one side of the stand-pipe thereby to form an upwardly flowing helical stream, the casing having at least one delivery hole in its side wall located above the level of the top of the stand-pipe but below the cover, said hole or holes leading to the collecting chamber and being operative to maintain a predetermined liquid head above the top of the stand-pipe whereby liquid, at constant velocity, enters and flows down the stand-pipe thereby creating a vortex in the upper portion of the stand-pipe, and means for delivering an untwisted strand down through the entrance port into said vortex.

15. Apparatus, according to claim 14, wherein the casing is cylindrical and the conduit is circular in transverse section and coaxial with the casing and the casing has a plurality of delivery holes in its wall having their centers at the same level and symmetrically spaced about the casing.

16. Apparatus, according to claim 14, wherein the means for delivering the untwisted strand downwardly into the entrance port comprises a pair of drafting rolls and a guide roll cooperating therewith.

17. In apparatus of the class described, means for imparting false twist to an untwisted strand including a vertical stand-pipe, open at its upper end, and means for creating a downwardly convergent liquid vortex in the upper portion of said vertical stand-pipe, means for delivering an untwisted strand into said vortex comprising fiber-drafting means including a pair of rolls turning in opposite directions, and means for delivering fiber into the nip of said rolls, one of said rolls being cylindrical and the other having a helical peripheral rib.

18. In apparatus of the class described, means for imparting false twist to an untwisted strand including a vertical stand-pipe, open at its upper end, means for creating a downwardly spiraling liquid vortex in the upper part of the vertical stand-pipe, means for delivering untwisted strand into said vortex comprising fiber-drafting means including a pair of oppositely turning rolls, and means for delivering fiber into the nip of said rolls, one of said rolls being smoothly cylindrical and the other roll being so shaped as, in cooperation with the first roll, to distribute the fibers to form overlapping parallel series in which the fibers are arranged in echelon.

19. Apparatus for imparting twist to an untwisted strand comprising a hollow casing having a floor provided with an opening through which a stream-guiding conduit extends vertically up into the casing, means at the upper end of the vertical portion of the conduit defining a passage into which the upper end of the conduit discharges a liquid stream carrying the advancing end of the strand to be twisted, said passage diverging from the axis of the conduit outwardly and upwardly, means defining an annular chamber, coaxial with the vertical portion of the conduit into which said passage opens, the upper part of the annular chamber tapering upwardly and merging with a cylindrical delivery port coaxial with the annular chamber, and means for delivering jets of high-pressure fluid into the annular chamber in a tangential direction thereby to impart twist to the fibers comprised in the strand as said fibers enter the annular chamber.

20. Apparatus for use in imparting twist to an untwisted fibrous strand, said apparatus comprising a hollow casing having a floor provided with an opening through which a conduit extends leak-tight vertically up into the casing, means for delivering a strand-conveying stream of liquid upwardly through the conduit whereby the strand is delivered with the liquid into the casing, means within the casing for twisting the fibers comprised in the strand as they are discharged into the casing, means for drawing the resultant twisted strand out of the casing, and means for preventing twist from running back into the conduit.

21. Apparatus for use in imparting twist to an untwisted fibrous strand, said apparatus comprising a hollow casing having a floor provided with an opening through which a conduit extends leak-tight vertically up into the casing, means for delivering a strand-conveying stream of liquid upwardly through the conduit whereby the strand is delivered with the liquid into the casing, means at the upper end of the conduit defining a passage through which the upper end of the conduit discharges the liquid and the advancing end of the strand, said passage diverging outwardly and upwardly from the axis of the conduit, means defining an annular chamber, coaxial with the conduit, into which said passage opens, and means for delivering jets of high-pressure fluid tangentially into the annular chamber thereby to impart twist to the fibers comprised in the strand as said fibers enter the annular chamber.

22. Apparatus for use in imparting twist to an untwisted fibrous strand, said apparatus comprising a hollow casing having a floor provided with an opening through which a conduit extends leak-tight vertically up into the casing, means for delivering a strand-conveying stream of liquid upwardly through the conduit whereby the strand is delivered with the liquid into the casing, a back-twist preventor comprising a head fixed to the upper end of the conduit and having a passage forming a continuation of the conduit and which diverges upwardly and outwardly from the axis of the conduit, the casing having therein means defining an annular chamber surrounding said head and into which said passage opens, the upper part of the head being conical and tapering

upwardly to a point located coaxially with the conduit, means defining an outlet port above the tapered upper end of the head, means defining a plurality of jet nozzles opening tangentially into said annular chamber and means defining a plenum chamber from which said nozzles receive said liquid at high pressure.

23. Apparatus, according to claim 22, wherein a stationary septum within the casing is shaped to provide a space within which the head is located, said space having an upwardly tapering upper portion within which the conical part of the head is arranged, said septum having therein an annular plenum chamber, means for supplying liquid at high pressure to the plenum chamber, and means for discharging liquid from the lower part of the casing.

24. Apparatus for use in imparting twist hydraulically to textile fibers thereby to form a twisted strand, said apparatus comprising a casing having a side wall and top and bottom walls, the top wall having therein a port for the delivery of the twisted strand, a conduit for guiding a stream of liquid, carrying with it the fibers to be twisted, to the casing, the conduit having a vertical portion, coaxial with said delivery port, which extends upwardly through the bottom of the casing and terminates at a point intermediate said top and bottom walls, a circular head fixed to the upper end of the conduit, said head having a passage which registers at its lower end with the conduit and which diverges outwardly and upwardly from the axis of the conduit, means fixed within the casing defining a cavity within which said head is located and whose wall is spaced from and coaxial with the upper end of the conduit to provide an annular chamber into which said passage opens, the upper part of the head tapering to a point coaxial with the delivery port in the top wall of the casing, and the wall of the cavity comprising a part which likewise tapers upwardly whereby the annular chamber tapers upwardly and merges with the delivery port, means defining an annular, plenum chamber within the casing from which jet nozzles extend inwardly and enter the annular chamber tangentially, means in the lower part of the casing for the reception of liquid discharged downwardly from the lower end of the annular chamber, and means for drawing off the twisted strand, as fast as it is formed, through the delivery port.

25. Apparatus, according to claim 20, wherein the means for twisting the fibers comprises a rotating part within the casing having an element which, by engagement with the strand, imparts positive twist thereto.

26. Apparatus, according to claim 20, wherein the means for twisting the strand comprises a rotor within the casing having a bore through which the strand passes on its way to the means for withdrawing the strand from the casing, said bore having at least one longitudinally extending groove in its wall.

27. Apparatus, according to claim 20, wherein the means for twisting the strand comprises a rotor within the casing having peripheral blades, and means for delivering liquid at high pressure against said blades thereby to turn the rotor.

28. Apparatus, according to claim 27, wherein the rotor is housed within a chamber of such dimensions that the rotor is free to move in any direction therein, the parts being so constructed and arranged that the rotor is suspended in a body of liquid as it rotates.

29. Apparatus, according to claim 20, wherein the means for twisting the strand comprises a rotor, means providing jets of high-pressure fluid for turning the rotor, the rotor having a central cavity whose lower portion is conical and within which the upper part of the conduit is located, said upper part of the conduit being tapered thereby providing between it and the wall of said cavity an annular chamber which tapers upwardly, the conduit having an eccentrically disposed discharge aperture at its upper end which delivers the strand-conveying liquid into the tapered portion of the annular chamber, the latter merging at its upper end with a cylindrical discharge bore, a cup-like receptacle disposed below the lower end of the rotor, the rim of the cup-like receptacle being located above the level of the lower end of the rotor, a fixed shroud defining a space surrounding the receptacle and into which liquid, overflowing the cup rim, is discharged, means for conveying liquid away from the lower part of the casing, and means for withdrawing twisted strand through the bore in the upper part of the rotor.

30. Apparatus, according to claim 29, wherein the rotor has peripheral blades and the casing has jet nozzles arranged for discharging pressure fluid against said blades, the parts being so constructed and arranged that the rotor is suspended in the liquid which is delivered by the conduit.

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