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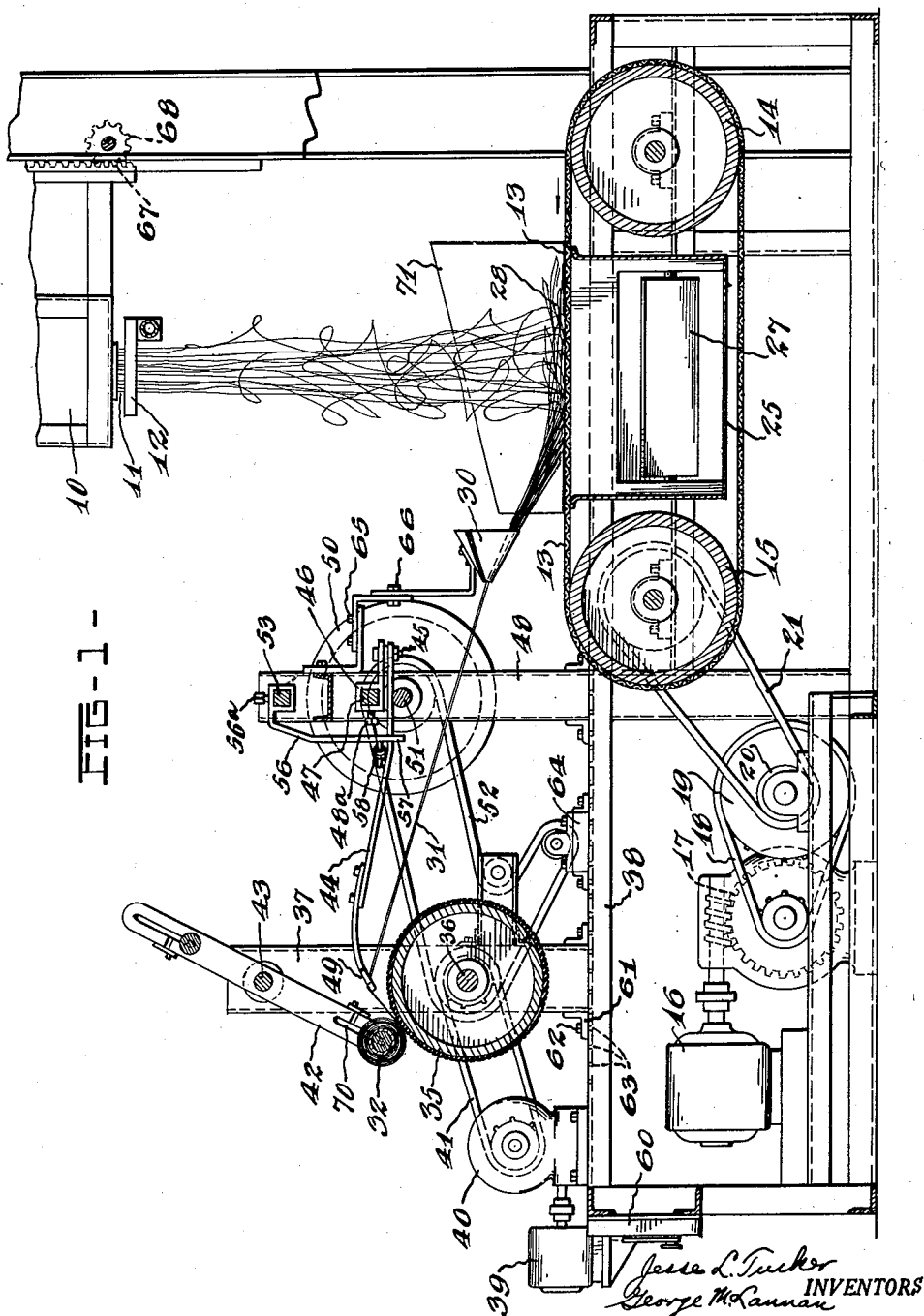
J. L. TUCKER ET AL

2,264,345

METHOD OF MAKING SLIVERS

Original Filed Nov. 29, 1935

3 Sheets-Sheet 1



BY

Riley & Hoge, ATTORNEYS.

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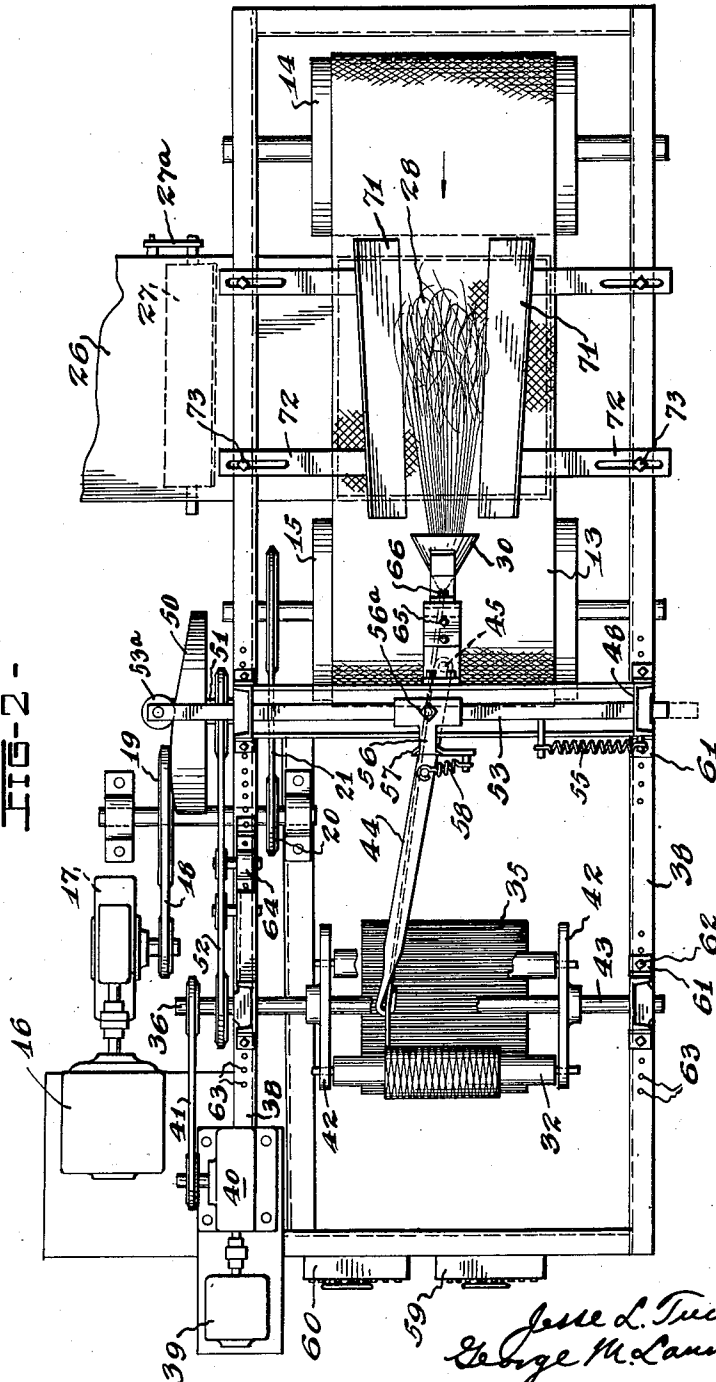
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FIG-2 -



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UNITED STATES PATENT OFFICE

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METHOD OF MAKING SLIVERS

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Renewed December 13, 1939

13 Claims. (Cl. 57—157)

Our invention relates to strands, slivers or yarns adapted for use in the manufacture of textiles or for various other uses. Strands or slivers ordinarily comprise a multiplicity of individual fibers which may extend in the general direction of the strand, but are twisted together or intertwined in a manner to give the strand the required tensile strength to permit it to be wound on spools, and for other manufacturing operations.

Our invention provides a sliver consisting of a group or multiplicity of parallel fibers having sufficient length to give it great tensile strength without the fibers being twisted together or intertwined, such slivers having ample strength to permit them to be wound on spools and otherwise manipulated.

Prior to our invention, no sliver has ever been produced, so far as we are aware, the fibers of which are substantially parallel and untwisted, having sufficient tensile strength to permit it to be wound on spools or withstand the strains to which it must be subjected in the usual operations incident to the production of fabricated articles.

Our invention further provides an untwisted sliver of the character indicated consisting of fibers of an inorganic material.

A specific object of the invention is to provide a sliver having the novel properties above pointed out, made of individual glass fibers of great fineness and length.

A further object of our invention is to provide a novel continuous method of making slivers of the character indicated.

A still further object of the invention is to provide a method of making slivers from a supply body of material in a viscous condition, by simultaneously flowing a multiplicity of small streams of the material, subjecting said streams to a pneumatic drawing force by which they are attenuated to the form of fine fibers and instantaneously hardened or solidified, accumulating the fibers, combing and drawing them to the form of a sliver and winding the sliver, all by a continuous process.

A further object of our invention is to provide a novel apparatus for producing slivers by a continuous process.

Other objects of the invention will appear hereinafter.

Referring to the accompanying drawings:

Fig. 1 is a part sectional side elevation of apparatus for continuously producing slivers in accordance with the present invention.

Fig. 2 is a plan view of the apparatus.

Fig. 3 is an end elevation of the apparatus, certain parts being omitted.

Fig. 4 is a cross sectional elevation of the apparatus.

Fig. 5 is a diagrammatic elevational view of a winding or spinning device adapted to twist the strands or slivers.

Our invention provides a method and means for manufacturing slivers, strands or yarns from various materials which may be flowed while in a viscous condition and subjected to a pneumatic blast or drawing force by which the streams of material may be drawn into fine fibers and the latter quickly solidified.

One group of materials adapted for such purpose may be defined as thermo-plastic. These, when heated, assume a viscous condition permitting them to be drawn into fine fibers by means of blowers. Examples of such thermo-plastics are cellulose acetate, sugar, rosin and vinolite. We have found that cellulose acetate and vinolite are examples of thermo-plastics well adapted for the purposes of the present invention, as they are capable of being reduced to extremely fine fibers and have sufficient strength and elasticity for making a strong sliver. Another group of materials adapted for the purpose of our invention comprises substances which may be dissolved in a solvent, the latter being evaporated during the process of forming the fibers. Rubber is an example of such a material.

A further group of materials suited for the purposes of our invention consists of inorganic substances or compounds which at high temperatures assume a molten or viscous condition and which may be drawn into fine fibers while in such condition and rapidly solidified. Among such materials we have obtained highly satisfactory results with solutions of metal oxides in silica, or a solution of silica and metal oxides in each other. A specific example of such a solution, and one with which we have obtained excellent results in practicing our method, is a solution having the formula of ordinary glass batch such as is generally used in the manufacture of bottles and numerous other glass articles.

Referring particularly to Fig. 1, the material for making the sliver may be supplied from a container 10 from which the material flows in a multiplicity of small streams 11. Where glass is the material to be reduced to fibers, said container as here shown may consist of a glass melting or refining tank. The streams 11 as they

issue from the tank descend through a blower 12. This may be a steam blower of approved form and construction, such as disclosed, for example, in the co-pending application of Games Slayter, Serial Number 197,442, filed March 22, 1938, which issued July 2, 1940, as Patent No. 2,206,060. The blower supplies a strong blast of steam which grips the flowing streams and carries them downward at a high velocity. This pulling force attenuates the viscous streams of material to the form of fine filaments which are instantly solidified while passing through space.

The fibers as they are formed, accumulate on a support 13, here shown as an endless reticulated conveyor consisting of woven wire screen or other openwork material. The conveyor 13 runs on rolls 14 and 15 and is driven by an electric motor 16. The motor has a driving connection with the drive roll 15 through speed reduction gears including worm gearing 17, belt 18, pulleys 19 and 20, and belt 21.

Beneath the upper lead of the conveyor 13 is a suction box 25 from which air is exhausted by means of a fan or other suction mechanism (not shown) communicating with the suction box through a duct 26. A damper 27 in said duct is adjustable by means of an adjusting device 27^a to adjustably regulate the degree of vacuum or exhaustion within the suction box. The fibers as they are formed, accumulate on the conveyor 13 directly over the suction box, in the form of a thin web or mat 28.

During the formation of the fibers, the streams of viscous material are drawn into the turbulent zones of the steam blast and are whipped back and forth in a zigzag or irregular path in such manner that each individual stream comprises a multiplicity of united sections or leads, all of which are being simultaneously drawn or attenuated by the force of the blast, so that the total fiber length produced from each stream is far greater than it would be possible to produce if the stream were maintained in a single straight path during the fiber formation. It is to be understood, however, that the action of the steam blast on a stream, as just described, does not generally disintegrate it or break it up into short lengths. On the contrary, the flowing stream maintains its integrity or continuity indefinitely, resulting generally in the formation of fibers of great length. In other words, the fibers as thus produced are in the main practically continuous in length and generally speaking, remain integrally united with the oncoming stream or supply body of the material throughout their formation.

In practice, these fibers are usually found to be many feet in length or practically continuous. They are also drawn out to extreme fineness, sometimes having an average diameter as low as three or four microns. The individual fibers being of microscopic dimensions are usually invisible during the formative process and can only be seen after they collect in the form of a thin mat or web on the conveyor 13. The illustration of these fibers in the drawings is for the purpose of indicating in a general way, the operation which takes place. It will be understood that the drawings greatly exaggerate the size of the fibers and also that the number of fiber lengths accumulating on the conveyor is much greater than can be accurately depicted by the drawings.

The fibers forming the mat 28 are collected and drawn through a funnel-shaped guide 30 or trumpet to form a strand or sliver 31 which, as

it is formed, is wound on a spool or holder 32. The suction within the box 25 maintains a continuous downward draft of air through that portion of the screen conveyor on which the fibers are accumulating. This holds the accumulating mat of fibers against the screen with a certain pressure so that a substantial amount of force is required to draw the collection of strands off the screen and through the funnel during the formation of the sliver.

The force of the steam and air blast during this sliver formation operates to comb the fibers so that they are straightened out as they approach the funnel guide and thereby form a sliver in which the fibers are substantially parallel. Owing to the great length of the individual fibers, which are in effect substantially continuous in the formed sliver, any given length of the sliver which may be placed under tension in the usual manufacturing operations, as, for example, a few inches or even a few feet, possesses great tensile strength. Owing to the length of fibers the sliver is not broken by the tension placed on it while being wound on the spool 32. The tensile strength of the sliver is ample to permit weaving, knitting or textile operations to which it may be subjected, thus obviating the necessity of twisting the strand to give it strength. Twisting of the sliver may be resorted to, if desired, for giving added strength, compactness or permanency of form, for better adapting it to certain specific operations and uses.

The sliver 31 is drawn and wound on the spool 32 by means of a winding drum 35 mounted on a shaft 36 journaled in standards 37, the latter mounted on a machine frame 38. The winding drum is driven by an electric motor 39 which operates through speed reduction gearing contained within a gear box 40, the motion being transmitted from said gearing through a sprocket chain 41 to a sprocket on the drum shaft 36.

The spool 32 is removably mounted in a frame comprising a pair of arms 42 fixed to a shaft 43 which is journaled in the standards 37. The spool 32 with the accumulating sliver thereon is held by gravity against the face of the winding drum and frictionally driven thereby. The sliver is evenly distributed on the spool by means of a distributing arm 44 which is connected by a pivot 45 to a bracket arm 46, the latter mounted on a horizontal bar 47 secured at its ends to uprights or standards 48. The arm 46 is adjustable lengthwise of the rod 47 and is secured in adjusted position by means of a clamping bolt 48^a.

The distributing arm 44 is provided at its forward end with a guiding loop 49 through which the sliver extends.

The arm is oscillated for uniformly distributing the sliver on the spool by means of a cam 50 mounted on the shaft 51, the latter driven as by means of a sprocket chain 52 running over sprockets on the shafts 51 and 36. A slide-bar 53 is mounted for lengthwise reciprocating movement in the upper ends of the standards 48. A cam roll 53^a carried by the bar 53 at one end thereof, bears against the face of the cam 50. A coil spring 55 attached at one end to the bar 53 and anchored at its opposite end to a standard 48, holds the roll 53^a against the cam so that as the latter rotates, a reciprocating movement is imparted to the bar 53. An arm 56 mounted on the bar 53 and extending downwardly therefrom, is adjustable lengthwise thereof, and is held in

adjusted position by a set screw 56^a. The lower end of the arm 56 is formed with a yoke or fork 57 which straddles the arm 44. The reciprocating movement of the bar 53 and arm 56 oscillates the distributing arm 44 about its pivot 45, the cam 50 being so designed that an even distribution of the sliver on the spool is obtained. A coil spring 58 connected to the distributing arm 44 and the arm 56, takes up or prevents any lost motion between said arms.

The winding drum 35 is driven at a peripheral speed much greater than the speed of the conveyor 13 on which the mat 28 is accumulated, so that during the formation of the sliver the mass of fibers is drawn out or attenuated to a considerable extent, the number of individual fibers in a cross-section of the sliver being much less than in a cross-section of the mat as it leaves the conveyor 13. In this connection it will be noted that in the accumulated mass or group of fibers leaving the conveyor 13, the individual fibers are doubled back and forth or extend in a devious path, so that the action of drawing out or attenuating of the mass of fibers or sliver as a whole consists largely in drawing the individual fibers more nearly into a straight line or straightening them to some extent. Comparatively few of the fibers are broken in this process. Means are provided for adjusting the speeds of the motors 16 and 39 independently of each other and thereby separately adjusting the speeds of the conveyor 13 and the winding drum 35. Such adjusting means comprises rheostats 59 and 60 in the circuits of the motors 16 and 39 respectively.

The standards 37 are adjustable lengthwise of the frame 38 and are held in adjusted position by brackets 61 secured to the frame by bolts 62 which extend through bolt holes 63 in the framework. The standards 48 are adjustable lengthwise of the frame 38 in like manner. A take-up device 64 for the sprocket chain 52 is also adjustable along the supporting frame to accommodate said chain to relative adjustments of the standards 37 and 48. The trumpet 30 is adjustable toward and from the standards 48, adjusting means 65 being provided for this purpose, and is also adjustable up and down by means of an adjusting device 66. The container 10 is vertically adjustable on its supporting frame by means of a rack 67 and pinion 68.

The arms 42 which carry the winding spools, are provided with longitudinal slots 70 to receive the spindles of said spools. While one spool is being wound, an empty spool may be placed in position at the upper ends of said arms. When one spool is filled, the spool frame is swung about the axis of its shaft 43 to swing the full spool upward and bring the empty spool into winding position. The sliver is then severed between the two spools, permitting the winding to proceed on the spool which has just been lowered. The filled spool may then be removed and replaced by another empty spool.

Although the apparatus as shown and as above described is particularly adapted for making a strand or sliver, the apparatus may also be adapted for forming a continuous mat or ribbon by the same general method. Such mat or ribbon may consist of fibers more or less interwoven or made in a ribbon-like or sheet formation. The downward draft of steam and/or air through the screen 13 is directed and controlled to a certain extent by a pair of shields or plates 71 positioned above the screen, said shields being

upwardly and outwardly flared. The shields also serve to guide the descending fibers and define the width of the accumulating mat. The shields are carried on arms 72 which have slot and pin connections 73 with the framework, permitting the shields to be adjusted to the desired position.

The slivers made in accordance with the present method may be twisted to form twisted slivers or yarns. A conventional apparatus for this type of twisting is shown in Fig. 5 in which spools 32 may feed the sliver strand 101 between rolls 103 forming a bite for the strand, then through an eye 104, through a traveller 105, and then around a rotating bobbin 107. The traveller 105 is revolvably mounted upon a traversing means 108 which reciprocates to distribute the strand 101 uniformly over the bobbin to form a package. The bobbin 107 is rotated by any suitable means such as the belt 109.

In order to show the tensile strength of slivers consisting of glass fibers and made by the method and apparatus herein disclosed, and to further show the comparative strength of such slivers and those made with other materials, particularly cotton and asbestos, we give below a tabulated statement showing the values obtained by a series of tests which we have made with such materials. This tabulation gives the weight in grains per yard of length of the samples tested, the length in inches of each section of sliver tested, and the tensile strength measured by the weight in grains required to break the sliver, as follows:

	Weight in grain/yd.	2" length break in grains	4" length break in grains
Cotton.....	67	1,248.94	793.10
Asbestos.....	8	452.76	420.42
Glass.....	45	15,199.80	10,327.24
Do.....	22	9,220.74	9,337.24
Do.....	11	6,246.24	4,732.42

Modifications may be resorted to within the spirit and scope of our invention.

We claim:

1. The method which comprises continuously and simultaneously flowing a multiplicity of fine streams of a material in a viscous state, continuously attenuating said streams to the form of fine filaments, causing them to solidify, and continuously and progressively collecting the filaments in the form of a matted mass of accumulated filaments in which individual filaments are doubled back and forth in such manner that the cross-section of the mass contains many more filaments than the number of said streams, and continuously drawing the material from the mass at the same rate as it is accumulated and simultaneously transforming it to the form of a sliver.

2. The method which comprises continuously and simultaneously flowing a multiplicity of fine streams of a material in a viscous state, continuously attenuating said streams to the form of fine filaments, causing them to solidify, accumulating the formed fibers continuously and progressively into the form of a web or mat in which individual filaments are doubled back and forth in such manner that a cross-section of the said web or mat contains many more filaments than the number of said streams, and continuously drawing the accumulating mat into the form of a sliver in which the fibers are substantially par-

allel and the number of fibers at a cross-section thereof is much less than the number at said cross-section of the web or mat.

3. A continuous method of reducing a supply body of molten inorganic material to the form of a strand or sliver consisting of a multiplicity of individual fibers, which method includes simultaneously flowing a multiplicity of small streams of said material in a viscous state from the supply body, applying to said streams as they flow through space, a force by which the streams are attenuated to the form of fine filaments, causing said filaments as they are formed, to solidify and accumulate in matted form in which the filaments extend promiscuously in all directions, and continuously drawing the mat of accumulated filaments and simultaneously transforming it to the form of a strand or sliver with the filaments arranged in substantially parallel relation.

4. The method of continuously forming a strand or sliver from a supply body of material, which comprises continuously spinning a predetermined number of streams of the material into fine filaments, accumulating and depositing the filaments as they are spun, in the form of a web or mat in which the number of filaments at a cross-section thereof is much greater than the said number of streams, confining the filaments during said accumulation to a predetermined zone, continuously drawing the matted filaments beyond said zone, and simultaneously compacting and rearranging the filaments in substantial parallelism in the form of a sliver.

5. The method of continuously forming a strand or sliver from a supply body of material, which comprises continuously spinning a predetermined number of streams of the material into fine filaments, accumulating and depositing the filaments as they are spun, in the form of a web or mat, confining the filaments during said accumulation to a predetermined zone, continuously drawing the matted filaments beyond said zone, simultaneously compacting and rearranging the filaments in substantial parallelism in the form of a sliver, and applying to the mat a holding force by which the sliver as it is formed, is attenuated and the number of filaments forming a cross-section thereof is reduced.

6. The method which comprises continuously flowing a predetermined number of streams of viscous material, attenuating the streams to the form of fine fibers, collecting and depositing the fibers as they are formed, in an accumulated mass on a support with the number of fibers at a cross-section of said mass many times greater than the said number of streams, and continuously drawing the mass of fibers from said support and transforming the mass, as it is drawn, to the form of a sliver or strand.

7. The method of forming a sliver which comprises continuously flowing from a supply body of viscous material, a predetermined number of streams of the material and continuously drawing said streams to attenuated filaments, causing them to solidify, depositing the filaments as they are produced, in matted formation on a reticulated surface, continuously gathering and drawing the mat of the deposited filaments into the form of a sliver, and winding the sliver as it is formed.

8. The method of forming a strand or sliver which comprises continuously flowing a predetermined number of small streams of viscous material, continuously drawing and attenuating said

streams to the form of fine filaments, solidifying said filaments as they are formed, projecting the filaments onto a supporting surface and causing them to accumulate in matted form on said surface with the filaments extending promiscuously in directions mainly substantially parallel with said surface, and continuously drawing the mat of filaments from said surface as the mat is formed and simultaneously transforming the mat into the form of a strand or sliver in which the filaments are arranged mainly in substantial parallelism.

9. The method of forming a strand or sliver which comprises continuously flowing a predetermined number of small streams of viscous material, continuously drawing and attenuating said streams to the form of fine filaments, solidifying said filaments as they are formed, projecting the filaments onto a supporting surface and causing them to accumulate in matted form on said surface with the filaments extending promiscuously in directions mainly substantially parallel with said surface, and continuously drawing the mat of filaments from said surface as the mat is formed and applying a holding force to the mat at said surface, whereby the mat of filaments is attenuated as it is drawn from said surface, and concentrating the mat of filaments to compact sliver form as it advances beyond said surface.

10. The method of forming a strand or sliver which comprises continuously flowing a predetermined number of small streams of viscous material in group formation from a supply body, applying to said streams a drawing force by which they are attenuated and drawn to the form of fine filaments, carrying said filaments forward as they are formed in a gaseous vehicle, arresting the filaments at a plane transverse to their path of movement with said gaseous vehicle and thereby causing the filaments to accumulate in the form of a web or mat, continuously drawing said web or mat from the zone of accumulation and in a direction diverse from that in which the filaments are carried by said vehicle, and causing the mat or web of filaments as it is drawn to be compacted, rearranged and oriented to the form of a strand or sliver in which the fibers extend mainly in substantial parallelism with the length of the sliver.

11. The method of forming a strand or sliver which comprises continuously flowing a predetermined number of small streams of viscous material in group formation from a supply body, applying to said streams a drawing force by which they are attenuated and drawn to the form of fine filaments, carrying said filaments forward as they are formed in a gaseous vehicle, arresting the filaments at a plane transverse to their path of movement with said gaseous vehicle and thereby causing the filaments to accumulate in the form of a web or mat, continuously drawing said web or mat from the zone of accumulation and in a direction diverse from that in which the filaments are carried by said vehicle, applying a holding force to the arrested filaments and thereby providing an anchorage permitting a drawing force to be applied to said mat or web, and causing the mat or web of filaments as it is drawn to be compacted, rearranged and oriented to the form of a strand or sliver in which the fibers extend mainly in substantial parallelism with the length of the sliver.

12. The method which comprises simultaneously projecting a multiplicity of individual fila-

ments from a supply body of plastic or viscous material, continuously accumulating the filaments in a mass formation in which individual filaments are doubled back and forth in such manner that a cross-section of the mass contains many more filaments than the said number which are being projected from the supply body, and continuously drawing the filaments from the mass and to the form of a strand while the material is still united with the supply body.

13. The method which comprises simultaneously projecting a multiplicity of individual filaments from a supply body of plastic or viscous

material, continuously accumulating the filaments in a mass formation in which individual filaments are doubled back and forth in such manner that a cross-section of the mass contains many more filaments than the said number which are being projected from the supply body, continuously drawing the filaments from the mass and to the form of a strand while the material is still united with the supply body, and twisting the strand to form a twisted yarn.

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