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APPARATUS FOR USE IN ASSEMBLING AND
INTERTWINING DISCRETE FIBERS
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2,944,381

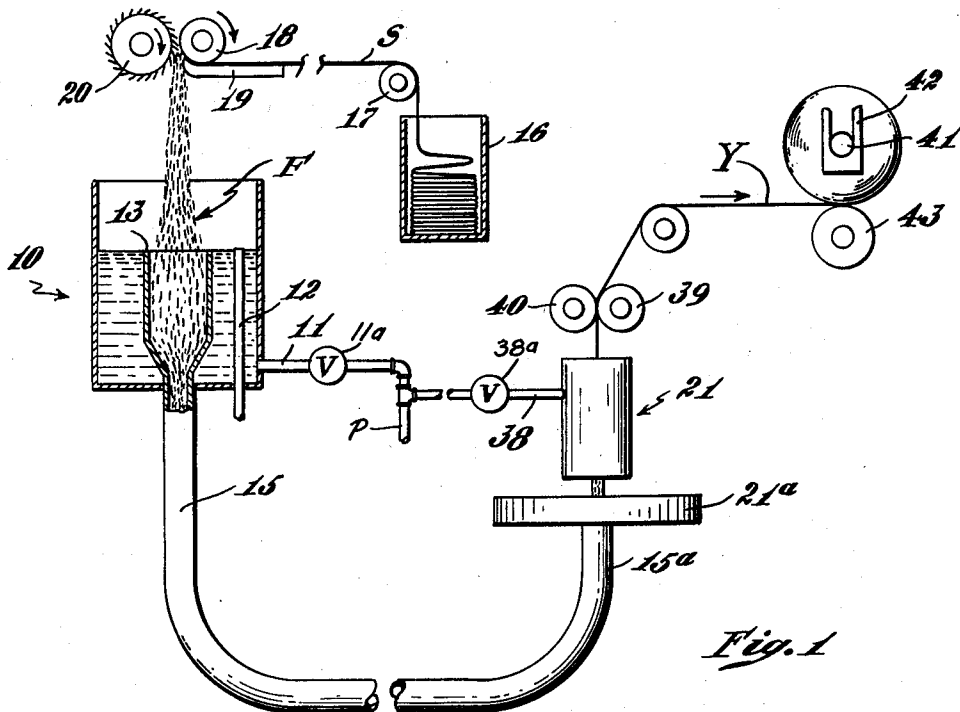


Fig. 1

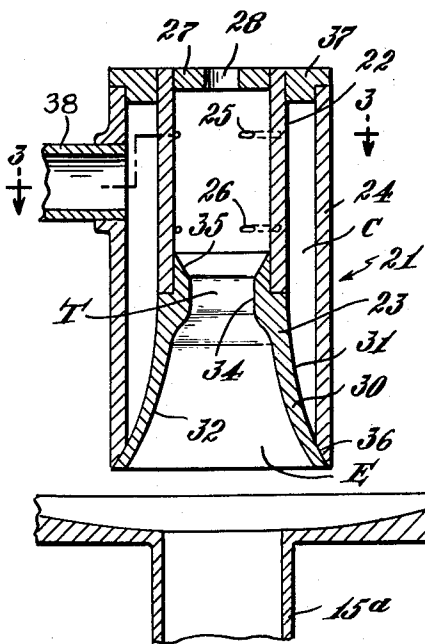


Fig. 2

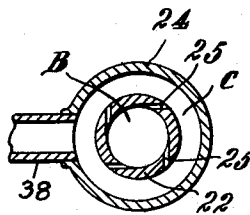


Fig. 3

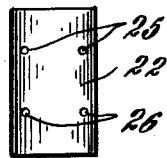


Fig. 4

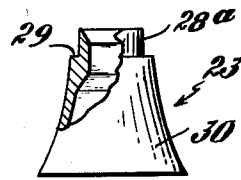


Fig. 5

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2,944,381

APPARATUS FOR USE IN ASSEMBLING AND INTERTWINING DISCRETE FIBERS

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This invention relates to textile manufacture and more especially to a novel method of and apparatus for use in assembling and intertwining discrete fibers, for example, fibers of textile length, thereby to produce roving or spun yarn.

In the patent to Strang, 2,700,866, dated February 1, 1955, there is disclosed a method of concatenating fibers for the formation of spun yarn wherein a stream of liquid having the fibers suspended therein is caused to flow through a smooth-walled conduit, a portion of which is rotated about its own axis, the rotation of said portion of the conduit frictionally entraining the flowing liquid so that the latter rotates about the axis of the conduit. The rotation of the flowing liquid imparts twist to the fibers suspended in the stream and the twisted fibers are drawn off as a continuous strand and separated from the liquid.

While the method disclosed in said patent is useful in the production of spun yarn, it is somewhat difficult to thread up the apparatus in starting, that is to say, to initiate the operation. Moreover, the driving, at high speed, of a rotating tube of sufficient length to impart the requisite rotational velocity to the flowing liquid involves difficulties, which, though not insurmountable, it is desirable to avoid.

The present invention has for objects the provision of an improved and novel method of and apparatus for use in the concatenation of fibers for the formation of roving or spun yarn, wherein the fibers are suspended in a stream of liquid flowing through a stationary rather than a rotating conduit, but wherein nevertheless, a portion of the stream is rotated, for spinning the fibrous material, at an angular velocity which may be as great as or greater than the highest spindle velocity employed in mechanical spinning. A further object is to provide a novel method of spinning fibrous material; wherein a body of liquid, in which the fibrous material is suspended, is caused to rotate by the action of a tangential jet or jets of high pressure fluid, for example, a liquid such as water. A further object is to provide novel apparatus for use in the assembly and the intertwining of fibrous material while suspended in liquid. Other and further objects and advantages of the invention will be pointed out in the following more detailed description and by reference to the accompanying drawings, in which:

Fig. 1 is a diagrammatic elevation, partly in vertical section, illustrating one desirable form of apparatus for use in the practice of the method;

Fig. 2 is a vertical diametrical section to larger scale than Fig. 1, showing the interior construction of the spinning head;

Fig. 3 is a horizontal section to smaller scale on the line 3—3 of Fig. 2;

Fig. 4 is a side elevation of the cylindrical conduit member of the spinning head, and

Fig. 5 is a side elevation of the entrance member of the spinning head.

Referring to the drawings, the numeral 10 indicates a tank or container which is kept filled to a predetermined

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level with a suitable liquid, usually water, by means of a supply pipe 11 connected to a pipe P (with an interposed valve 11^a), the pipe P being connected, for example, to a city water main providing water under a substantially constant and customary pressure head. The tank 10 is desirably provided with an overflow pipe 12. Within this tank there is arranged a fiber suspending chamber 13 open at its top and which receives water from the tank 10 and into which the fibers which are to be spun are delivered. The use of the inner chamber 13 is desirable, since it insures a quiescent body of liquid, undisturbed by the inflow of pressure fluid through the pipe 11. As here illustrated, the fibers are received in sliver form from a receptacle 16, here shown as a conventional coiler can, such as is used for receiving the sliver from a carding machine, although it is to be understood that this is merely by way of example, and that any appropriate supply of fibrous material may be employed. Sliver S from this container 16 is here illustrated as being drawn upwardly over the guide roll 17, and is then delivered by a feed roll 18 and trough 19 to a licker-in roll 20, by means of which the sliver is disintegrated so as to deliver the fibrous material in the form of discrete fibrous elements F into the liquid contained in the receptacle 13. While this mode of delivering the fiber into the suspending liquid is desirable, it is to be considered as illustrative of any other appropriate means for accomplishing the desired result. For instance, a set of customary drafting rolls may be used instead of the parts 18, 19 and 20.

The lower part of this receptacle 13 converges downwardly in diameter and merges with the upper end of a pipe 15, which extends to a location appropriate for the installation of the spinning head, which is here designated by the numeral 21. Immediately below this spinning head 21 there is arranged an annular baffle 21^a having a central opening into which the terminal portion 15^a of the pipe 15 projects, the terminal portion 15^a, as shown in Fig. 1, being substantially vertical and axially aligned with the spinning head 21.

The spinning head 21, as more clearly shown in Figs. 2, 3, 4 and 5, comprises a cylindrical conduit 22 (Fig. 4) which defines the spinning chamber B and which may be of any suitable material, for example, metal or preferably a hard and rigid plastic. The part 22, by way of example but without limitation, may be of the order of 1" in length and have an internal diameter of $\frac{3}{8}$ " and a wall thickness of $\frac{1}{16}$ ". The spinning head 21 also comprises the entrance member 23 (Fig. 5), which may be of the same material as the conduit 22, or of other material if preferred, the parts 22 and 23 being disposed in axial alignment. The entrance member 23, and the conduit 22 are housed within an external casing 24 (here shown as cylindrical), and of an external diameter of $\frac{7}{8}$ " for example, the internal diameter of this outer casing being such, as referred to the external dimensions of the conduit 22 and entrance member 23, as to provide an annular plenum chamber C (Fig. 2).

The conduit 22 is provided, as here shown, with two axially spaced groups of jet orifices 25 and 26 respectively, extending through the thickness of its circumferential wall. As here illustrated, and has been found desirable, although without limitation, the upper group 25 of orifices may be spaced from the upper end of the conduit a distance of $\frac{3}{8}$ ", and the lower group of jet orifices 26 may be spaced below the upper group a distance of $\frac{3}{8}$ ". Each group of orifices (as illustrated for example in Fig. 3) comprises four orifices arranged at 90° apart, and with their axes passing through the thickness of the wall of the conduit at such an angle that a stream of fluid, for example water, issuing through an orifice into the interior of the conduit 22 will be substantially tangent to the inner surface of the conduit wall.

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The upper end of the conduit 22 has a closure member 27, fixed leak-tight to the conduit wall, and provided with a central delivery orifice 28 of a diameter appropriate to permit the passage of the yarn which is being made.

The entrance member 23 comprises a short cylindrical sleeve portion 28^a of an external diameter to fit snugly within the lower end of the conduit 22, the external diameter of the entrance member 23 increasing suddenly at the lower end of the sleeve portion, to provide a radial shoulder 29 on which the lower edge of the conduit 22 rests. Desirably, although not necessarily, the height of the sleeve portion above the shoulder 29 is of the order of $\frac{3}{16}$ ", the shoulder being of a radial width equal to the thickness of the conduit wall, so that the outer surface of the entrance member below the shoulder 29 is flush with the outer wall of the conduit at the point where they meet. The entrance member 23 also comprises the lower or bell portion 30, whose outer surface 31 is curved and flares outwardly and downwardly, while the inner surface 32 likewise flares outwardly and downwardly, thus defining an entrance passage E (Fig. 2) which converges upwardly from the lower end of the spinning head 21 toward the lower end of the conduit 22.

The upper or smaller end of the passage E is desirably of approximately the same diameter as the interior of the conduit 22 but above the passage E, the wall of the bell member 30 has a thickened portion which defines a cylindrical throat passage T, for example, of the order of $\frac{1}{4}$ " in diameter. At its upper part this passage flares in diameter, the cylindrical inner wall 34 of the passage merging with a beveled or conically inclined surface of the conduit 22. As shown in Fig. 2, the lower or larger end of the bell member 30 fits snugly at 36 against the lower end portion of the outer casing 24, these parts being connected leak-tight, for example by welding if of metal or by interfusion, or by the use of cement if the parts are of plastic. The upper end of the chamber C in the casing 24 is closed by an annular plug 37 having a central aperture in which the upper end portion of the conduit 22 fits snugly and leak-tight, the plug overlapping the upper edge of the casing 24 and being secured leak-tight to the latter in any appropriate way.

Spaced above the delivery aperture 28 in the closure member 27 is an arrangement for drawing off the spun strand, this drawing-off means here being shown, merely by way of example, as comprising a pair of driven rolls 39 and 40 which pull the spun material up out of the chamber B in the conduit 22 in which the spinning takes place. These rolls 39 and 40 are driven by any suitable means (not here illustrated) but desirably with provision for changing their speed so that the rate at which the spun yarn Y is drawn off (thus providing one way in which the number of twists per inch), may be varied as desired. After passing through the rolls 39 and 40 the yarn is suitably guided to means for winding it up, which for example, may comprise a rotary core carried by a spindle 41 which may move up and down in suitable guides 42, the rotation of the yarn mass on the core being accomplished by means of a constantly driven friction drum 43 on which the yarn mass rests.

In the operation of the apparatus, the liquid in the tank 10 is kept at a constant level such as to produce a head sufficient to insure a velocity of flow in the pipe 15 of the order for example, of two or more feet per second. The jet nozzles are of such dimensions and provided with water under a pressure such that preferably the amount of water delivered by the jet nozzles is approximately one-half that which is delivered into the entrance passage E by the pipe 15. As here illustrated, the water for the nozzle is supplied by a pipe 38 connected to the pipe P with an intervening valve 38^a, the valve being of conventional type and providing means whereby the nozzle pressure may be regulated. As the fiber-bearing liquid is projected upwardly from the end 15^a of the pipe 15 into the entrance passage E, it moves up through the

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throat T into the spinning chamber B in the conduit 22, and is set into very rapid rotation about the axis of the conduit by the action of the jets. The velocity of rotation depends upon several factors, including the supply pressure, the diameter of the orifices 25 and 26, the diameter of the chamber B and the velocity of the fiber-bearing stream. Variation in the rotational velocity of the stream provides another way of varying the twist per inch. Velocities of rotation of the body of liquid in the chamber B of the order of 30,000 r.p.m., or more are readily obtained in this manner while employing water under a pressure such as is customary in a city supply main.

In starting up the operation, a suitable device is passed down through the aperture 28 into the spinning chamber B for receiving the forming end of the spun yarn resultant from the intertwining of the fibers within (what for convenience may be termed) the "spinning zone," and as the embryo yarn is formed within said zone and becomes attached to this device, the latter is moved upwardly, thus carrying the initially formed or embryo portion of the yarn upwardly toward and through the aperture 28, this initial portion of the yarn then being introduced between the rolls 39 and 40, which then are effective to continue the drawing-off operation. One implement suitable for this threading-up operation is an ordinary pipe cleaner, which consists of lengths of wire twisted together and having tufts of fibrous material gripped between the twists, and which is quite flexible so that if desired, the entire pipe cleaner may be caused to pass through the rolls 39 and 40, pulling the advancing end of the yarn along with it. After the operation has started, the spun strand continues to be pulled off by the rolls 39 and 40. Any suitable drying means (not shown) may be used for drying the yarn on its way to the winding spindle 41.

Centrifugal force causes the water to hug the inner surfaces of the chamber B. The water introduced into the chamber B by the pipe 15 and also by the jet nozzles escapes downwardly along the walls of the chamber E, forming as it were an annular rotating curtain surrounding the incoming stream of fiber-bearing liquid. This downward motion of the waste water is believed to be the result of the downward flare of the entrance passage E and centrifugal force acting on the flowing fluid. Little or no water escapes from delivery orifice 28. Obviously, the water from which the fiber has been separated may be returned to the tank 10 for recirculation.

By the use of this apparatus it is possible to spin yarns of any desired number, including coarse yarns, with the certainty that all of the fibers composing the yarn will be subjected to twist such that they all contribute to the strength of the spun material. It is also possible, as above noted, to obtain a very high speed of twist, even exceeding any speed which has thus far been found to be possible in the employment of mechanical spindles. Thus the rate of production is greatly increased, while at the same time the difficulties and disadvantages inherent in mechanical spinning devices, particularly such problems as are consequent upon the use of very high spindle speeds, are eliminated.

While one desirable embodiment of the invention has herein been disclosed and illustrated by way of example, it is to be understood that the invention is broadly inclusive of any and all apparatus falling within the scope of the appended claims.

We claim:

1. Apparatus for use in concatenating discrete fibrous elements to form a twisted strand comprising means defining an elongate cylindrical chamber whose axis is vertical, a top closure for said chamber having a constantly open central yarn delivery port of a diameter substantially less than that of said chamber, means defining an upwardly tapering entrance passage, open at top and bottom, coaxial with said chamber, whose lower end is of a diameter exceeding that of said cham-

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ber, means defining a throat passage, of a diameter less than that of the chamber, coaxial with and which connects the lower end of the chamber with the upper end of the entrance passage, the peripheral wall of the chamber having jet orifices therein whose axes are tangential to the inner surface of the chamber, a supply conduit having a delivery end which is coaxial with said entrance passage and spaced from the lower end of the latter, means supplying liquid under pressure to the jet orifices, and means for supplying fiber-bearing liquid to the conduit under a substantially constant head such as to project a jet of liquid upwardly through the entrance and throat passages into said chamber.

2. Apparatus according to claim 1 for use in concatenating discrete fibers to form a twisted strand further characterized in having means operative continuously to draw off twisted strand material from the yarn port at the upper end of said chamber, and an annular baffle spaced from the lower end of the chamber and coaxial therewith, and to which the upper end of the conduit is secured leak-tight, said baffle having a basin-like cavity in its upper surface substantially exceeding the conduit in diameter.

3. Apparatus for use in spinning fibrous material by hydraulic action, said apparatus comprising an elongate cylindrical conduit, means providing a converging entrance passage at one end of the conduit, the conduit having at its opposite end a closure provided with a central delivery aperture, the wall of the conduit having therein jet orifices which open tangentially into the interior of the conduit at the inner surface of said wall, a casing providing a chamber at the exterior of said conduit from which the jet orifices lead, means for supplying fluid under pressure to said chamber, and means for delivering a jet of fiber-laden liquid axially into the converging entrance passage.

4. Apparatus according to claim 3, wherein the entrance passage converges to the entrance to a cylindrical throat passage, of a diameter less than the interior diameter of the conduit and which provides communication between the small end of the converging entrance passage and the conduit proper.

5. Apparatus according to claim 3, having means defining a cylindrical throat passage of a diameter less than that of the interior of the conduit and less than that of the smaller end of the converging entrance passage, and which merges with a portion of increasing diameter.

6. Apparatus according to claim 3, comprising means providing a restriction between the small end of the converging entrance passage and the conduit proper, the jet orifices being located between said restriction and the delivery end of the conduit.

7. Apparatus according to claim 3, wherein a plurality of jet orifices are symmetrically spaced apart about the periphery of the conduit.

8. Apparatus according to claim 3, wherein a plurality of jet orifices are spaced apart longitudinally of the conduit.

9. Apparatus for use in spinning textile fibers hydraulically, said apparatus comprising a cylindrical conduit having at one end an annular closure provided with a constantly open central delivery aperture of a diameter substantially less than the internal diameter of the conduit, an entrance member comprising a sleeve portion which fits within the opposite end of the conduit, said entrance member also including a bell portion which, in internal diameter, flares away from the sleeve portion to provide a smooth, upwardly convergent, constantly open entrance passage whose smaller end merges with a throat

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passage of smaller diameter than said conduit, the conduit having jet orifices in its circumferential wall, and means for delivering a fibre-bearing jet of liquid upwardly into said entrance passage.

10. Apparatus for use in spinning textile fibers hydraulically, said apparatus comprising a cylindrical conduit having at one end an annular closure provided with a central delivery aperture of a diameter less than the internal diameter of the conduit, an entrance member comprising a sleeve portion which fits within the opposite end of the conduit, said entrance member also including a bell portion which, in internal diameter, flares away from the sleeve portion to provide a smoothly convergent entrance passage whose smaller end is of approximately the same diameter as that of the interior of the conduit, the sleeve portion of the entrance member providing a cylindrical throat passage of a diameter smaller than that of the smaller end of the entrance passage and which provides communication between the entrance passage and the conduit proper, and means for delivering tangential jets of fluid into the conduit.

11. Apparatus for use in spinning textile fibers hydraulically, said apparatus comprising a cylindrical conduit having at one end an annular closure provided with a central delivery aperture of a diameter less than the internal diameter of the conduit, an entrance member comprising a sleeve portion which fits within the opposite end of the conduit, said entrance member also including a bell portion, which in internal diameter flares away from the sleeve portion to provide a smoothly convergent entrance passage whose smaller end is of approximately the same diameter as that of the interior of the conduit, the entrance member having an external shoulder which abuts the end of the conduit, the sleeve portion of the entrance member having a thickened wall which defines a cylindrical throat passage, the conduit wall having orifices for delivering jets of fluid tangentially into the interior of the conduit.

12. Apparatus according to claim 9, comprising an outer casing which houses the conduit and entrance member and which provides a leak-tight annular chamber surrounding the conduit, and means for delivering pressure fluid into said chamber.

13. Apparatus according to claim 9, comprising mechanical means for drawing twisted strand material out through the delivery orifice at the end of the conduit.

14. Apparatus according to claim 9, comprising an annular baffle coaxial with and spaced from the outer end of the entrance member, the baffle being of a diameter exceeding the maximum diameter of said bell portion, and means for delivering a jet of fiber-bearing liquid through the center of the baffle into the larger end of the converging entrance passage.

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