OPEN END ROVING, SPINNING, AND SPINNING AND TWISTING METHODS


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Abstract

An open end roving, spinning, and spinning and twisting machine in which a twist belt or twist drum or twist drums cooperates with an elongate twist needle along the length of which drafted lengths of fibrous material are delivered sequentially so that the fibrous material will be loaded and wound upon the twist needle and then passed to delivery rolls for removing the fibrous material as a continuous length from the twist needle while imparting twist thereto. The twist needle is sandwiched between the rotating twist drums or the twist belt and a rotating twist drum having individual sectors which longitudinally reciprocate and help in feeding the fibrous material from the twist needle. The twist needle may be hollow so as to receive and pass a roving, yarn or the like which is integrated into the final product. A single twist needle or plurality of twist needles may be used, mounted in a circular pattern around the circumference of the twist drum and sequentially indexed to be engaged with the twist belt or twist drum or drums while a drafted length of fibrous material is fed thereto. In this fashion a multi-ply yarn may be obtained. The central twist drum contains a hollow central shaft which permits the feeding of a yarn or other materials through the center of the central drum thereby permitting the building of a large multi-ply yarn.

3 Claims, 27 Drawing Figures
OPEN END ROVING, SPINNING, AND SPANNING AND TWISTING METHODS

BACKGROUND OF THE INVENTION

This application is a division of my application Ser. No. 883,226 filed on Dec. 8, 1969 which matured into United States Letters Patent No. 3,555,802, issued Jan. 19, 1971, which application was a continuation-in-part of my application Ser. No. 788,216 filed on Dec. 31, 1968 which matured into United States Letters Patent No. 3,488,935, issued Jan. 13, 1970, in which drafted lengths of fibrous material may be fed to loaded along the length of a twist needle rotating in contact with a twist belt. The twist needle is inclined to the direction in which the belt travels so that a continuous length of yarn or the like flows from the end of the needle and is taken up by a pair of delivery rolls so that appropriate twist is imparted to the yarn or the like.

BRIEF SUMMARY OF THE INVENTION

The present invention relates to an open end roving, spinning, and spinning and twisting machine of the type generally referred to above wherein the twist needle is engaged on one side with the twist belt or twist drum or drums and on an opposite side with a twist drum which has individual segments thereof formed so as to reciprocate longitudinally in timed relationship with their engagement with the needle so as to assist in feeding the fibrous material toward the extremity of the needle whereafter it is taken up by the delivery rolls as a continuous length of suitably twisted material.

The twist needle may be provided with perforations and with suitable means associated therewith whereby air is continuously sucked into the interior of the needle to assist in holding the fibrous material against the outer surface of the needle.

The present invention also contemplates the utilization of a hollow twist needle whereby a continuous length or core of fibrous material may be fed through the twist needle and also around which fibrous material is twisted so as to be delivered as a continuous length wound upon the core from the free end of the twist needle.

Additionally, the twist drum may be associated with a single needle or a plurality of needles arranged in a circular pattern and which are rotated to engage the twist belt or twist drum or drums sequentially as sequential lengths of fibrous material are fed thereto. The utilization of a twist needle or a plurality of twist needles arranged circumferentially in spaced relationship around the feed or twist drum or roll allows a multiply yarn or the like to be formed, the means for delivering predetermined lengths of fibrous material to the twist needles being timed with the sequential indexing of the needles so that when each is placed in a position between the twist drum and the twist belt or between the twist drums, a predetermined length of fibrous material is fed thereto and loaded thereon, a continuous length of material thereby issuing from each needle.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

FIG. 1 is a vertical section illustrating certain component parts of the machine;

FIG. 2 is a side elevation of the machine, certain components being omitted for clarity;

FIG. 3 is a transverse vertical section taken generally along the plane of section line 3—3 in FIG. 1;

FIG. 4 is an enlarged vertical section showing details of the twist drum and related drive mechanism;

FIG. 5 is a partial side elevation showing certain drive components;

FIG. 6 is another view of the drive components shown in FIG. 5;

FIG. 7 is a vertical section taken through the twist drum;

FIG. 8 is a bottom view of the twist drum drive member 302;

FIG. 9 is a schematic view of a cylindrical cam illustrated in the flat for the purpose of exposing the profile of the cam;

FIG. 10 is an elevation of one twist drum segment;

FIG. 11 is a top plan view of the segment;

FIG. 12 is a longitudinal section through the segment;

FIG. 13 is a top plan view of the indexing mechanism;

FIG. 14 is a fragmentary view illustrating a modified form of twist belt;

FIG. 15 is a horizontal section of the modification of FIG. 14;

FIG. 16 is an elevation of a modified form of twist needle;

FIG. 17 is a partial view showing the operation of the modified twist needle;

FIG. 18 is a longitudinal section through a further modification of the twist needle;

FIG. 19 is an elevation of the twist needle of FIG. 18;

FIG. 20 is a sectional view similar to FIG. 1 but illustrating a modified form of the machine;

FIG. 21 is an enlarged vertical section taken through the multiple needle assembly;

FIG. 22 is a fragmentary view illustrating details of the drive assembly;

FIG. 23 is a top plan view of the Geneva stop mechanism;

FIG. 24 is a fragmentary view illustrating an optional attachment for the multiple needle machine; and

FIG. 25 is a view similar to FIG. 9 but showing a cam profile for the multiple needle machine;

FIG. 26 is an elevation view of a modified form of the needle and associated mechanism; and

FIG. 27 is an elevation view of another modification form of the needle and associated mechanism.

DETAILED DESCRIPTION OF THE INVENTION

With reference now more particularly to FIG. 1, the reference character 10 indicates in general the frame of the machine and which will be seen to include a bed plate 12, uprights such as those indicated by the reference characters 14 and 16, a table portion 18 supported by uprights 14 and carrying at its forward end a frame 20 of generally C-shaped configuration as shown. The table 18 supports a draft roll assembly indicated generally by the reference character 22 which is adapted to receive the fibrous material from a suitable source 24 and deliver it in intermittent drafted lengths to the delivery belt assembly indicated generally by the reference character 26. The main drive shaft for the machine is indicated by the reference character 28 and imparts drive as hereinafter described to the shaft 30 which is journaled in suitable supports 32 and which carries a cam 34 engageable with a follower 36 on the arm 38 which is pivoted as at 40 to the depending member 42 fixed to the bed 18. The free extremity of the
arm 38 slidably engages with the boss 44 which carries a pair of upstanding rods 46. These two rods project upwardly in parallel relationship and are guidably received in the upper and lower arms 48 and 50 of the frame 20. These rods are disposed inside-by-side relationship and each rotatably carries a pulley 52 over which the respective belts 54 and 56 are trained, these belts being also trained about pulley portions 58 and 60 such that adjacent flights of the two belts are in juxtaposition and oscillatingly carry intermittent drafted lengths of fibrous material between them for lateral delivery from top to bottom or bottom to top to, in this instance, the twist belt indicated generally by the reference character 62. The mechanism thus far described is in conformity with my aforesaid copending application and the subject matter of such copending application is incorporated herein by reference.

As is also described in the aforesaid copending application, the mechanism for delivering the intermittent drafted lengths of fibrous material to the belts 54 and 56 includes the back bottom roll 64, the bottom break draft roll 66, the bottom front drafting roll 68, and the corresponding top back roll 70, top break draft roll 72, and top front drafting roll 74.

A stand 76 is rigidly affixed to the table 18 as by means of suitable fastenings 78 and a support stand 80 is in turn mounted thereon for supporting the two rolls 64 and 66 substantially as shown, the main stand 76 also supporting the roll 68 and, in the upstanding spaced portions 82 thereof, the shafts 84 and 86 which carry the pulleys 58 and 60 over which are trained the delivery belts 54 and 56 respectively.

An upper stand 88 is pivotally secured to the lower stand 76 by means of the pivot shaft 90, a depending portion 92 carrying the roll 74 as shown and there being a floating stand portion 94 guidably held by the upper stand 88 by means of a slotted guide arm 95 extending downward from the upper stand 88 and an upstanding rod portion 96 suitably guided in the stand 88 and with there being a compression spring 98 urging the stand 94 downwardly so as to carry the rolls 70 and 72 which are supported thereon into resilient engagement with their corresponding rolls 64 and 66.

The upper stand 88 is provided with a depending rod 100 pivotally pinned thereto as at 102 and depending therefrom for pivotal connection at 104 with the arm 106 which is in turn pivoted to the table 18 through the intermediary of the pin 108 carried by the depending member 110. The opposite end of the arm 106 is provided with a compression spring 112 which urges the stand 88 downwardly as will be evident. Thus, the various rolls are in proper interengagement and yet are allowed a certain and limited degree of floating action.

On opposite sides of the assembly 22 and upstanding from the bed plate 12 are the side support plates 114, one of which is shown in FIG. 2 and the other of which support the previously mentioned shaft 28, and shaft 30 is journaled in said supports 32. The two shafts are drivingly coupled by means of the respective gears 116 and 118 and the shaft 28 carries a sprocket 120 over which the chain 122 is trained, the chain being engaged with a further sprocket 124 fixed to the cross shaft 126. The shaft 126 has a bevel gear 128 affixed thereto which is in mesh with a further bevel gear 130 fixed to the downwardly inclined shaft 132 which is journaled adjacent its opposite ends by means of the respective bearing stands 134 and 136. The shaft 132 carries a further bevel gear 138 which is in mesh with the bevel gear 140 on the vertical shaft 142 which is journaled in the bed plate portion 12 and in suitable horizontal support portions 144 and 146 of the upright 16. It will be appreciated that the assembly shown in FIG. 2 is at one side of the machine and, as will be seen in FIG. 3, a generally similar shaft 150 is journaled in the other corner upright 16 at the opposite side of the frame 10. These two shafts 142 and 150 are provided with the pulleys 152 and 154 over which the twist belt generally indicated by the reference numeral 62 is trained, the aforementioned drive for the shaft 142 imparting motion to the belt flight 156 in the direction of the arrow A as shown in FIG. 3. The lower ends of the two shafts 142 and 150 have pulleys 158 and 160 affixed thereto and a belt 162 is trained about these pulleys so as to impart drive from the shaft 142 to the shaft 150 and maintain the flight portion 156 of the twist belt 62 taut as it travels in the direction of the arrow A.

The upper end of the shaft 142 is provided with a sprocket 163 over which the chain 164 is trained and a corresponding sprocket 166 which is journaled in the upper arm portion 48 of the frame 20 as may be seen better in FIG. 4. The shaft 168 carries a further sprocket 170 over which the chain 172 is trained to drive the sprocket 174 fixed to the discharge drum drive shaft 176.

The shaft 168 further carries a gear 178 in mesh with the gear 180 engaged with the needle 182. The needle 182 and the discharge drum indicated generally by the reference character 184 are inclined at an angle with respect to the path of movement of the twist belt 62 substantially as is illustrated in FIG. 3.

Before proceeding with the description of the novel discharge drum twist needle arrangement according to the present invention, certain more conventional drive arrangements will be described first. The delivery rolls 190 and 192 are adapted to draw the finished fibrous product 194 from the end of the needle 182 as will hereinafter be more fully described. As may be seen in FIGS. 2 and 3, the delivery roll shaft 190 is journaled between the corner upright 16 and is provided at one end with a worm wheel 196 which is driven by a worm gear 196 journaled in the bearing mount member 198 carried by an extension 200 of the side plate 114 and which includes a shaft portion to which the pulley 202 is affixed. The pulley 202 is driven through the medium of the belt 204 from the pulley 206 fixed to the previously mentioned shaft 142. The roll 192, on the other hand, is mounted for slight movement toward and away from the roll 190 and, to this end, as may be seen more clearly in FIG. 1, the L-shaped arm 208 is provided. This arm has its upstanding portion 210 pivotally secured as by the pin 212 between the bifurcations of a horizontal support member 214 fixed to the cross brace member 216 with the lower extremity of the portion 210 being provided with a tension spring 218 serving to urge the roll 192 resiliently against the roll 190 substantially as is shown.

The continuous drive for the bottom front drafting roll 68 and the bottom fiber carrier shaft 86 is shown in FIG. 2. These two portions are provided with the respective gears 224 and 226, one of which is in mesh with a gear at one end of the shaft 126 in mesh with a gear at the other end of the shaft 126 so as to impart unidirectional rotation to these two portions 68 and 86.
The intermittent motion for the back bottom roll and the bottom break roll in turn issues intermittent lengths of fiber to the delivery belts 54 and 56 in shown in FIGS. 5 and 6. As illustrated in these two Figures, the main drive shaft 28 is provided with a cam 230 which engages a follower 232 carried by the bell crank lever 234, the opposite end of which carries a pawl 236 spring (not shown) urged against the teeth of the ratchet gear 238. The ratchet gear 238 is carried by a shaft 240 to which the gear 242 is attached and this gear is in mesh with the gears 244 and 246 connected respectively to the back bottom roll 64 and the bottom break draft roll 66. The holding pawl 252 is provided for the ratchet gear 238, substantially as is shown.

In operation of the machine as thus far described, the fibrous material from the supply creel 24 is intermittently issued by the rolls 64, 66, 70 and 72 while the continuous motion of the roll 68 and 74 will draft or break the material into predetermined lengths fed to the belts 54 and 56 where the lengths are fed to the needle 182 either from top to bottom or from bottom to top thereof. Actually, the fibrous material is fed to the twist belt 62 closely adjacent the needle 182 in the fashion disclosed in my aforesaid copending application. Preferably, the delivery is from the bottom to the top of the needle although it will be understood that either method may be utilized.

With reference now more particularly to FIG. 4, the construction of the discharge drum may be seen therein. The discharge drum shaft 176 is provided with a pair of drive members 308 and 320 affixed thereto, each having a plurality of longitudinally extending and circumferentially spaced T slots 304 therein as is illustrated in FIG. 8. Fixed to the arm 48 of the frame assembly 20 immediately above the drive element 308 is the cam element 306 having a cam groove 308 therein which is illustrated in FIG. 9 in flat form and a plurality of segments 309 are arranged to form a cylindrical outer surface for the discharge drum assembly 184. One of the segments 309 is illustrated in FIGS. 10, 11, and 12 wherein it will be seen that each includes a pair of inwardly directed T head members 310 engageable in the respective T slots 304 of the driving elements 308 and 320 and each is also provided with a cam follower portion 312 adjacent its upper end engageable in the cam slot 308 of the cam member 306. The opposite sides of the segments 309 are provided with tongues 314 in a groove 316 for interfitting engagement between adjacent segments to form the smooth cylindrical outer surface. A bushing member 318 is suitably feathered or splined to the cam element 306 and projects upwardly therethrough around the shaft 176 to terminate in an indicator plate portion 320 and spacer portion 322 substantially as is shown in FIGS. 7 and 13.

The plate portion 320 is provided with an elongate slot 324 through which a fastener 326 is engaged, see particularly FIG. 4, and an indicator pin 328 is provided on the frame arm 48 for registration with suitable indicia 321 on the plate 320 so as to time the cam 306. Timing of the cam 306 can be varied which in turn will vary the length of downward travel of the segments 309 at the point adjacent the needle 182. Travel of the four segments 309 while they are in contact with the needle is always a downward movement so as to discharge the twisted fibers downward along the needle to the tensioning and delivery rolls 190 and 192. The profile view of the cam 306 illustrated in the flat in FIG. 9 will reveal the downward movement which the cam imparts to the segments 309, X, lengthy downward movement; Y, medium downward movement; and Z, short downward movement, respectively. Thus it is seen that the cam follower 312 of the segment 309 with respect to the cam track 308 determines the rate of flow of the fiber discharge, wherein more slope dictates greater discharge, and inversely less slope dictates less discharge. Also note that the up stroke U is rapid and of short duration as it serves no purpose other than to orient the plates to segments 309 in an upward position to position them for their primary movement down along the twist needle 182. It will be noted that the rotation speed of the discharge drum 184 is slower due to its greater diameter, that the rotation speed of the twist needle for smaller diameter so as to maintain the same surface speed between the two adjacent surfaces as they bias the fiber between them urging it down off the twist needle 182 to the tensioning and delivery rolls 190 and 192. It will be noted that the discharge drum 184 and the flight 156 of the twist belt sandwich the needle 182 therebetween. The perimeter of the segments of the discharge drums may be covered with rubber or leather or other suitable material.

To aid in helping the fibrous material to cling closely to the needle 182, same may be provided with perforations throughout as is indicated in FIG. 4, with its bottom end plugged or closed with a conically shaped end to facilitate feed to the delivery rolls 190 and 192 and with the frame arm portion 48 being provided with a suitable chamber 326 communicating through the conduit 328 with a suitable source of vacuum so as to maintain suction at the surface of the needle 182 to aid the fibrous material in clinging thereto.

Alternatively or additionally, the twist belt 62 may be perforate as is illustrated in FIGS. 14 and 15 and a suction shoe 330 may be engaged against the inner surface of the flight position 156 and provided in perforations through its wall portion 332 engaging the belt so as to cause the fibrous material more closely to cling to the belt during the delivery action. To this end, the shoe 330 is of course, connected to a suitable source of suction as is indicated by the reference 334.

FIG. 16 illustrates another form of needle assembly 182" which will be seen to be hollow throughout so as to provide an open lower end 336. With such arrangement, a yarn 338 or other continuous length of fibrous material may be fed through the hollow interior of the needle 182" to issue through the lower end thereof while the continuous fibrous strand is being formed by the needle, such continuous strand being indicated by the reference character 340 in FIG. 17 wrapped and twisted about the central yarn or core 336.

With the arrangement shown in FIG. 17, a certain amount of the suction will be lost due to the open ends construction for the needle 182". Accordingly, the arrangement shown in FIG. 18 and 19 may be utilized as an alternative for the needle 182" illustrated therein.

The needle in this instance comprises a solid interior tube portion 342 which projects upwardly through the gear 180 and which is provided with an annular sealing flange 344 engaging against the interior surface of the upper imperforated portion of needle 182, the lower end of the needle body being provided with an imperforate end having an opening aligned with the bottom of the tube 342 and the tube having a further sealing
flange portion 346 as is shown in FIG. 18. With this arrangement, a better control of the vacuum or suction on the needle surface is afforded while feeding a core 338 through the needle as is described in conjunction with FIG. 17.

A further embodiment of the invention is illustrated in FIG. 20. In this embodiment, the frame 20 is provided with an additional arm portion 350 within which is journaled a carrier 352 carrying a pair of needles 182. A discharge drum 354 is located between the two needles 182 and, if desired, an additional discharge drum 356 may be provided in engagement with the non loading needle 182 which is the left hand needle illustrated in FIG. 20. As may be seen in FIG. 21, the discharge drum 354 is continuously driven through the medium of a sprocket 358 fixed to a quill shaft 360 and to which an internal gear member 362 is also affixed. A member 364 is fixed to the quill shaft 374. Also fixed to the quill shaft is sprocket 362 and the needle carrier 352. The member 364 rotatably supports a shaft 366 to which a gear 368 is affixed and which is in mesh both with the internal gear 362 and with the central gear 370. The gear 370 is affixed to the quill shaft 372 which depends through the bushing member 374 and has drive members 300 and 302 previously described thereto. A hollow central shaft 376 projects through the quill shaft 372 and extends therebelow and to which the cam element 378 is affixed, at the lower end of the assembly. This allows the cam member to be readily changed for purposes hereinafter more apparent.

The discharge drum 354 in this case is provided with four segments 380C constructed generally in accord with the arrangement herein before described and cooperate with the needles as previously mentioned.

The direction of sprocket 382 which rotates the needle carrier 352 journaled in suitable support 350 is opposite the direction of sprocket 358 which imparts rotation to the discharge drum 354. The needles 182 journaled within the needle carrier 352 are rotated through gears 392 and 394 fixed to the needles, and these gears engage the rotatable gear 390 fixed to the discharge drum 354. This novel gear arrangement, while imparting a faster axial motion to the needles 182 and a relatively slower axial motion to the drum 354, keeps and maintains a equal surface speed of the cylindrical bodies which are in tangential agreement with each other. Furthermore, motion is transmitted to sprocket 362 by virtue of chain 446 trained over said sprocket 382 and sprocket 446 which in turn imparts intermittent motion, by means of the geneva stop mechanism 438, to the sprocket 382 which is fixed to the needle carrier 352 of which needles 182 are journaled therein. In this fashion the needles 182 are indexed from the twist belt (load station) radially around the discharge drum 354 to a diametrically disposed position from the twist belt adjacent the discharge drum 354 (discharge station), while this indexing or cycling is taking place.

The previously mentioned bushing 374 has a sprocket 382 affixed thereto and this bushing is splined or otherwise keyed to the needle carrier 352 to rotate the same intermittently, a Geneva stop mechanism being provided as herein after described to drive the sprocket 382 for this purpose, and in so doing indexes the needles to different stations. The one adjacent the twist belt is the load station while the other is diametrically from the load station relative to the rolls 190 and 192.

The continuous drive for the needles 182 is effected through the quill shaft 372 and the gear 390 affixed thereto is in mesh with the gears 392 and 394 affixed to the respective needles 182. For setting the cam 378, the rotatable member 364 is provided with a suitable pointer 400 which, by backing off the set screw 402, will allow the central shaft 376 to be rotated a limited degree to position the collar 404 relative to the pointer 406. The collar 404 is fixed to shaft 376 by a set screw. Retightening the set screw 402 will secure the member 364 to the rotatable central shaft 376, and the rotational adjustment of the central shaft 376 will of course cause more or less motion of the cam assembly relative to segments 380 of the discharge drum 354.

With the arrangement as is shown in FIG. 21, and referring also to FIG. 20, a core or yarn 400 may be fed downwardly through the tube 376 and the continuous yarns 402 and 404 formed by the two needles 182 will be twisted there around to form the desired multi-ply yarn. The twist drum 356 is continuously driven in a manner herein after described and is of construction similar to those previously described hereabove. It will be appreciated that the intermittent motion effected by the herein after described Geneva stop mechanism 438 may rotate the needle carrier 352 either one half revolution, one and a half revolutions, two and a half revolutions, etc., to impart the desired twist to the outer plies. Additionally, more than two needles may be employed if so desired.

FIG. 22 illustrates the drive arrangement for the embodiment of the invention shown in FIG. 20 and 21. As illustrated in FIG. 2, the previously described shaft 126 is driven through the sprocket 124 by the chain 122 from the main shaft 26 and the bevel gear set 128, 130 drives the vertical shaft 142. FIG. 22 also illustrates the drives to the two rolls 68 and 86 previously described, the shaft 126 being provided with spur gears 410 and 412 at its opposite ends in mesh with the respective gears 224 and 226 on the two shafts 68 and 86 respectively.

Additionally, the shaft 126 is provided with a bevel gear 418 in mesh with the bevel gear 420 which drives the vertical shaft 422 journaled in the arm portions 424 and 426 affixed to the plate 114, as shown. A gear 430 fixed on the shaft 422 in mesh with the gear 420 on the shaft 434 which effects the continuous drive to the twist drum 356 through the medium of sprocket and chain connections as indicated by the reference character 436, the drive shaft for the drum 356 being indicated by the reference character 439.

The shaft 422 carries a Geneva stop mechanism indicated generally by the reference 438 which intermittently drives the shaft 440 through the Geneva cam 442 as to impart intermittent rotation to the sprocket 444 which is connected by means of the chain 446 to the previously mentioned sprocket 382. The sprocket 448 fixed to shaft 422 drives the previously mentioned sprocket 358 through the medium of the chain 450. The Geneva stop mechanism 438 is conventional in construction and an embodiment thereof is illustrated in FIG. 23.

In FIG. 21 to aid in helping the fibrous material to cling closely to the needles 182, the needle carrier 352 is provided with a suitable annular chamber 326 communicating through the conduit 328 with a suitable
source of vacuum so as to maintain suction at the surface of each needle carried by the carrier, to aid the fibrous material to cling thereto.

In the embodiment of the invention shown in FIG. 24, a ram or compressor 460 may be provided immediately below the needle assembly to compress the yarn as it enters the nip between the tow rolls 192 and 190.

FIG. 25 illustrates the cam profile, in flat, of the cam 378 shown in FIG. 21. This cam has two dwell portions O, tow up stroke portions U and two downstroke portions D. It will be appreciated that while the needle is loading, the downstroke portion D will be effective to cam the associated segment in a downward direction while the other downstroke portion D cams the opposite segment downwardly with respect to the nonloading needle. The slopes of the downstroke portions D control, to some extent, the amount of twist applied to the yarn and it is for the purpose of allowing different downdraws to be achieved that the cam 378 is located at the lower end of the unit 354 as is illustrated in FIGS. 20 and 21 where it is readily accessible for replacement by a different cam. As previously described, cam 378 can be positioned to a greater degree of slope or a lesser degree slope opposite each needle by loosing set screw 402 and revolving shaft 376 to the desired cam position. The set screw 402 is then tightened which sets the cam 378 to give the desired downward rate of movements of the drum segments in contact with the needles. Due to the fact that the needle and fibrous material is rotating while the rolls 190 and 192 hold the discharge fibre stationary, a single yarn twist is imparted to the twist needle itself, but in the space portion between the needles and the rolls 190 and 192. In effect, if a strand of fibre is discharged rapidly from the rotating needle 182 to the stationary rolls 190 and 192 it will have less twist that a rotating strand discharged at a slower rate. The revolving of the needle carrier 352 for position the needles in the loading position also inserts the twist in the ply yarn.

In any event, for the single needle embodiment of the invention as was described for example, in conjunction with FIG. 4, it will be appreciated that the intermittent drafts of fibrous material are fed to the needle in such fashion as to overlap the ends thereof so that the fibrous material issues as a continuous length from the end of the needle. The twist imparted to the yarn is controlled not only by the speed of the belt 156 and the rotational speed of the discharge drum 184 and the rotational speed of the needle 182 but also by the slope of the cam urging the segment downward along the needle and the rotational speed of the needles 182 in relation to the rate of discharge from the segments to the rolls 190 and 192. Various desired twists may be effected by changing the relative speeds of the various components as well as by changing the degree of the cam setting or by changing the entire cam.

The same is true for the multiple needle embodiments such as are shown in FIG. 20 except, in this case, a continuous length of yarn is fed from each needle so that a multi-ply yarn is achieved. Additionally, it will be appreciated that feeding the fibrous material from the top to the bottom of the needle will effect more twist. That is to say, if the needle is loaded from the delivery end thereof upward or toward the top of the needle the spirals on the needle reduce the twist on the single yarn whereas when the needle is loaded from top to bottom or toward its delivery end, the spirals on the needle add to the single yarn twist. In any event, more efficient single yarn twisting is effected when the needle is loaded from top to bottom.

In operation of the open end spinning and ply twisting machine as described, the fibrous material from the supply creel 24 is intermittently issued by the rolls 64, 65, 70 and 72 which the continuous motion of the rolls 68 and 74 will draft or break the material into predetermined lengths which are fed to the belts 54 and 56. The juxtaposed belts 54 and 56 deliver the fiber lengths to spinning and ply twisting embodiment of the invention illustrated in FIG. 21 and FIG. 20. The needle on the right side of the drawing or next to the twist belt 62 is considered to be in the loading position. In order to identify the needles on the carrier 352 the needle on the right side is No. 1 needle and the needle on the opposite side is No. 2 needle. The juxtaposed belts 54 and 56 on the upstroke deliver a fibrous length to the twist belt 62 near the loading needle No. 1. The needle No. 1 with the aid of the suction on the surface of the needle winds the fibrous length spirally upward on the needle. The Geneva stop mechanism is timed to revolve the carrier 352 ¼ revolution, placing the No. 2 needle in the loading position and No. 1 needle between drums 356 and 354, during the down stroke of the juxtaposed belts 54 and 56. Again the belts 54 and 56 on the upstroke deliver a fibrous length to the twist belt 62 whereby it is spirally upward wound on the No. 2 needle. As previously explained the twist belt and drums 356 and 354 assist in revolving the fibrous material on the needles and also feed the fibrous spiral lengths toward the needles extremities. The rate the spiral lengths are moved toward the needle extremity is predetermined to give the correct amount of overlap of the fibrous spiral lengths on the needle. It may be seen that the repetition of the above operations places a continuous spiral of fibrous material on each needle and the revolving of each needle twists the single yarn 402 and 404. In the overlap portion of the fibrous material on the needle it is preferred that the delivered spiral of fibrous material be placed over the preceding spiral of fibrous material. The revolving of carrier 352 for positioning the needles for loading also twists the two single yarns 402 and 404 into a ply yarn. As previously explained a ply yarn 400 may be fed through the center shaft 376 to the delivery or tensioning rolls 190 and 192 thereby making possible the production of a ply twisted yarn of a relative high number of twisted plies.

In reference now more particularly to FIG. 26, it will be seen that the twist belt 62 shown in all the aforementioned embodiments has been done away with in this instance. Delivery of the drafted fibre from the juxtaposed delivery belts 54 and 56 in this embodiment deliver the fibre directly to the twist drum 184 in the same fashion as they delivered it to the twist belt 62 as has been herein before disclosed. In this novel delivery fashion of the delivery conveyor 26 to the outer periphery of the twist drum 184 it will be seen that the twist belt 62 is not necessary for the function of the machine and if desired can be eliminated entirely. The configuration of the fibre as is delivered to the twist drum in this embodiment duplicates closely the same configuration of the fibres as they were accumulated on the twist belt 62 previously mentioned. This is due to the fact that the surface speed of flight 156 of the twist belt assembly 62 and the surface speed of the twist drum 184 are approximately equal speeds.
Referring now to FIG. 27, it will be seen that the juxtaposed delivery belts 54 and 56 of the conveyor 26 may also deliver the drafted fibre directly to the needle and thereby eliminating again the necessity of the twist belt assembly 62 for delivery of the drafted fibres to the twist needle 182. In this embodiment the needle could be oriented perpendicular to the train of the pulleys 52 and wedged closely adjacent the bifucation caused by the two juxtaposed delivery belts 54 and 56 trained around pulleys 52. A twist drum 184 is diametrically disposed from the delivery belts 54 and 56 and its primary function in this instance is to discharge the fibres downward along the twist needle 182 to the tension rolls 190 and 192. This needle 182 picks up the fibre from the delivery belts 26 which will be referred to as the load station and rotably carries it to the discharge station which is that point when the loaded fibres are in tangential agreement with the twist drum 184 for discharge to the rolls 190 and 192.

In this particular embodiment only one needle can be used due to its wedged orientation between the pulleys 52. But it will be obvious to those skilled in the art that a plurality of needles could be used in conjuction with this direct delivery to the needle, through the employment of conventional linkage to swing the needle 182 and drum 184 assembly away from the pulleys 52 to un-wedge the needles 182 for indexing. Or visa versa the pulleys 52 and their associated parts could be moved away from a rotably fixed needle, 182 and drum assembly 184.

I claim:
1. A process of producing yarn comprising providing a plurality of elongated cylindrical bodies spaced about a longitudinal axis, rotating each said body about its longitudinal axis, feeding separated fibers to the outer surfaces of such rotating bodies and twisting said fibers on such surfaces to form yarns, withdrawing said yarns from said surfaces and twisting them as they are withdrawn, and revolving said cylindrical bodies about said first-mentioned longitudinal axis so as to twist yarns together to form a ply yarn.
2. A process as in claim 1 comprising the further step of feeding a continuous length of fibrous material along said first-mentioned longitudinal axis and twisting said yarns about said fibrous material as a core.
3. A process of producing yarn comprising providing a plurality of elongated cylindrical bodies spaced about a longitudinal axis, rotating each said body about its longitudinal axis, feeding separated fibers to the outer surfaces of such rotating bodies, withdrawing fibers from extremities of said surfaces and twisting them as they are withdrawn to form yarns, and revolving said cylindrical bodies about said first-mentioned longitudinal axis so as to twist said yarns together to form a ply yarn.

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