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2,621,391

YARN FEEDING AND TENSIONING DEVICE AND PROCESS

Filed Oct. 20, 1949

2 SHEETS—SHEET 1

Fig. 1.

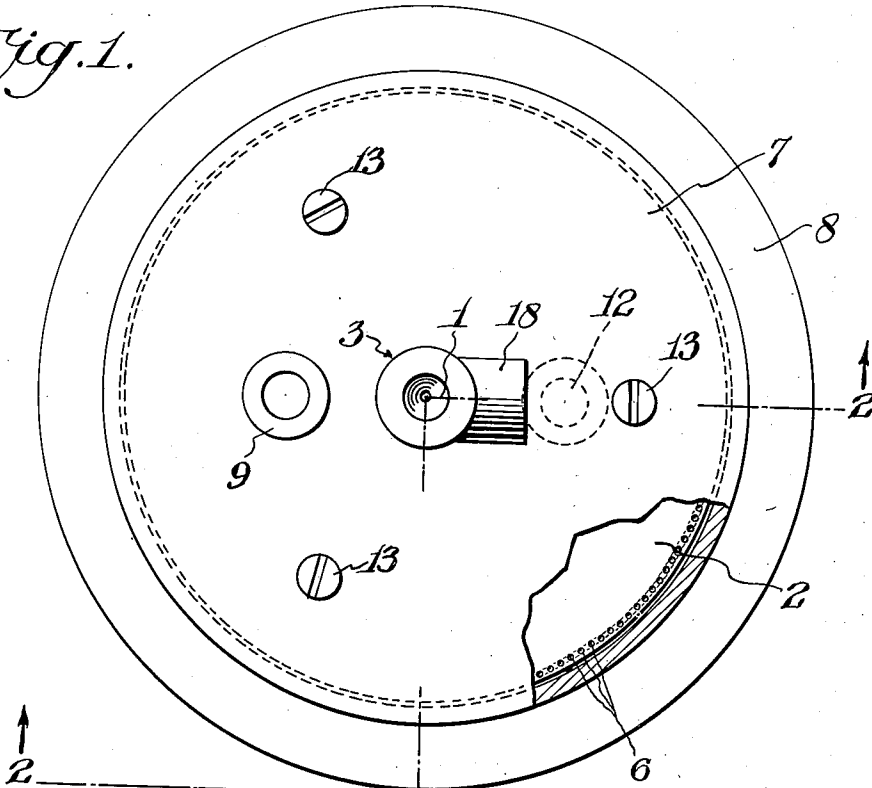
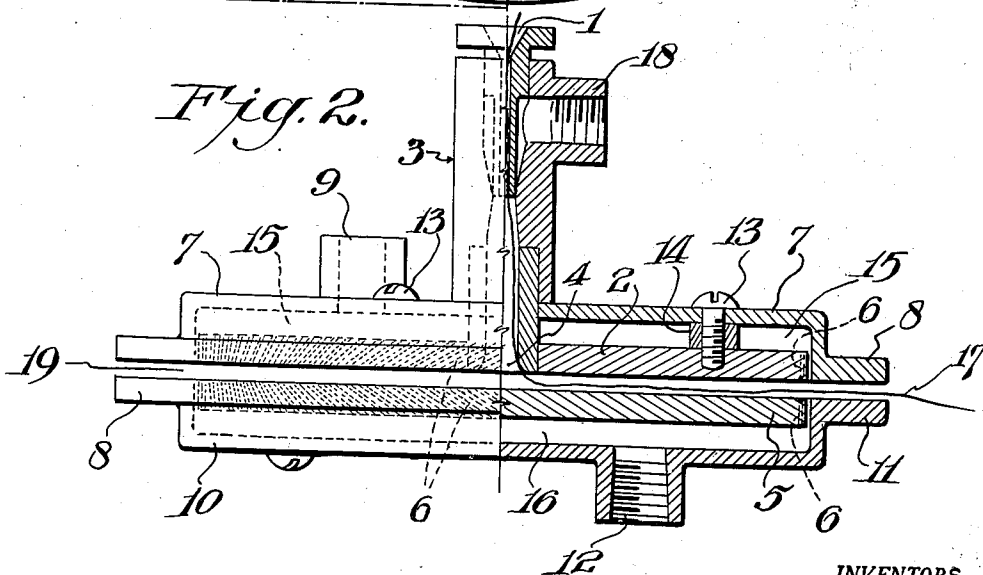


Fig. 2.



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2 SHEETS—SHEET 2

Fig. 3.

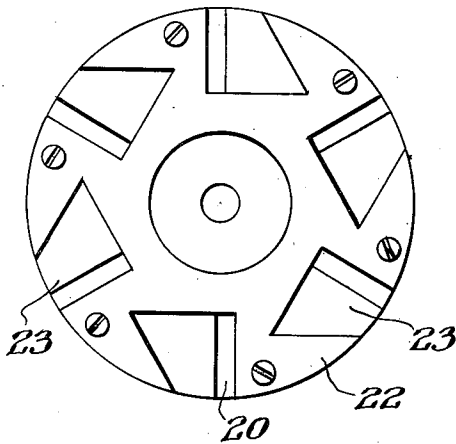


Fig. 4.

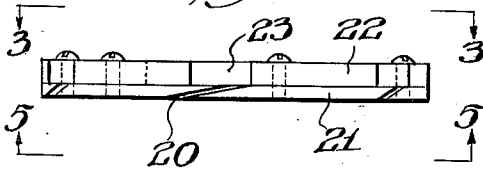


Fig. 5.

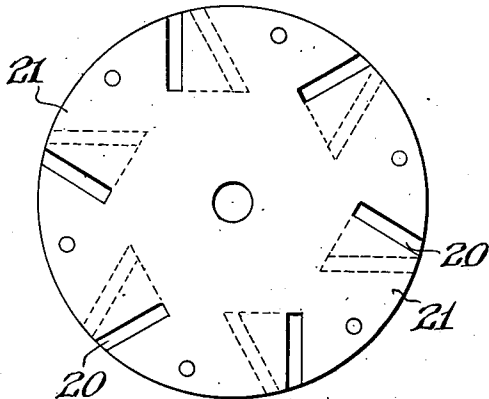


Fig. 6.

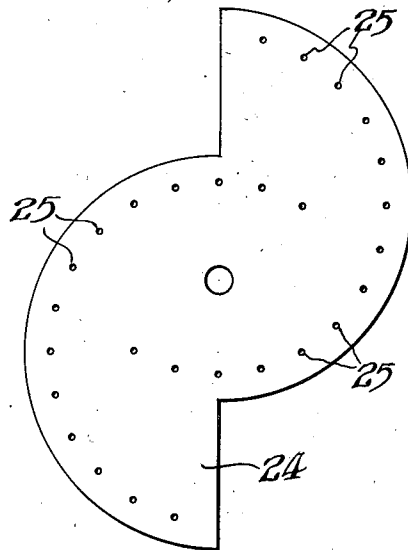
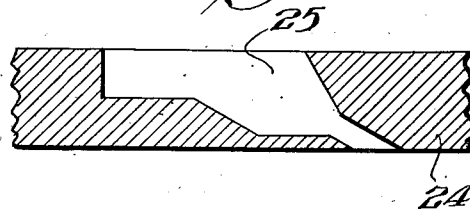


Fig. 7.



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YARN FEEDING AND TENSIONING DEVICE
AND PROCESS

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8 Claims. (Cl. 28—71.5)

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This invention relates to textile staple and winding processes. More particularly it relates to a device and process for feeding and tensioning yarn and delivering the yarn at very high speeds to a suitable collecting surface or inter-

mittently to a cutting blade for the conversion of continuous filaments into staple fiber.

In the manufacture of filaments, yarns, threads and the like, it is highly desirable to wind or deliver freshly formed filaments at very high speeds. This is especially true in connection with the extrusion of some of the synthetic filament formers which are melt-spun and which are capable of being drawn away at speeds heretofore thought to be entirely impracticable. For example, speeds in the range of from 3,000 to 6,000 yards per minute and upward have been found entirely practical from the standpoint of extrusion but difficulties have arisen in delivering or winding up filaments or yarns at such high speeds.

It is, therefore, an object of this invention to provide a filament or yarn take-up device capable of drawing the filamentary or funicular structure away and maintaining it under tension until it is wound up or cut into staple lengths. A further object of the invention is to provide a tensioning draw off device capable of handling yarns, ribbons, tubes, rods, artificial horsehairs, straws or other monofilaments or other filamentary structures at extremely high rates of delivery, such as from 3,000 to 6,000 or even 10,000 yards per minute. Other objects will be apparent from the description that follows.

The objects of this invention are accomplished by the use of an apparatus which consists of a chamber equipped with a plate having a ring of blower holes. Preferably, there are two such chambers, circular in shape and mounted so that the plates are directly over each other with a small space separating them and with the holed surface of each lying face to face. Actually, only one plate need be perforated, but, in practice, both plates are preferably blower plates. Each of the holes composing the ring of the upper plate is machined so that emitted air is directed down and approximately tangentially forward with respect to the ring of holes. In the lower plate the holes direct the air up and approximately tangentially forward. A suction inlet is located in the center of one of the chambers, preferably in the top center of the upper chamber. The suction inlet facilitates the "stringing up" operation, but it is not necessary for advancing the yarn after that operation is completed. Upon passing through the yarn inlet and through the space between the two blower plates, the advancing yarn is given a rotary motion by the tangential jets of air. These jets do not rotate; the yarn is merely propelled from one jet to the next so that it moves at a high speed in a circular path.

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It thereby acquires a centrifugal motion and tends to move radially outward. One or more times each revolution the protruding end passes a properly positioned knife blade which cuts the fiber into short lengths.

The apparatus, then, comprises means for feeding a fluid under pressure to an area of turbulence and means for feeding the traveling structure to this area. By releasing the fluid under pressure from the plenum chamber into a small space the fluid moves at a high speed. By feeding the structure into this area of rotating, high speed turbulence, the structure is rotated at high speeds.

Reference is made to the discussion below and to the figures which are given only for illustration and of which:

Figure 1 is a plan view partly in section;

Figure 2 is a side elevation partly in section taken on line 2—2 of Figure 1;

Figure 3 is a plan view of a backup plate, taken on 3—3 of Figure 4;

Figure 4 is a side view of the backup plate attached to a slotted plate;

Figure 5 is a bottom plan view, taken on 5—5 of Figure 4, of a slotted plate;

Figure 6 is a plan view of a spiral slotted plate; and

Figure 7 is a detail of a jet hole in the plate of Figure 6.

In Figure 2, a yarn inlet 1 is centrally located perpendicular to upper blower disk 2. The inlet is in the top of tubular member 3, which also has yarn outlet 4 at the bottom. Situated close to upper blower disk 2 is lower disk 5. In each of these disks is a plurality of blower holes or slots 6. While one blower hole is sufficient, for greater uniformity of fluid distribution and hence, yarn movement, a plurality is preferred. For example, each plate may be equipped with a ring of 36 blower holes uniformly spaced, each hole having a cross-sectional area of 0.0016 square inch. The holes are conveniently formed by machining rectangular slots in the peripheral edge of the blower plate but may be formed in any desired manner and with any cross-sectional shape. The plates are mounted directly over each other with a small space (about $\frac{1}{8}$ inch) separating them and with the discharge end of each ring of holes lying face to face. Each of the holes composing the ring of the upper plate is formed so that emitted air is directed down and approximately tangentially forward with respect to the ring of holes. In the lower plate the holes direct the air up and approximately tangentially forward. The holes are formed at an angle of from 10° to 30° from the horizontal. Actually, the tilt of the hole from the horizontal may be greater than 30° but at the greater angles efficiency drops. Accordingly, the holes are usually drilled at angles of from 10° to

50° from the horizontal with angles of 10° to 30° being preferred.

Situated around the upper disk is a housing 7 bearing flange 8 and fluid inlet 9. Similarly, other lower disk has a housing 10, flange 11 and inlet 12. The housings are suitably attached to the respective disks by means, for example, of screws 13 and spacers 14. An upper pressure chamber 15 and a lower chamber 16 of a desired size are thereby formed. The upper section comprising the blower plate, housing and yarn inlet may be mounted in any convenient way (not shown) independent of the mounting of the lower section, or the two sections may be bracketed together providing for sufficient clearance for the rotating yarn and the unit may be suitably mounted on a frame (not shown).

In operation the yarn 17 or article to be handled is fed into the yarn inlet 1. The device may be inverted and the yarn fed upwards to it if desired. Usually, the device is used in the position shown. Air or the fluid being used is fed under pressure into the upper plenum chamber 15 via inlet 9 and into plenum chamber 16 via lower inlet 12. Since the air jets in the plates, consisting of holes and/or radial slots, are tilted at an angle of 30° or less to the horizontal, the air from both plates is led into the space between the plates in a rotating or whirling manner. As a result of this rotation, air is exhausted from the central portion of the area between the plates and a suction is created in the tubular member 3 or in the yarn inlet 1. When a yarn is introduced in the inlet tube, it is pulled down between the plates and then outwardly. An auxiliary jet 18 may be located on the tubular member 3. Forcing fluid through this inlet creates additional suction and facilitates the string-up. After the yarn reaches the space between the plates, designated as the area of turbulence or yarn rotation 19, it is picked up by the air from jets 6, blowing at right angles to the radial exhaust of air and is propelled in a rotary motion from jet to jet. This rotational motion gives rise to a centrifugal force, some of which appears as tension in the yarn. The yarn is led to a suitable wind-up device or to a knife edge placed at a desired distance from the flange edge 8 or 11 to cut staple of proper length. Generally a plurality of knife edges are placed about the periphery of the blower plates.

The plates 2 and 5 are separated by a short distance of $\frac{3}{16}$ inch to $\frac{1}{8}$ inch or up to $\frac{1}{4}$ inch. The distance will, of course, depend upon such factors as the size of the article passing through the device, the pressure used, etc. It is advantageous to construct the device of this invention so that the area of rotation 19 may be varied during operation. Adjustable plates permit ready control of R. P. M. of the yarn and the use of initial large spacings to facilitate string-up.

Normally, the pressure that is employed is from 20 to 180 lbs./sq. in. Any suitable fluid may be used. Air, of course, is preferred in view of its availability, and is used under a pressure of 25 lbs. per square inch gauge. Steam is also very useful because of its low cost, and through its use a yarn may be heat set on the run. Other fluids which may be used include nitrogen, hydrogen, argon, helium, water, alcohols, oils, liquid compositions for lubricating, softening or sizing the filaments, or other similar materials.

The plates may vary in diameter from 2 to 8 inches. They may be of any desirable thickness provided, of course, that they withstand the pres-

sure and that the passageways do not impede fluid flow. Generally, the plates are flat but they need not be. Plates of concave contour may be employed, but for convenience in construction, flat plates are preferred.

As shown in Figure 5 the circular holes shown in Figure 1 may be replaced by narrow slots 20 cut at even a lower angle. The holes are usually cut at a 15° angle. The slots in plate 21, as shown in Figures 4 and 5, may be cut at an angle of 10° to the horizontal, being about 1" deep as measured along the radius, $\frac{1}{2}$ in. wide and contained in a 4 inch diameter plate. With the slots almost as long as the radius, almost the entire rotating yarn segment is acted upon rather than just the tip as is the case with the hole jets. Used with slotted plate 21 is a backup or support plate 22 shown in Figure 3. This plate is bolted to plate 21 as shown in Figure 4. The plate 22 has portions 23 cut away, which are aligned with the slots 20 when the two plates are bolted together.

Another modification is shown in Figure 6. This is a spiral cutter 24 in which the diameters of the plate increases as the length of the rotating yarn grows. The R. P. M. depends on the length of protruding yarn and decreases as the length protruding increases. With the jets 25 arranged as shown in the two off-set circles, giving a spiral effect, the retardation of the protruding yarn segment by the relatively slow moving air outside the cutter plate periphery is avoided. Shown in Figure 7 is a detail of a jet 25. These jets can be replaced with advantage by slots. Fewer drillings are necessary. About four slots are all that are needed. Further, the slotted spiral cutter is more efficient.

The rate of yarn delivery and/or tension on the yarn can be varied widely by changing the number, size and location of the fluid jets or by changing the fluid pressure or character or composition of the fluid. By arranging the jets in a larger or smaller diameter circle, the centrifugal force created can be substantially increased or diminished. The number of jets can be greatly increased or decreased in the same diameter circle and made smaller or larger in cross-sectional area as is desired. The angle at which the slots or other equivalent jet openings are formed around the periphery of the blower disc also may be varied widely.

The rate of yarn delivery may also be increased by the use of auxiliary devices. For example, the yarn may be passed through an auxiliary air jet prior to entering the turbo-cutter. The jet is controlled to accelerate the yarn yet avoid looping. In another arrangement a long tube of small diameter, for example of 4 inch length and $\frac{1}{2}$ inch inside diameter, is vertically attached to the yarn inlet 1 and the yarn is fed into it prior to passing to the cutter. The use of this results in increased through-puts without increased air consumption.

Table

Device	Through-put, yd./min.	Staple Length (cm.)
Turbo device only	3,333	1.9-1.9
Turbo device with auxiliary jet	5,100	3.8-5.1
Turbo device with tube	6,166	2.5-5.1

From the above it can be seen that under the same conditions of operation, more yards/min. of filament are processed with the inlet tube attachment. The auxiliary aspirator draws the

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yarn away from the spinneret and feeds it to the cutter under low tension. The inlet tube permits the air pumping action of the device to act for a longer time on the yarn. Some care has to be exercised to prevent jamming the cutter by feeding it too much yarn, but usually no difficulty is encountered.

By the use of this invention yarns or similar articles may be tensioned, fed to desired wind-up or package forming devices, or cut into staple length at high speeds. For example, delivery rates may be from 3,000 to 10,000 yards/minute. There are no moving mechanical parts that wear out and that interfere with high speed operations. Rate delivery, staple length and amount of tension may be varied and controlled. It is indeed surprising that the delivery rates can be maintained sufficiently constant and uniform to obtain the desired denier uniformity and in the case of staple to obtain substantially uniform length of the cut fiber.

In these respects, the device of this invention has been used successfully to cut such yarns as melt spun polyamide yarns or such other yarns as cellulose acetate or those from vinyl chloride/vinyl acetate interpolymers. Besides being useful as a staple cutter in connection with a spinning unit, it can be used to unwind continuous filament yarn from a suitable package and cut it to staple on the run. Speeds up to 3000 Y. P. M. are reached. Staple length can be varied at will by proper choice of the number of knives and through-put speed.

Any departure from the procedure described herein which conforms to the principles of the invention is intended to be included within the scope of the claims below.

We claim:

1. Apparatus for handling a traveling funicular structure with a fluid under pressure which comprises two plates situated close to each other, one of which is a blower plate having a plurality of orifices through which said fluid is emitted; and an inlet for said structure extending through said blower plate.

2. Apparatus for handling a traveling funicular structure with a fluid under pressure which comprises an upper blower plate and a lower blower plate situated close to each other the said upper plate having a plurality of orifices to direct fluid

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downwardly and tangentially forward and the said lower plate having a plurality of orifices to direct fluid upwardly and tangentially forward; and an inlet for said structure extending through one of said blower plates.

3. Apparatus for handling a traveling funicular structure with a fluid under pressure which comprises an upper blower plate and a lower blower plate situated close to each other, each plate containing a jet and fluid inlet to said jet; and an inlet for said structure extending through one of said blower plates.

4. Apparatus in accordance with claim 3 in which said jet in each of said plates comprises a plurality of holes.

5. Apparatus in accordance with claim 3 in which said jet in each of said plates comprises a plurality of slots.

6. Apparatus for handling a traveling funicular structure with a fluid under pressure which comprises an upper plenum chamber and a lower plenum chamber, each having a blower plate and mounted so that said plates are directly over each other separated by a small space each plate having a plurality of orifices through which said fluid is emitted; and an inlet for said structure extending through one of said blower plates.

7. Apparatus in accordance with claim 6 in which said plates are substantially circular.

8. Apparatus in accordance with claim 6 in which said holes are arranged to give a spiral effect.

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