Aug. 19, 1952 H. H. HEBELER 2,607,418

STAPLE CUTTER

Filed April 10, 1951

Fig. 1.

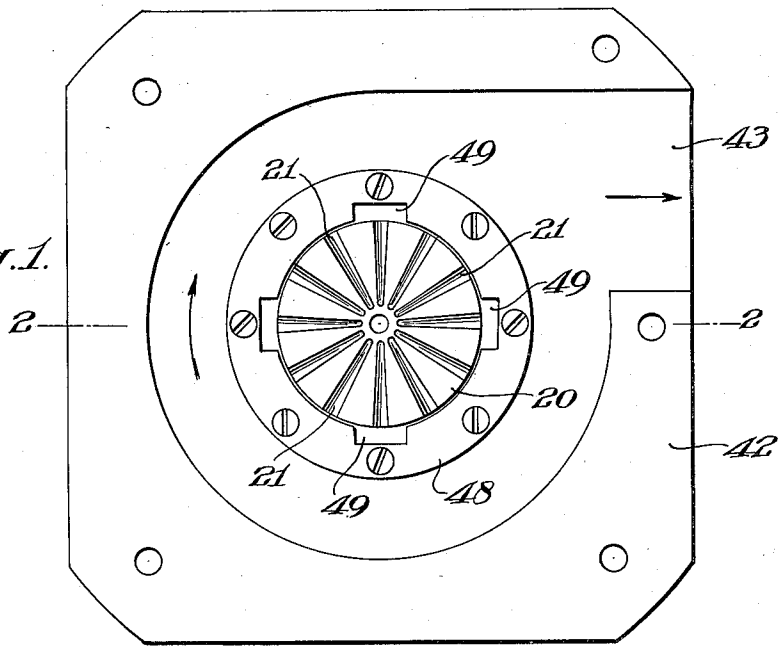


Fig. 3.

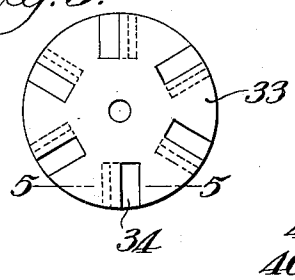


Fig. 4.

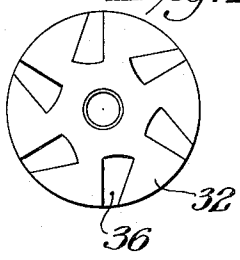
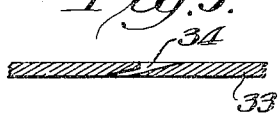


Fig. 2.

Fig. 5.



INVENTOR.
HAROLD HENRY HEBELER
BY
Norris E. Ruckman
ATTORNEY.

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STAPLE CUTTER

Harold Henry Hebeler, Eggertsville, N. Y., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del., a corporation of Delaware

Application April 10, 1951, Serial No. 220,152

5 Claims. (Cl. 164—38)

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This invention relates to a device for drawing continuous lengths of yarn, and the like, from a filament-forming operation and cutting the yarn into staple.

In the manufacture of staple from filaments, yarns, threads, and similar continuous structures, it is desirable to draw off and cut up freshly-formed filaments at very high speeds. This is especially true in connection with the extrusion of some of those synthetic filament-formers which are capable of being melt-spun and drawn away at exceptionally high speeds, such as in the range of from 2,000 to 5,000 or more yards per minute. One method of accomplishing this is disclosed in the co-pending application of Hoffman and Signaigo, Serial No. 122,422, filed October 20, 1949 and assigned to the assignee of the present application. In accordance with this earlier application the high-speed draw-off and delivery to a wind-up or cutting blade are achieved through the action of high velocity jets, and these alone are relied upon to create the desired centrifugal force. This method and apparatus may be used very effectively in many instances. However, when long length staple is to be cut, there is a tendency for this equipment to jam due to a reduction of velocity in the yarn resulting from excessive windage losses when the long tail of the filament bundle moves through the relatively immobile air surrounding the blower. Furthermore, excessive amounts of air must be used with this earlier-described apparatus which reduces its attractiveness from a practical point of view.

It is, therefore, an object of this invention to provide an improved filament or yarn draw-off and staple cutter capable of pulling a filamentary or funicular structure away from a forming operation under tension and moving it at high velocity against a cutting blade. A further object of the invention is to provide an improved tensioning draw-off cutter capable of handling yarns, ribbons, artificial horse hair, straws, or other monofils or other filamentary structures at extremely high rates of delivery while maintaining high-operating efficiency. Other objects will become apparent from the description which follows, the drawings and the appended claims.

The objects of this invention are accomplished by the use of an apparatus comprised of a plate having a ring of tangentially directed blower holes and a co-acting revolvable disc rotated by the jets. Yarn or the like fed into this apparatus is thereby tensioned and held by the centrifugal force created while being cut by a knife suitably disposed near the periphery of the revolvable disc.

In the drawings, which illustrate a preferred embodiment of the invention,

Figure 1 is a plan view with the top of the apparatus removed,

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Figure 2 is a vertical section through the middle of the apparatus, passing through the portion shown in Fig. 1 on the line 2—2,

Figure 3 is a plan view of a slotted blower plate used in the apparatus,

Figure 4 is a plan view of a plate used to support the blower plate, and

Figure 5 is an enlarged section to show details of one of the slots of the blower plate, taken on the line 5—5 of Fig. 3.

In the description that follows reference is made especially to Fig. 2. In the vertical section of the apparatus shown there is a bottom supporting plate 11, bolted to suitable supporting members 12 and 13, and also bolted to stationary rotor housing 14. Inside the housing 14, centered on the vertical center line thereof, is a revolvable shaft 15 mounted in high grade ball bearings 16. The bearings are suitably spaced apart by means of spacer tube 17 fitted loosely over the shaft 15. These bearings are lubricated through oil vapor line 18 running diagonally through rotor housing 14. To the upper end of shaft 15 is fastened, by means of screw threads, a rotor plate 20 having a flat upper face provided with a plurality of radial grooves 21 (shown more clearly in Fig. 1), which will be described in detail hereinafter. Above the rotor 20, and centered on the same vertical center line as shaft 15, is a yarn inlet tube 22. Above this, on the same center line, are an aspirator or yarn string-up jet 23 and an introductory yarn inlet tube 24. Air to operate the jet 23 is supplied through tube 25.

Around the lower end of the yarn inlet tube 22 is an annular chamber 30 formed by an inverted shallow cup-like member 31, which forms the side wall and upper face of this chamber, and flat bottom plates 32 and 33, which form the bottom of the chamber. In the lower plate 33 there are provided six narrow radial slots 34 (Figs. 3 and 5). The slots 34 do not pass vertically through the bottom plate 33, but are tilted at an angle of 12° to the horizontal, as shown in Fig. 5. Plates 32 and 33 are bolted together, and plate 32 is centrally supported by screw threads on yarn tube 22 to form the lower face of chamber 30. To this annular chamber there is a pipeline connection 35 for feeding compressed air or other compressed fluid thereinto. Openings 36 (Fig. 4) are provided in plate 32 for passage of the compressed air out of the chamber through the slots in plate 33.

Surrounding the rotor housing and the blower assembly just described is a chamber 40 formed by two thick, cup-shaped members designated 41 and 42. The upper member 41 forms a guard around the side wall of the pressure chamber formed by member 31. The lower member 42 is press-fitted around the stationary rotor housing 14, mentioned previously. Each of these guard pieces, 41 and 42 is made with a circular cavity

having a tangent exit **43** to serve as a yarn outlet (Fig. 1).

Four rectangular notches **44** are evenly spaced around the inside of member **41** adjacent to rotor **20** for location of cutting knives and their supporting parts. The cutting knife **45** is supported by a two-piece holder **46**, which is bolted together, and held in position in notch **44** by a horizontal bar member **47** bolted in the top outer surface of the guard **41**. The knife **45** extends down into the open space between the top of rotor housing **14** and the roof of the cavity formed by the guard **41** at the side of rotor **20**. To reduce the air resistance and free space, and to serve as an additional guard member, a ring **48** is fastened to the top face of housing **14**. This ring also has four rectangular cut-out portions **49** for knives (Fig. 1), conforming to the notches **44** in the upper section of the guard **41**. Although four knife positions are shown any desired number may be used and it is usually preferable to use only one or two knives.

A top view of the rotatable disc or plate **20** is shown in Fig. 1. In the instant case the upper surface is milled out as shown to provide twelve grooves **21**, cut to a maximum depth of $\frac{3}{16}$ inch at the outer edge and tapering up to zero depth at $\frac{5}{16}$ inch from the center. It is important that the clearance between the top of this rotatable plate **20** and the bottom of slotted plate **33** be small, as for instance, from $\frac{1}{32}$ to $\frac{1}{8}$ inch to prevent wastage of air. The aspirator jet **23** and the extension tube or introductory yarn inlet tube **24** are desirable to facilitate string-up and to provide increased attenuating force for drawing the yarn, but they are not necessary to the operation of this device.

It is to be understood, of course, that the specific apparatus hereinbefore described is for illustrative purposes, and numerous changes may be made in the details of this construction without departing from this invention. The arrangement and assembly details or parts may be altered extensively. The slotted blower plate **33** may contain fewer or more than six inclined slots, and the angle of inclination of the slots may vary widely. The bearings **16** for the shaft **15** supporting the rotor plate may be of any suitable design; it is important only that the frictional resistance be kept at a minimum while maintaining the plate and shaft substantially centered and balanced at all times. The knife supports may be other than shown, and their spacing may be regular or irregular if desired. One or as many as six or eight knives or more may be disposed around the periphery of the rotatable plate as required to produce desired staple lengths.

The upper face of rotor plate **20** may have fewer of more than twelve radial grooves **21**, and the grooves may be of various shapes and sizes. The jets of air from the slots of the blower plate **33** impinge against these grooves, and the grooves also serve as channels for the yarn. While rounded grooves, i. e., having a semi-circular cross-section, are usually satisfactory for this dual purpose, it will sometimes be desirable to provide other shapes. The grooves may have side walls which are vertical or even undercut or slanting like a dovetail slot. If desired to get more positive holding of the yarn the slots may be provided with an overhanging lip covering ¼ to ½ the width between substantially vertical side walls on the rear side of the slot with reference to the direction of its rotation. The tendency for the yarn to escape from the rounded groove, mentioned subsequently in connection with Table I, would thereby be minimized or entirely avoided.

In operation a yarn or the like **50** is brought to the tube **24**. The jet action of the aspirator **23**, to which air is brought through the side arm **25**, then draws the yarn down through tube **24** and impinges it against the center of the rotor plate **20**. At the same time air is being fed into the annular chamber **30** through pipe **35**, which chamber is maintained at a pressure of from 50 to 100 p. s. i. or more. This air passes out of the chamber **30** through the slots in plate **33**, forming jets of air which are pointed downward and sidewise to provide a tangential component of velocity. The air introduced into the apparatus from the aspirator jet **23** spreads radially outward and some of it carries the yarn along until the yarn is acted up by the air jets from the slotted plate **33** and is caused to revolve. At the same time these air jets act on the rotor **20**, and aided by the radially-grooved surface thereon, the rotor is brought to a very high rate of rotation, preferably over 30,000 R. P. M. for good yarn draw-off. The centrifugal force created by the rotating air field developed by the tangential jets and rotor **20** produces tension on the yarn **50**, and the yarn is drawn radially outward as it revolves. When the yarn reaches that portion of the rotor plate which is grooved, it is caught by one of the grooves **21** and then receives a far more positive revolving force than is possible with jets alone, since it is now effectively capable of receiving the full momentum of the rapidly rotating rotor **20**. The yarn is carried beyond the periphery of the rotor and the protruding end of yarn is thrown against the razor-sharp cutting edge **45**. The end of the yarn is cut off immediately, and the uncut yarn continues to revolve at high rotational velocity, since it is part of a system having high angular momentum. Pieces of staple **51** cut at any of the knife positions follow a spiral path through chamber **40** and are eventually blown out of the tangential exit channel **43** by the emerging air stream.

Data obtained when using this apparatus for cutting continuous filament yarn, which has been melt-spun and fed directly to the cutter, is set forth in the table below:

Table I

Example	No. of Blades	Air Pressure (p. s. i.)	Rotor Speed (R. P. M.)	Yarn Revolution Speed (Calculated) (R. P. M.)	Yarn Throughput Speed (Y. P. M.)	Staple Length	As spun Fil. Den. (d./f.)
						Inches	
1	1	70	41,000	31,000	4,030	4¾	2.8
2	1	70	41,000	37,000	4,100	4	2.8
3	2	70	41,000	26,000	2,500	1¾	4.6
4	4	70	41,000	18,500	2,050	1	5.6

Examination of Table I will show that the apparatus of this invention is especially useful for cutting long-length staples at high speeds. The effective yarn speed dropped off as the number of cutting blades was increased to cut shorter staple lengths, but it was still possible to obtain relatively high speeds and relatively good efficiency of operation. In this table it is reported that the measured rotor speed of the revolvable plate was 41,000, whereas the speed of revolution of the yarn (calculated from the yarn throughput and length of staple produced) was considerably less. This difference between the rotor R. P. M. and the yarn R. P. M. indicates that the yarn escaped from its groove 21 after each cut. By the time the yarn had found a new groove, it had lost a portion of its rotational velocity. The more cutting blades used, the more often this happened during each revolution, which explains the falling off of yarn revolution speed as the number of blades was increased. The falling off in speed of revolution greatly reduced the draw-off tension, as is indicated by the marked increase in denier and decrease in yarn throughput speed.

Through the use of this invention, yarns, filaments and similar continuous structures may be tensioned and cut into staple at high speeds. Delivery rates may be from 2,000 to 4,000 and more yards of yarn per minute, and the rate of delivery, staple length, and amount of tension may be varied and controlled. Rates of delivery can be maintained sufficiently constant to yield yarns of the desired denier uniformity, and substantially uniform length staple.

This invention may be used for the tensioning and cutting of any filamentary or funicular structure, whether in conjunction with the spinning thereof or from a previously-formed package or the like. The invention is especially suited for tensioning and cutting yarns formed of synthetic polymers continuously as they are spun as, for instance, in the melt-spinning of polyamide or polyester yarns.

Since many different embodiments of the invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited by the specific illustrations except to the extent defined in the following claims.

What is claimed is:

1. A yarn draw-off and staple-cutting apparatus which comprises an annular chamber having a circular bottom plate, means for supplying air to said chamber under pressure, said plate being provided with several inclined radial slots arranged to emit said air with a tangential component of velocity to create a rotating air field, a rotor having a circular upper face rotatably supported closely adjacent to, parallel to and on a common axis with said slotted plate in position to be rotated by the air emitted from said slots, said rotor face being provided with radial grooves for the air to impinge against, means for guiding yarn to a central location between the rotor face and said slotted plate, and a fixed knife located adjacent to the periphery of said rotor in position to cut off protruding yarn ends.

2. An apparatus as defined in claim 1 in which said yarn guiding means comprises an inlet tube through the center of said slotted plate provided with an air jet to help draw the yarn down through the tube and impinge the yarn against the center of the face of said rotor.

3. An apparatus as defined in claim 1 in which said radial grooves of the rotor are arranged to catch yarn passing outward over the rotor face and apply a positive revolving force to the yarn.

4. An apparatus as defined in claim 1 in which said rotor is arranged to be driven at rotational speeds in excess of 30,000 R. P. M.

5. An apparatus as defined in claim 1 in which the rotating air field and rotor are arranged to provide yarn revolution speeds in excess of 30,000 R. P. M.

HAROLD HENRY HEBELER.

No references cited.