

Feb. 16, 1965

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3,169,296

APPARATUS FOR FLUID TREATMENT OF SYNTHETIC FILAMENTS

Filed Feb. 14, 1963

2 Sheets-Sheet 1

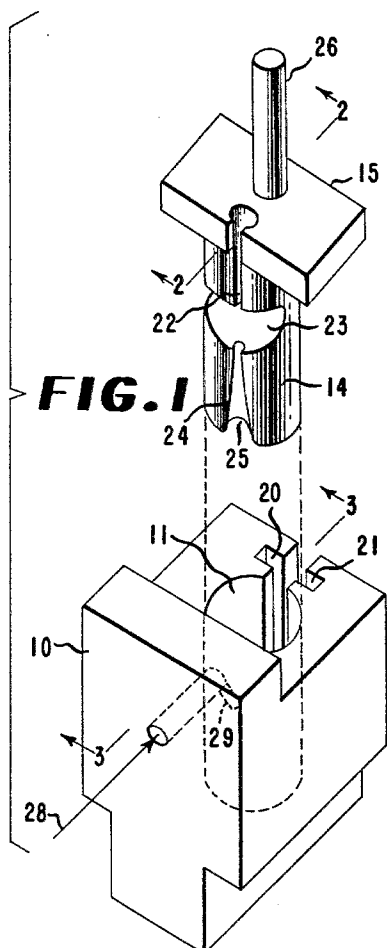


FIG. 1

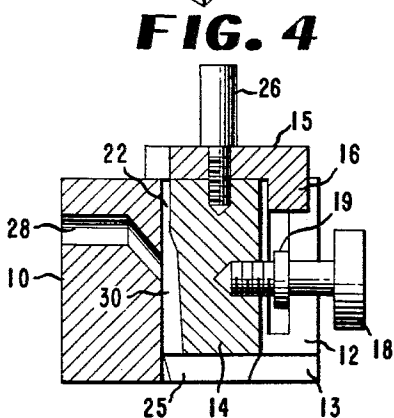


FIG. 4

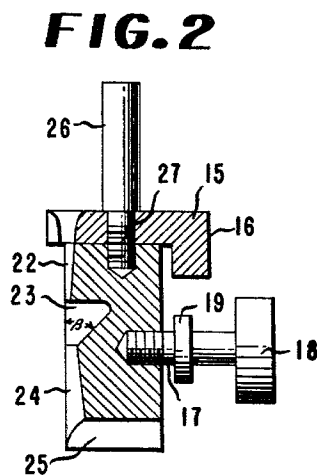


FIG. 2

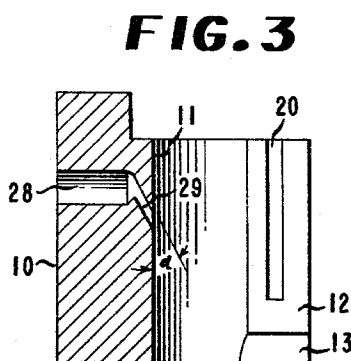


FIG. 3

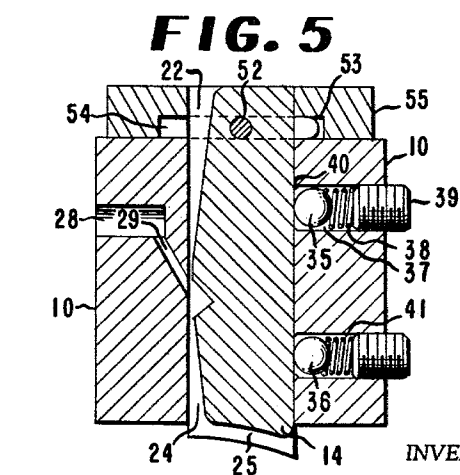


FIG. 5

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FIG. 6

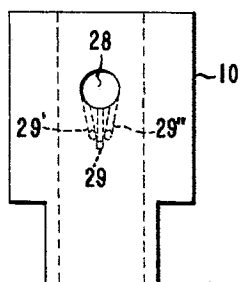
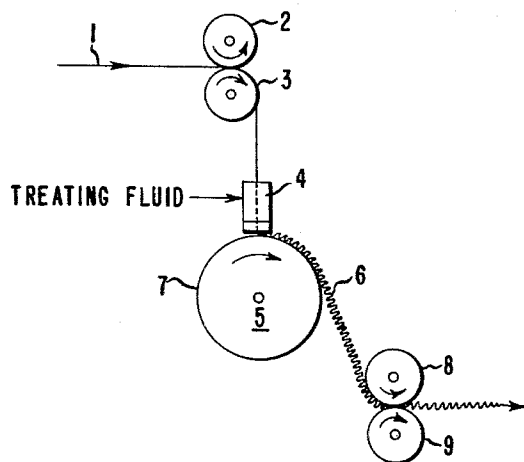


FIG. 7



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APPARATUS FOR FLUID TREATMENT OF SYNTHETIC FILAMENTS

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Filed Feb. 14, 1963, Ser. No. 258,461
6 Claims. (Cl. 28—1)

This invention relates to apparatus for use in treating synthetic filaments with hot gas or steam to introduce a curvilinear crimp, improve dyeability or modify other properties, and is more particularly concerned with jet treatment devices which can be strung up with a rapidly moving filamentary strand without breaking an endless strand. Since these devices are especially useful for providing bulk in multifilament yarn or tow, they will be referred to hereinafter as bulking jets. However, they are also useful for treating filamentary strands with fluids for other purposes, in various processes known to those skilled in the art.

The bulking jets of the present invention are most useful for the types of yarn treatments disclosed in greater detail in Hallden, Jr., et al., U.S. Patent No. 3,005,251 dated October 24, 1961, and Claussen et al. U.S. Patent No. 3,055,080 dated September 25, 1962, both issued to the assignee of the present application. Treatment with the bulking jets of these patents requires starting with free ends of yarn, as in treatment of yarn fed from a package. The free end of yarn must be passed through the bulking jet and transferred to yarn forwarding means before continuous operation can begin. This string-up procedure is not practicable for starting the treatment with yarn forwarded continuously from another operation at high speed, as when the fluid treating process is coupled with other continuous yarn manufacturing or treating steps.

The present invention provides an improved type of bulking jet which can be strung up easily with an endless strand of yarn or tow which is traveling past the jet at high speed, without breaking the strand to provide a free end or otherwise interrupting the continuous travel of the strand. Other objects and advantages of the invention will become apparent from the disclosure and claims.

The bulking jet of the invention has a recessed body portion, a removable core which mates within the body recess, guide means for positioning the core within the body, and locking means for holding the core in position in the body. The body recess is preferably a cylindrical hole extending completely through the body, but a variety of recesses are suitable. A slot is provided through the body to the hole so that an endless strand of yarn or tow can be strung up to pass axially through the hole, without breaking the strand to provide a free end. An inlet for gas or steam is drilled through another portion of the body to exit through an orifice duct into the hole. The strand is led past this orifice through inlet and exit passages cut into one or both of the mating surfaces of the body and core. The strand inlet passage is preferably only slightly larger than the strand to avoid excessive escape of gas or steam through this inlet. The exit passage is large enough for the strand and treating gas to exit together. It is preferably of a venturi shape and leads to a tunnel on the end of the core for guiding the treated strand onto a conveyor having a foraminous receiving surface for separating the strand from treating fluid. An enlarged treating chamber may be located between the strand inlet and exit passages where intercepted

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by the stream of gas or steam from the orifice to provide more effective treatment.

In the drawings, which illustrate specific embodiments of the invention,

FIGURE 1 is an exploded perspective view of a preferred form of bulking jet,

FIGURE 2 is a cross-sectional side elevation of the core of this bulking jet, the section being taken on line 2—2 of FIGURE 1,

FIGURE 3 is a cross-sectional side elevation of the bulking jet body, the section being taken on line 3—3 of FIGURE 1,

FIGURE 4 is a cross-sectional side elevational view corresponding to FIGURES 2 and 3, but of an assembled bulking jet, to show a modified form of treatment chamber,

FIGURE 5 is a cross-sectional view corresponding to FIGURE 4 of another embodiment of bulking jet,

FIGURE 6 is a front view of a bulking jet body similar to that of FIGURE 3 but having plural orifice ducts for treating fluid, and

FIGURE 7 is a schematic illustration of an arrangement of apparatus for feeding yarn through the bulking jet, including foraminous conveyor means for receiving treated yarn from the bulking jet.

Referring to FIGURES 1 to 3, the body 10 of the bulking jet has a central recess formed by cylindrical hole 11 and string-up slot 12, both extending from top to bottom of the body. The bottom portion of the slot is flared outward to form a tunnel 13 for yarn or tow leaving the body. A core 14 fits snugly in cylindrical hole 11. A block 15, secured to the top of the cylindrical portion of the core, seats on top of the body 10 to position the core. This block has a projecting key 16 which fits in the string-up slot 12 to assist in positioning the core. A jack screw 17 is used to lock the core in position in the body. This is screwed in or out of the back side of the core by turning handle 18. Collar 19 on the screw fits in grooves 20 and 21 on each side of the string-up slot 12. When the core is positioned in the body recess, the jack screw is turned to press the front side of the core tightly against the mating surface of the body recess.

The front side of the core 14 is machined to provide an inlet passage 22 for yarn or tow, a treatment chamber 23, and a venturi-shaped exit passage 24 for yarn or tow and gas, steam or other treating fluid. These are open on the outer side of the core for introducing yarn or tow during string up. They are closed by the mating surface of the body when the core is positioned in the recess 11. The bottom of the core is provided with a tunnel 25 for exiting yarn or tow, corresponding to tunnel 13 in body 10. The handle 26, for use when inserting or removing the core from the body, has a threaded portion 27 which screws into the core to secure both the handle and the block 15 to the cylindrical portion of the core.

The front face of the body 10 is drilled to provide an inlet 28 for treating fluid which terminates in an orifice duct 29 of smaller diameter and angled in the direction of yarn travel. The orifice is located so that the stream of gas or steam is directed into the treating chamber 23 along a path which lies in the same plane as the axis of yarn inlet passage 22 when the core is positioned within the body. The angle α between the stream and the direction of yarn travel into the chamber, i.e., the included angle defined by the axis of the orifice duct and the axis of the yarn inlet passage 22, should be from 10° to 70° and preferably from 20° to 45°. The surface of chamber 23 opposite the orifice is angled away from the wall

of hole 11 at an angle β of 30° to 60°, preferably from 40° to 50°, to provide an impact surface for the stream of gas or steam issuing from the orifice.

Conventional materials of construction, such as steel or brass, are suitable for the bulking jet. If steam is used for the treatment, the materials should be corrosion resistant. It is desirable to use abrasion resistant materials for surfaces contacted by yarn or tow in order to reduce wear. This may be accomplished with high carbon steel, by inserts of hard material such as ceramic inserts, or by hard surface coatings known to those skilled in the art, for example, as in England et al. U.S. Patent No. 3,084,134 or Steijn U.S. Patent No. 3,080,135, both issued March 5, 1963, to the assignee of the present application.

This bulking jet is strung up with the core retracted as in FIGURE 1. The yarn or tow is guided through slot 12, to pass through hole 11 of the body, and through the open yarn passages 22-24 of the core. This is readily accomplished with a continuous moving yarn or tow, there being no need for a free end. The core is then positioned in the body and secured with the jack screw as described. Treatment of the yarn or tow can begin at once since the treating fluid need not be shut off during string-up.

The bulking jet of the present invention is suitable for treating the yarn or tow in accordance with the process conditions disclosed in the referenced patent to Hallden et al., and has the advantage that it is adapted for use in a coupled process. Thus the jet can be positioned directly after a high speed drawing operation to bulk the drawn yarn with hot gas or steam in a continuous process. Preferably, the bulking jet is mounted with the bottom close to conveying means having a foraminous surface for receiving the yarn or tow from the jet and separating it from the treating fluid, as illustrated in FIGURE 7, which shows screen-surfaced drum conveyor 5 positioned at the exit of bulking jet 4. Yarn 1 travels between feed rolls 2 and 3 to pass at controlled speed through the bulking jet, which is supplied with the treating fluid. The treated yarn 6 is deposited on the screen surface 7 of the drum and is conveyed away from the treating fluid through tunnels 25 and 13 in the core and body of the bulking jet. The yarn cools while being conveyed on the screen, and cooling may be assisted by spraying with water. The yarn is withdrawn from the drum surface by a pair of take-off rolls 8, 9 and then passes to further processing, which may be merely packaging for shipment.

A number of modifications can be made in the bulking jet without departing from the basic features of the embodiment already disclosed. The hole 11 in the body and the mating core 14 can have various non-circular cross-sections, such as triangular, square, rectangular or hexagonal. The yarn passageways and treatment chamber may be modified for optimum results with specific yarns or treatments. One modification of the bulking jet of FIGURES 1 to 3 is illustrated in FIGURE 4, which shows a bulking jet assembled for operation. The treatment chamber and exit passage for yarn and treating fluid are combined in one passage 30 of uniform cross section. This is much simpler to fabricate than the chamber 23 and exit 24 shown in FIGURE 2.

Alternative means for holding the core in position in the body can obviously be used instead of the key 16 and jack screw 17 of FIGURE 2. In the embodiment of FIGURE 5, spring loaded balls 35 and 36 perform the function of the jack screw in pressing the core against the portion of the body wall containing the inlet orifice 29. The ball 35 is retained within an opening 37 through the wall of the body opposite to the inlet orifice and urged against the core by spring 38 and screw 39. The pressure of the spring against the ball can be varied by adjusting the screw in or out. A neck 40 of smaller diameter than the ball is provided in opening 37 at the inner

side of the wall to prevent escape of the ball when the core is removed from the body. The other ball 36 is similarly retained within an opening 41 through the wall.

A string-up slot (not shown) is provided as in the case of the previous bulking jets, and string up can be accomplished in similar fashion by first removing the core from the body. However, in this embodiment, the core can also be turned within the body to align the yarn passages 22 and 24 with the string-up slot so that the yarn can be placed within the passages without removing the core. Rotation of the core to this position automatically stops the flow of treating fluid, i.e., the core also acts as a valve. After placing the yarn in the passages the core is turned back to operating position. A handle inserted in hole 52, near the top of the core, provides means for rotating the core when string up is to be accomplished in this manner.

The core is precisely positioned for operation by a key or pin 53 projecting from the core to engage slot 54 in block 55, which block is secured to the top of the jet body 10. The slot is preferably of the bayonet socket type to stop rotation of the core when operating position is reached, and to disengage the pin 53 at another position so that the core can be removed from the body. This embodiment also differs from the previous ones in that the bottom of the core and its tunnel 25 are curved to conform to the screen surface on which the treated yarn or tow is deposited (of a drum conveyor). This facilitates proper deposition on the screen. Since this portion of the core projects from the body, no tunnel is provided in the body.

Other modifications of the bulking jet comprehended by the present invention include plural treatment orifices 29, 29' and 29'' as illustrated in FIGURE 6, instead of the single orifice duct 29 shown in FIGURE 1. A more cohesive crimped yarn is produced by providing two orifice ducts for directing treating fluid into the chamber 23 to impinge against the yarn from different directions. Preferably, the ducts are in a single plane which would be perpendicular to the paper when viewing the duct as in FIGURE 3, and the angle α is the same for both. Parallel ducts can be used but it is preferable to have them converge toward the yarn, an included angle of about 20° being particularly effective. It is convenient to have the ducts sufficiently close together to be supplied with treating fluid from a single inlet 28.

The turbulent fluid used to crimp filamentary material may be air, steam, or any other gas or vapor capable of plasticizing action on the yarn provided that it has a temperature above the second-order transition temperature of the filament. The fluid temperature may exceed the melting point of the fibers. Hot air will give sufficient plasticization in the turbulent region for many fibers, although it may be desirable for certain fibers to supplement the temperature effect with an auxiliary plasticizing medium. Steam may also be used in the subject apparatus since it is a cheap and convenient source of a high pressure fluid with adequate plasticizing action.

The apparatus of this invention can be used to crimp and bulk any natural or synthetic plasticizable filamentary material. Thermoplastic materials such as polyamides, e.g., poly(epsilon-caproamide), poly(hexamethylene adipamide); cellulose esters; polyesters, e.g., polyethylene terephthalate, poly(hexahydro-p-xylylene terephthalate), etc.; polyvinyls and polyacrylics, e.g., polyacrylonitrile; polyolefins, e.g., polyethylene and polypropylene, as well as copolymers thereof can be crimped to a three-dimensional, random, curvilinear configuration. While the preferred form of material is continuous filaments, the treatment is useful with staple yarns as well. Both types of materials can be made into bulky yarns and fabrics having improved bulk, covering power (opacity) and hand.

The following examples illustrate the operation of the apparatus of this invention:

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Continuous filaments of poly(hexamethylene adipamide) were treated by the process previously designated, using the jet apparatus shown in FIGURES 1 to 3, and under the operating conditions shown below:

	Example I	Example II
Yarn denier.....	1,300	3,700
Filaments.....	65	204
Treating fluid.....	Steam	Steam
Temperature, °C.....	260	282
Pressure, p.s.i.g.....	220	220
Ratio, Yarn input speed/Yarn windup speed.....	1.16	1.32

The products were bulky crimped yarns characterized by a random, three-dimensional curvilinear crimp. The amplitude, permanence, and number of crimps per unit of length in the filaments make these yarns particularly suitable for rug or pile yarns.

Example III

A 160 denier, continuous filament yarn of poly(hexamethylene adipamide) with 13 filaments of trilobal cross-section was similarly processed, using the jet apparatus of FIGURE 5. The treating fluid was air at 70 p.s.i.g. pressure and 250° C. The yarn input linear speed was 95% greater than the take-up speed. The crimped product had high bulk and cover, soft, dry hand, and improved dyeing characteristics which are desirable for upholstery fabrics.

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.

I claim:

1. In an apparatus for treating synthetic filaments with hot gas or steam to introduce a curvilinear crimp with a bulking jet having passages for a filamentary strand passing through the bulking jet, a chamber for treating the strand during passage through the bulking jet, and means for introducing treating fluid into the chamber to impinge against the filaments; means for feeding a strand into the bulking jet for treatment and conveyor means having a foraminous surface for receiving the treated strand from the bulking jet, separating the strand from treating fluid and conveying the strand away; the improvements comprising a bulking jet having a body with a recess, a removable core which mates within the body recess and extends through the body, guide means for positioning the core within the body, locking means for holding the core in operating position within the body, strand passages and a treating chamber cut into the sur-

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face of the core, a string-up slot through the body into the body recess located so as to be sealed from said passages and chamber when the core is in operating position, said string-up slot, passages and chamber being opened by removal of the core from the body to provide for string up with a traveling endless strand, an orifice duct in the body for directing treating fluid into said chamber to intersect the direction of strand travel into the chamber at an angle of 10° to 70°, and a tunnel located on the end of the core for guiding the treated strand onto the foraminous surface of said conveyor means.

2. A bulking jet as defined in claim 1 wherein said core has a generally cylindrical surface, said strand passages and treatment chamber are cut into said cylindrical surface to guide the strand in an axial direction, and said body recess has a corresponding cylindrical surface which mates with the surface of the core to bring the orifice duct and yarn treating chamber into proper relation.

3. A bulking jet as defined in claim 1 wherein said guide means for positioning the core within the body includes a block secured to one end of the core for limiting axial movement of the core into the body recess, said block having a projecting key which engages said string-up slot in the body of the bulking jet.

4. A bulking jet as defined in claim 1 wherein said locking means for holding the core within the body comprises a jack screw engaging said string-up slot in the body and threaded into the core.

5. A bulking jet as defined in claim 1 wherein said locking means for holding the core within the body comprises spring-loaded balls mounted in the body to press against the core.

6. A bulking jet as defined in claim 1 wherein said treating chamber has a surface angled away from the direction of strand travel at an angle of 30° to 60° to provide an impact surface for the stream of treating fluid from the orifice duct.

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