Nov. 28, 1961 A. RICHMOND ET AL 3,010,270

APPARATUS FOR PRODUCING VOLUMINOUS YARN

Filed Feb. 11, 1958

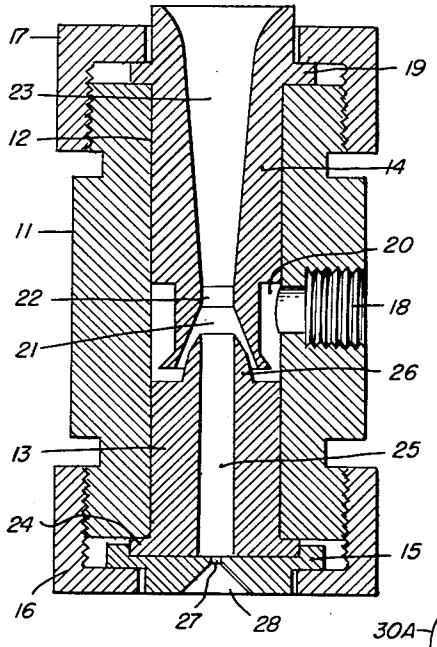

FIG. 1

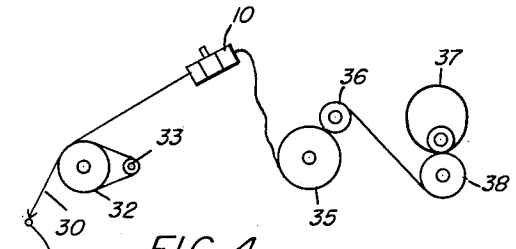

FIG. 4

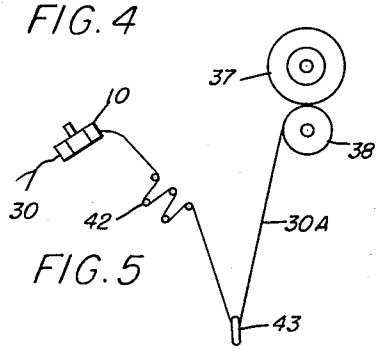

FIG. 5

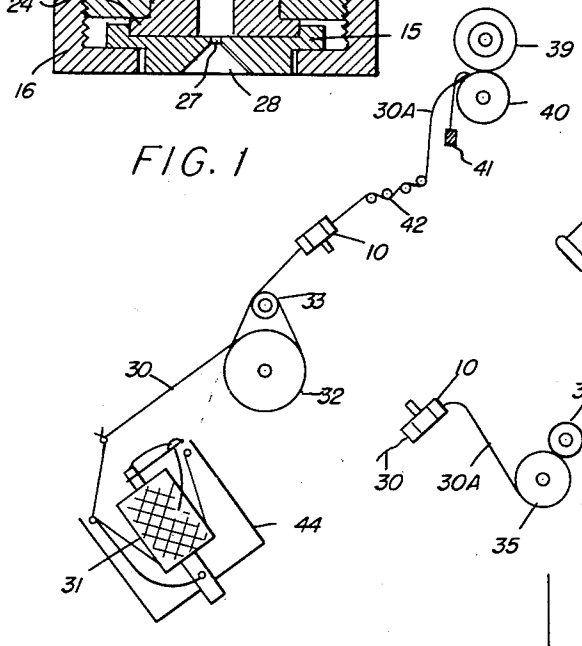

FIG. 6

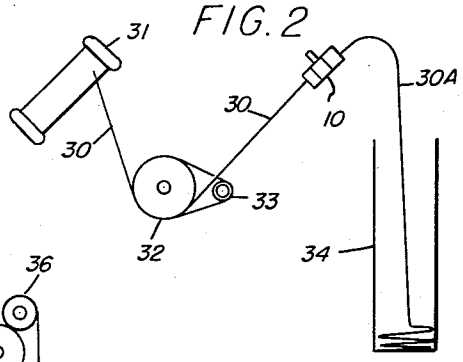

FIG. 2

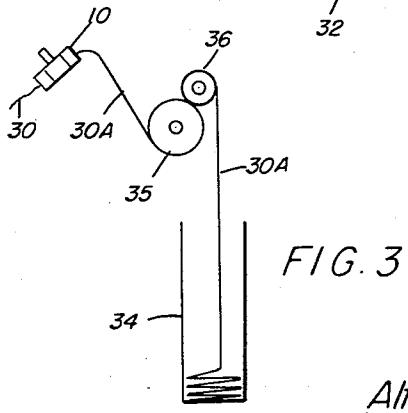

FIG. 3

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APPARATUS FOR PRODUCING VOLUMINOUS YARN

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Claims priority, application Great Britain Mar. 1, 1957
8 Claims. (Cl. 57—34)

This invention relates to the production of voluminous yarn and particularly to an improved form of jet, and method of using it, whereby a continuous bundle of filaments, particularly continuous filaments, can be subjected to the action of a turbulent stream of fluid to give a yarn or like textile product of voluminous or wool-like nature having a characteristic appearance and handle similar to those of a staple fibre product.

U.S. application Serial No. 540,596, by W. Pool, filed October 14, 1955, now Patent 2,982,082, describes a jet suitable for this purpose, in which an inlet tube for the entry of the yarn into the jet extends into a chamber within the jet and is provided with a tip facing and entering the mouth of a venturi passage through which the yarn and a stream of gas supplied under pressure to the chamber leave the jet, the venturi passage and the outer surfaces of the tip of the inlet tube being so shaped that the gaseous stream creates a vortex at the tip. The inlet tube, though flared at its input end, is of its minimum internal diameter at its tip, being uniformly of this diameter for the greater part of its length. It has now been found that striking improvements in the voluminous character of the yarn can be obtained by employing, in a jet of this character, an inlet tube which is of small diameter at or near its inlet end and is of substantially larger diameter thereafter up to its tip. It appears that, with such an inlet tube, the portion of larger diameter acts as a resonance cavity in which vortices or other cyclic irregularities of flow take place in addition to any such effect occurring beyond the tip of the inlet tube. As a result the filaments are subjected to the turbulent action of the fluid stream over a greater distance, resulting in an improved yarn.

According to the present invention, therefore, in subjecting a continuous bundle of filaments (hereinafter referred to as a yarn) to the action of a turbulent stream of fluid, the yarn is passed into the stream by way of a passage which is initially of small cross-section and thereafter of substantially greater cross-section up to its end where the yarn emerges into the turbulent stream by which the filaments of the yarn are whipped about and the yarn is carried forward as a voluminous product. An apparatus according to the present invention for this purpose is in the form of a jet having an internal chamber to which fluid is supplied under pressure and from which the yarn is carried by the fluid, and an inlet tube for the entry of the yarn into said chamber, said tube being of small cross-section at its inlet end and thereafter of larger cross-section.

The small aperture at the inlet end of the yarn entry tube is preferably no longer than is necessary for the free passage of the yarn through it. For instance it may be a circular aperture of 0.01 to 0.03 or 0.05 inch diameter. To facilitate threading-up, the aperture may be led into by a converging funnel-like portion. Alternatively, or in addition, the aperture may be made of variable diameter, as by the use of an iris mechanism, so that the aperture can be enlarged for the specific purpose of threading-up and thereafter reduced to its working size. The main portion of the inlet tube may have a diameter of at least twice, but preferably of from 5 to 15 times, that of the small aperture at the inlet end and a length of at least

three times, e.g. 5 to 10 times, its diameter. It is preferable that, as in the above application, the tip of the inlet tube should face and enter the mouth of a venturi passage through which the fluid stream and the filamentary bundle leave the chamber, and that the outer surfaces of the tip should be so shaped in relation to the surfaces of the venturi passage that a vortex is created in the mouth of the venturi. Thus, the tip of the inlet tube may have the external shape of a double cone, the cone-angle at the extremity of the tip being greater than that of the mouth of the venturi and the cone-angle a little way back from the tip (but still within the mouth of the venturi) being slightly less than the cone-angle of the venturi which is preferably less than 60° or better less than 40°.

The fluid employed as the turbulent stream is preferably a gas and, while any gas that is chemically inert to the substance of the filaments can be used, whether at or below atmospheric temperature, or above as in co-pending application of A. Richmond, R. A. King and A. H. Gentle, Serial No. 714,601, filed February 11, 1958, the most suitable gases are compressed air and moist stream under pressure. Pressures whether of compressed air or moist steam may range from 5 lb. gauge pressure up to 100 lb. or more (according to the speed of travel of the yarn and the intensity of treatment desired). The gas is supplied to the chamber of the jet, generally from one side thereof, and leaves the chamber by way of the same outlet as that through which the yarn leaves, the gas being caused to pass across the enlarged mouth of the yarn entry tube so as to produce the desired effect upon the filaments passing through the tube.

Any convenient arrangements may be made for the supply of the yarn to the jet and for reception of the voluminous product emerging from the jet. Thus the yarn may be drawn by a pair or set of feed rollers either from a stationary package if the yarn has been sufficiently pre-twisted, or from a rotating package or a double twist spindle if it is desired to impart further twist to the yarn before it reaches the jet, and delivered from the feed rollers to the input end of the jet. The product emerging from the jet can be allowed to drop straight into a sliver can or like receiver, this method giving the greatest increase in the bulk of the yarn and having the maximum effect of reducing the length of the yarn. Preferably, however, the yarn is positively drawn away from the jet by a pair of take-off rollers and delivered by them into the receiver. The take-up rollers are driven at a lower speed than the feed rollers and, though they may reduce the voluminosity of the resulting yarn, give positive control of the denier of the resulting product. Instead of delivering the product to a can or like receiver, it may be delivered to a winding device, preferably one winding the product without further twisting it, in which case the delivery speed, instead of being determined by a pair of take-off rollers may be determined by the constant take-up speed of the winding device itself.

The invention may be applied to continuous filament textile materials in general but is particularly applicable, especially in conjunction with moist steam, to thermoplastic materials such as acetone-soluble or other cellulose acetate or other organic derivative of cellulose, copolymers of vinyl chloride and vinyl acetate, polymers of acrylonitrile and copolymers of acrylonitrile with moderate proportions of other vinyl compounds. Of particular value, especially where steam or a hot gas is used, are filaments of materials susceptible to heat-setting, such as cellulose acetate of acetyl value at least 59 percent calculation as acetic acid (hereinafter referred to as cellulose triacetate), copolymers containing a substantial proportion of vinylidene chloride, polyaminocaproic acid,

polyhexamethylene adipamide and polyethylene terephthalate. Such materials may further, whether or not steam or hot gas is used, be subjected to a heat-setting treatment after they have passed through the jet and been collected. The invention is applicable to "yarns" of a wide range of total deniers, from fine bundles of continuous filaments having a total denier of 75 or less up to heavy bundles or tows of a denier of 2,000 to 10,000 or more. A particularly important application of the invention is the preparation of such heavy bundles for use as the pile yarns in carpets, especially tufted carpets, in which the pile is inserted as loops (which may be cut after insertion) into a base fabric wherein the loops are secured by an adhesive or otherwise.

If desired two or more yarns may be bulked by passing them together through the jet of the invention. Depending on the conditions employed and also on the twist and/or other characteristics of the yarns, the latter may be separated after bulking and wound separately, or the product may be such that, owing to entanglement of the filaments of one yarn with those of another, separation is not feasible.

By way of example one form of jet according to the present invention and several examples of its application and use will now be described in greater detail with reference to the accompanying drawings in which:

FIGURE 1 is a cross-section of the jet;

FIGURES 2, 3, 4, 5 and 6 are diagrams showing applications of the jet unit of FIGURE 1.

The jet shown in FIGURE 1 and indicated as **10** in FIGURES 2 to 6 comprises a tubular body portion **11** of plain internal bore **12**, an inlet tube portion **13** and an outlet venturi portion **14** both of an external diameter fitting said bore **12**, an inlet aperture plate **15** and a pair of securing collars **16**, **17** for holding the elements together.

The body portion is, as stated, of plain internal bore and is slightly reduced externally at its ends and screw-threaded for the attachment of the securing collars **16**, **17**. Through the unreduced portion is bored and threaded a radial gas inlet passage **18** midway along the length of the body portion **11**. The venturi outlet portion **14** is provided with an external flange **19** near its outlet end, which engages the outlet end face of the body portion **11** and over which fits an internal flange of the outlet securing collar **17**. The venturi portion **14** extends from the outlet inwards past the gas inlet passage **18**, and is formed with a wide deep circumferential groove **20** opposite the gas inlet passage **18** which constitutes the main part of the chamber within the jet. The diameter of this portion beyond the groove **20** is slightly less than that of the body portion to allow free passage of the gas. Internally the bore of the venturi portion **14** has an inlet section or mouth **21** in the form of a conical passage of 40° cone-angle, converging to an intermediate throat section **22** of parallel bore, which leads in turn to an outlet section **23** of 10° cone-angle.

The inlet tube portion **13** is furnished at its inlet end with an external flange **24** engaging with the end face of the body portion; it is bored with a parallel passage **25** of a diameter equal to that of the parallel portion **22** of the venturi. The external diameter fits the internal diameter of the body portion but is sharply reduced at its inner end and formed into a double cone **26** having a cone-angle of 33° near its base and of 47° near its tip. The reduced portion **26** enters into the mouth **21** of the venturi outlet. Over the flange face of the inlet tube portion is fitted an aperture plate **15** which in turn is externally flanged for engagement by an internal flange of the inlet securing collar **16**, whereby both the aperture plate **15** and the inlet tube portion **13** are secured to the body portion. The aperture plate has a central aperture **27** of about one-tenth of the diameter of the bore **25** of the inlet tube portion; this aperture is led into by a flared or funnel-like entry **28** of 90° cone-angle. In the assembly of the jet, suitable shim washers (not shown) are inserted beneath the flange **24** of the inlet tube portion and beneath the flange **19** of the outlet venturi portion so as to provide a small clearance between the shoulder at the tip **26** of the inlet tube portion (where the two portions of differing conicity meet) and the inner surface of the mouth **21** of the venturi portion.

The jet described above may be used in a variety of ways. In its simplest arrangement it may be made to point upwards at an angle of about 45° as shown in FIGURE 2 to receive a filamentary bundle **30** supplied upwards to it from a rotatable package of material **31** (which may contain twist) by a suitable feed roller **32** round which the bundle is wrapped several times, being lifted at each turn from the surface of the feed roller **32** by a wrap-separating roller **33** disposed approximately parallel thereto. Steam is supplied to the inlet passage of the jet which exerts a suction effect, drawing the filamentary bundle away from the feed roller **32** as fast as the feed roller delivers it. The steam emerging from the jet is directed upwards in line with the jet axis. The bulked filamentary product **30A** emerging with the waste steam falls away immediately after emerging to be received into a suitable placed sliver can **34**. As a development of the above arrangement shown in FIGURE 2, a pair of output rollers **35**, **36** may be disposed as shown in FIGURE 3 to receive the bulked product, the output rollers being driven at a speed lower than that of the feed rollers but slightly faster than the bulked yarn would be delivered in their absence, so that the output-input ratio of the material is positively determined. As a still further development, as shown in FIGURE 4 or 5 the sliver can in the last mentioned arrangement can be replaced by a cone-winding or cheese-winding device in which a collecting package **37** is driven by surface contact with a traverse and driving roller **38** around which the bulked product passes; again as shown in FIGURE 6 the sliver can may be replaced by a cheese-winding device in which a collecting package **39** is driven by surface contact with a driving roller **40** and the bulked product **30A** led to a traverse guide **41** which guides it to and fro along the length of the take-up package. Yet again, in the last mentioned arrangements, the output rollers, as shown in FIGURES 5 and 6, may be replaced by a suitable tension device imparting a light but constant tension to the product passing through it, the rate of draw-off for the product being determined by the constant take-up rate of the collecting device. The tension device may be a gate of rods **42**, if desired in combination with a compensating weight in the form of a ring **43** depending from a loop of the bulked filamentary bundle **30A** as shown in FIGURE 5. In each of the above arrangements the filamentary bundle may have been pre-twisted to a degree appropriate to the voluminising operation and may be drawn, by the feed rollers, from a stationary supply package. Alternatively, however, additional twist may be imparted to the bundle as it is drawn forward by the feed rollers, by mounting the supply package on a stationary or rotating spindle **44** as in FIGURE 4 and drawing the bundle over-end from the supply package **31** or by mounting the supply package **31** in a 2-for-1-twisting device **44**, as in FIGURE 6, in which the product, as it is drawn from the stationary package, is formed in a loop which is caused to rotate rapidly round the package.

The following are given as examples of yarns produced by the method, and using the jet of the present invention. The jet is of the construction shown in FIGURE 1 of the drawings; the inlet tube **13** has a bore **25** of diameter about 0.15 inch and of length about 6 diameters while the diameter of the inlet aperture **27** is about 0.015

inch or such as will just permit comfortable passage of the yarn; the diameter of the throat section **22** of the venturi passage **14** is about 0.125 inch.

Example I

An acetone-soluble cellulose acetate continuous filament yarn of 300 denier and consisting of 120 continuous filaments twisted together with 10 turns per inch is withdrawn from a stationary bobbin at a speed of 120 yards per minute and fed into the jet which is supplied with steam at 65 lbs. per sq. inch. The resulting product is withdrawn from the jet by means of a pair of feed rollers driven with a surface speed of 90 yards per minute and wound up on a surface-driven cheese. The resulting yarn is bulky in character, to a degree greater than that represented by its increased denier due to contraction.

Example II

A heavy yarn of acetone-soluble cellulose acetate of about 6,000 denier is formed by doubling two ends each of 1,500 denier and each consisting of 100 filaments with a doubling twist of 3.5 turns per inch **S**-twist and doubling two of the resulting yarns with 3.0 turns per inch **Z**-twist. The heavy yarn is forwarded by the feed rollers to the jet at a speed of 40 metres per minute and the jet is supplied with steam at 65 lb. per sq. inch. The resulting yarn is withdrawn from the jet at 30 metres per minute through a tension device imparting a light tension thereto and is wound up into a cheese on a winding device in which the package being wound is surface-driven with a take-up speed of 30 metres per minute. The resulting yarn is very bulky in character exhibiting at all points along its length a large number of arch-like loops of varying amplitudes. The yarn is used as the pile yarn in a tufted carpet having excellent cover and appearance and good abrasion-resistance.

Example III

A heavy yarn is formed by doubling together, with 2.5 turns per inch **S**-twist, 12 ends of cellulose triacetate yarn each of 230 denier and consisting of 15 continuous filaments associated without twist. Two of the yarns so formed are doubled together with 2.3 turns per inch **Z**-twist and the resulting yarn is fed at 40 metres per minute to a jet supplied with steam at 105 lb. per sq. inch. The resulting bulky yarn is used as the pile yarn in a tufted carpet as in Example II.

Example IV

A heavy yarn of the character employed in Example III is supplied to a jet fed with compressed air at 60 lb. per sq. inch and a jet of steam is directed at the jet inlet, along with the yarn. The resulting yarn is similar to that of Example III but has a thinner and more solid core and a less dense "mantle" of loops, a few of which are ring-like in form. The carpet into which the yarn is incorporated is of good cover and abrasion-resistance but slightly stiffer and more felt-like than that of Example III.

Example V

A heavy yarn is prepared by doubling together, with 2.5 turns per inch **S**-twist, seven ends of cellulose triacetate yarn each of 355 denier and comprising 30 continuous filaments associated without twist, and associating two of the doubled ends with 3.0 turns per inch **Z**-twist. The yarn is supplied to the jet at 40 metres per minute, the jet being supplied with steam at 95 lb. per sq. inch, and is withdrawn at 30 metres per minute and allowed to drop into a sliver can. The mass of yarn in the sliver can is treated with steam at 30 lb. per sq. inch gauge pressure for 5 minutes and is then drawn from the can and wound into cones before being made up into tufted carpet.

Example VI

A tow of continuous filaments of polyaminocaproic acid having a total denier of 6,800 and consisting of 140 filaments associated together with 2.5 turns per inch **Z**-twist is fed at 40 metres per minute to a jet supplied with steam at 90 lb. per sq. inch, is withdrawn at 30 metres per minute, and wound into cones. The resulting yarn is used as the pile yarn in a tufted carpet, resulting in a carpet of excellent cover and appearance and particularly good abrasion-resistance.

What we claim is:

1. A jet suitable for the production of bulky yarn from a continuous filament yarn, comprising a chamber having an inlet tube of circular cross section for entry of a yarn into said chamber, said inlet tube being of small diameter at the yarn entry end and of larger diameter thereafter and the diameter of the larger diameter portion of the inlet tube being from 5 to 15 times that of the entry end, in combination with a yarn exit tube in the form of a venturi passage into the mouth of which the inlet tube extends, said chamber having an inlet adapted to feed a fluid into said chamber and thereby to create a flow of fluid out of the chamber through the venturi passage.

2. A jet according to claim 1, wherein the length of the larger diameter portion of the inlet tube is at least 3 times its diameter.

3. A jet according to claim 1, wherein the small diameter entry end of the inlet tube is preceded by a converging funnel-like conical portion.

4. A jet according to claim 1, wherein the mouth of the venturi passage is in the shape of a cone having a vertical angle of less than 60°.

5. A jet according to claim 1, wherein the mouth of the venturi passage is in the shape of a cone having a vertical angle of less than 45°.

6. A jet suitable for the production of bulky yarn from continuous filament yarn, comprising a chamber having an inlet tube of circular cross section for entry of a yarn into said chamber, a yarn exit tube in the form of a venturi passage of which the mouth is in the shape of a cone having a vertical angle of less than 60° and into which the inlet tube extends, said chamber having an inlet adapted to feed a fluid into said chamber and thereby create a flow of fluid out of the chamber through the venturi passage, the said inlet tube being of small diameter at the yarn entry end and of 5 to 15 times this diameter thereafter and the wider portion being of a length at least 3 times its diameter, and the external form of the tip of the said inlet tube being in the shape of a double cone of which the cone angle at the extremity of the tip is greater than that of the mouth of the venturi and the cone angle a little way back from the tip, but still within the mouth of the venturi, is slightly less than the cone angle of the mouth of the venturi.

7. A jet according to claim 6, wherein the venturi passage has a conical mouth of about 40° cone-angle, converging to an intermediate section of parallel bore leading in turn to an outlet section of about 10° cone angle, and the tip of the inlet tube has a cone angle of about 33° near its base and about 47° near its tip.

8. Apparatus suitable for the production of a bulky yarn from continuous filament yarn, said apparatus including a bulking jet, said jet comprising a chamber having an inlet tube of circular cross section for entry of a yarn into said chamber, said inlet tube being of small diameter at the yarn entry end and of larger diameter thereafter and the diameter of the larger diameter portion of the inlet tube being from 5 to 15 times that of the entry end, a yarn exit tube in the form of a venturi passage into the mouth of which the inlet tube extends, said chamber having an opening for feeding a fluid into said chamber and thereby creating a flow of fluid out of the chamber through the venturi passage, feed means for forwarding a yarn to the entry of the inlet tube of the

jet, and yarn drawing off means adapted to withdraw yarn from the venturi passage of the jet at a determined speed lower than that of said feed means.

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CERTIFICATE OF CORRECTION

Patent No. 3,010,270 November 28, 1961

Alfred Richmond et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 61, for "longer" read -- larger --;
column 2, line 23, for "stream" read -- steam --.

Signed and sealed this 10th day of July 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents