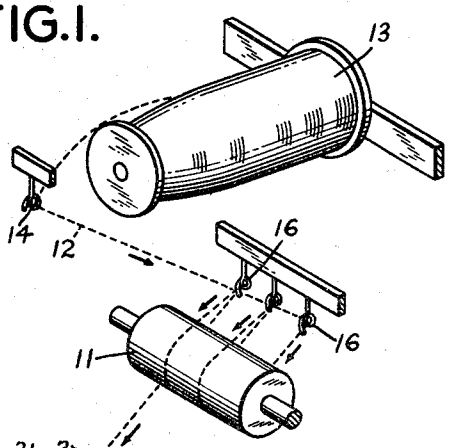
June 28, 1960 C. W. PALM 2,942,402

PROCESS AND APPARATUS FOR PRODUCING VOLUMINOUS YARN

Filed May 21, 1953

FIG. 1.



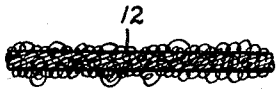




FIG. 3.

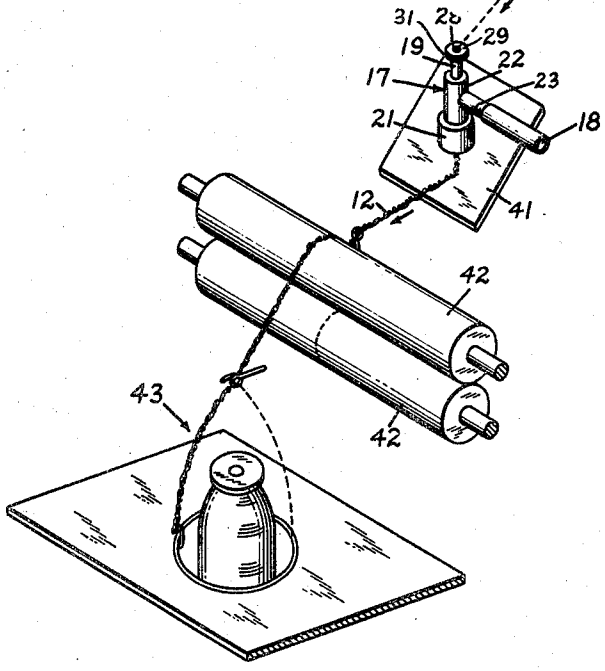
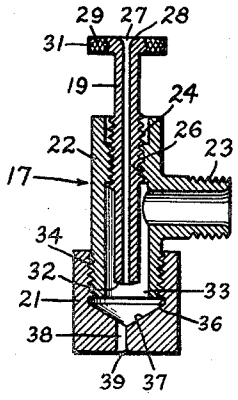



FIG. 2.

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# PROCESS AND APPARATUS FOR PRODUCING VOLUMINOUS YARN

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21 Claims. (Cl. 57—34)

This invention relates to a loopy yarn and to a method and apparatus for the production of said yarn.

It is an object of this invention to provide a new loopy yarn composed of a bundle of continuous filaments, which yarn has a novel appearance and has the hand or feel of a spun yarn made of staple fibers.

A further object of this invention is the provision of a novel and economical process and apparatus for the production of voluminous yarn.

Other objects of this invention will be apparent from the following detailed description and claims.

According to the present invention, a continuous filament yarn, i.e. a yarn made of a plurality of continuous filaments, is subjected to the action of a turbulent stream of a fluid to produce a continuous filament yarn having loops of individual filaments projecting from the main body of said yarn.

In a preferred embodiment of this invention, a continuous filament yarn is delivered by a driven feed roller, or other suitable means, to a jet where the yarn is subjected to the action of a turbulent stream of a fluid, which is preferably a gas, such as air, substantially inert to the material of said yarn. The jet, which hereinafter will be called an "air jet," since air is the preferred and cheapest fluid, comprises a yarn inlet tube and an outlet fitting, both adjustably mounted on a hollow T-shaped body, or T having an air inlet connected to a source of compressed air. The yarn enters the air jet through the relatively long and narrow inlet tube, passes to a relatively wide chamber where it is subjected to the turbulent stream of air, and leaves the air jet, together with the air, through a relatively narrow orifice in the outlet fitting. For best results it is preferred to have the latter orifice slightly offset from, or out of alignment with, the bore of the inlet tube. It is also desirable to adjust the yarn inlet tube and the outlet fitting so that the air leaves the air jet not only from said fitting but also from the entrance to said inlet tube, with the air leaving from said fitting having a substantially higher velocity than the air leaving from said entrance to the inlet tube.

The turbulent stream of gas acts on the continuous filament yarn passing through the air jet, causing the yarn leaving the air jet to be voluminous and to contain loops of individual filaments projecting from the main body of said yarn. The loops may be made more uniform in size and the frequency of the loops may be increased by impinging said yarn, as it leaves the jet, against a solid surface, preferably against a flat smooth surface held at an angle of about 45° to the direction of flow of the yarn leaving the air jet. Although optimum results have been obtained when the angle is 45°, other angles, for example, angles of 15° to 75°, have been employed with good results. The distance between the air jet and the point where the yarn impinges on the solid surface should preferably be relatively short, e.g. on the order of ¼ inch to 1 inch.

The formation of loops in the yarn naturally results in a decrease in the tenacity of said yarn, since individual filaments of the yarn are pulled out of their normal substantially parallel position. In order to increase the tenacity of the loopy yarn and in order to make sure that the loops will remain permanently in said yarn, the loopy yarn should be given twist, using for this purpose a ring spinner or other suitable device. The amount of twist which should be inserted into the yarn depends on several factors, such as the denier of the yarn, the tenacity desired and the yarn cross-section desired. For best results the twist should be at least about 3 turns per inch for a 300 denier yarn and at least about 1 turn per inch for an 1800 denier yarn. Very much higher twists may be employed if desired, and, if necessary, such twists may be set by a steaming operation in a manner well known in the art.

The loopy yarn may be fed from the air jet to the ring spinner, or other twisting device, in any suitable manner. In a preferred embodiment of the invention a plurality of driven secondary feed rolls are provided for this purpose. Since the yarn decreases in length due to the looping operation, these secondary rolls must be driven at a peripheral speed which is lower than the peripheral speed of the primary feed roll, i.e. the roll which supplies the yarn to the air jet. Preferably the relative speeds of the primary and secondary rolls are so regulated that there is substantially no slack and the yarn is under substantially no tension between the air jet and the secondary rolls.

While this invention has its greatest value when employed with yarns of cellulose acetate, it is also applicable to yarns made of other materials. For example, the invention may be practiced with yarns composed of filaments of other materials, such as other organic derivative of cellulose materials, e.g. cellulose esters, such as cellulose propionate, cellulose butyrate, cellulose acetate-propionate or cellulose acetate-butyrate, or cellulose ethers, such as ethyl cellulose or benzyl cellulose; polyesters such as polyethylene terephthalate; polyamides such as nylon; regenerated cellulose; or other similar materials. All the filaments of the yarn may be made of a single material or, if desired, a yarn composed of a blend of filaments of different materials may be employed. For practical purposes it is desirable to use a yarn which has a denier of about 150 to 4000. For best results, it is also desirable that the yarn being treated should be substantially dry, i.e. substantially free from surface moisture, and that the filaments of the yarn should carry a coating of a small amount, e.g. 1% to 4%, of any of the conventional anti-static textile lubricating agents commonly employed in the art. The yarn being treated should be made up of at least 80 filaments and should not have a twist above 1 turn per inch for best results.

A preferred embodiment of this invention is shown in the accompanying drawing, wherein

Fig. 1 is a perspective view of the apparatus of this invention,

Fig. 2 is a cross-sectional view of the jet, and

Fig. 3 is an enlarged view of a portion of the loopy yarn produced in accordance with this invention.

Referring now to the drawing, reference numeral **11** indicates a primary feed roll, which is mounted for rotation and is driven by any suitable means, such as a variable speed drive (not shown). The rotation of the feed roll **11** serves to draw a yarn **12** from a bobbin **13**, through pigtail guides **14** and **16**, in the direction shown by the arrows, and to deliver said yarn to an air jet **17**, which is supplied with compressed air through an air line **18**. The air jet **17** comprises an inlet tube **19**, an outlet fitting **21** and a tubular T **22**, said T being provided with screw threads **23** (Fig. 2) for connecting the air line **18** thereto. The inlet tube **19**, which is adjustably

mounted within the T 22 by means of screw threads 24 and 26, has an internal diameter greater than the diameter of the yarn 12, which internal diameter is uniform throughout the length of said tube, except that the entrance to said tube is flared, as at 27, to allow the yarn to enter said tube more easily. At its entrance end 28 the tube 19 is provided with a broad head 29 having a knurled edge 31 to enable said tube to be rotated manually to adjust its position in relation to the T 22. The opposite end 32 of said tube 19 is beveled slightly.

For best results the position of the tube 19 in the T 22 is adjusted so that the beveled end 32 extends to a point adjacent to the outlet end 33 of said T. At this outlet end 33 the T 22 carries the fitting 21, which fitting is adjustably mounted on said T by means of screw threads 34. The internal diameter of the fitting 21 varies along the length thereof, there being in said fitting a wide portion 36 and a tapered portion 37 leading to a relatively long narrow orifice 38 having a flared end 39. The orifice 38 is not aligned with the tube 19 but is instead so located that its center line is parallel to, but offset from, the center line of said tube. Offsetting the tube and orifice in this manner increases the turbulence in the air jet 17 and produces a yarn having more loops. The positions of the fitting 21 and tube 19 are so adjusted that the air which enters from the line 18 leaves the air jet 17 from both the flared entrance 27 of the tube and the flared end 39 of the orifice 38, although the air leaves from the end 39 at a much higher velocity than from the entrance 27.

The yarn 12, which as it leaves the air jet 17 has a loopy appearance, is caused to come into contact with the smooth surface of a flat plate 41 with some force by the action of the stream of air leaving the end 39. The plate 41, which may be made of aluminum or other suitable material, is so mounted that the yarn impinges against its surface at an angle to said surface. Thus, it is desirable to mount the air jet 17 so that the path of the yarn through, and out of, said jet is substantially vertical, and to mount the plate 41 at an angle of about 45° to the direction of flow of the yarn, i.e. an angle of about 45° to the vertical. It is found that impinging the yarn against the plate 41 improves the quality of the loopy yarn by making the loops more uniform in size and by increasing the frequency of said loops.

The yarn is conveyed from the surface of the plate 41 by the action of a pair of driven secondary feed rolls 42, and is then twisted and wound by means of a ring spinner, or down twister, of conventional construction, indicated generally by reference numeral 43. Since the yarn decreases in length due to the looping operation, the secondary feed rolls 42 must be driven at a correspondingly lower peripheral speed than the primary feed roll 11. The relative speeds of the rolls should be regulated so that there is substantially no slack and very little tension in the yarn passing from its point of impingement on plate 41 to the secondary rolls. Such regulation of the speeds may be accomplished, for example, by driving the secondary rolls 42 at a constant speed and adjusting the speed of the primary roll 11, or vice versa.

As illustrated in Fig. 3, the yarn produced by the process of this invention comprises a twisted bundle of continuous filaments having loops of individual filaments projecting from the main mass of said bundle all along its length. Considering one individual filament of the yarn, loops formed therein project from the main body of the yarn at one or more spaced points along the length of the yarn, and the portion of said filament between loops constitutes part of the main twisted bundle of filaments. Loops formed by other individual filaments project from said main twisted bundle at other spaced points along the length of the yarn. The loops project from the main body of yarn for varying distances, up to several times the thickness of said main body, but most of the loops are of approximately equal size.

*Example I*

The apparatus described above is used for the treatment of a dry 300 denier yarn made up of 80 filaments of cellulose acetate, said yarn having a twist of 0.15 turn per inch and carrying 2.75% by weight of a conventional anti-static lubricant. The rolls 11 and 42 are run at peripheral speeds of 180 feet per minute and 137 feet per minute, respectively. In the jet used in this example, the vertical inlet tube 19 is 2 inches long and has an internal diameter of 0.031 inch and an external diameter of 0.203 inch; the T 22 has an internal diameter of 0.261 inch, so that the annular passage between the outer walls of the tube 19 and the inner walls of the T 22 has a width of 0.029 inch; the orifice 38 is 1 inch long and has a diameter of 0.062 inch; the center line of the orifice 38 is offset by 0.031 inch from the center line of the bore of the tube 19; the beveled end 32 is spaced approximately 0.061 inch from the entrance to the orifice 38; and the taper of the section 37 is 60°. The plate 41 is made of aluminum and is mounted at an angle of 45° to the vertical. The distance between the end 39 and the plate is ½ inch, measured along the path of the yarn. Air at room temperature and at a pressure of 15 to 20 pounds per square inch gauge is supplied to the jet. The ring spinner 43 is operated at a speed such that the yarn is given a twist of 4.5 turns per inch. The resulting loopy yarn has a denier of 350 and has the hand or feel of a spun yarn produced from staple fibers.

*Example II*

Example I is repeated with the following changes: The starting material is a 450 denier yarn made up of 120 filaments of cellulose acetate and having a twist of 0.15 turn per inch, and the primary roll is run at a peripheral speed of 190 feet per minute. The resulting loopy yarn has a denier of 520 and the hand or feel of a spun yarn produced from staple fibers.

*Example III*

Example I is repeated with the following changes: The starting material is an 1800 denier yarn made by pretwisting, to a twist of 0.6 turn per inch, 4 ends of the 450 denier yarn employed in Example II. The primary and secondary rolls are run at peripheral speeds of 85 and 72 feet per minute, respectively. The resulting loopy yarn has a denier of 2350 and the hand or feel of a spun yarn produced from staple fibers.

In the process described in the above examples the yarn is subjected to a high velocity gas jet under conditions such that the filaments are separated and whipped about sufficiently to form convolutions and are then removed abruptly from the gas jet and brought together to form a twisted yarn, while, throughout the process, avoiding tension which would straighten out the convolutions of the filaments.

It is to be understood that the foregoing detailed description is given merely by way of illustration and that many variations may be made therein without departing from the spirit of my invention.

Having described my invention what I desire to secure by Letters Patent is:

1. Process for the production of voluminous yarns which comprises passing a yarn of continuous filaments into the yarn inlet end of a jet, passing a gas under pressure into said jet, subjecting said yarn to a turbulent stream of said gas in said jet, passing said yarn and the main portion of said gas out of the outlet of said jet while passing a portion of said gas out of the yarn inlet end of said jet, whereby there is produced a continuous filament yarn having loops of individual filaments projecting from the main body of said yarn.

2. Process for the production of voluminous yarns which comprises passing a yarn of continuous filaments into the yarn inlet end of a jet, passing a gas under pres-

sure into said jet, subjecting said yarn to a turbulent stream of said gas in said jet, passing said yarn and the main portion of said gas out of the outlet of said jet while passing a portion of said gas out of the yarn inlet end of said jet, whereby there is produced a continuous filament yarn having loops of individual filaments projecting from the main body of said yarn, and twisting said loopy yarn.

3. Process for the production of voluminous yarns which comprises passing a yarn of continuous filaments into the yarn inlet end of a jet, passing a gas under pressure into said jet, subjecting said yarn to a turbulent stream of said gas in said jet, passing said yarn and the main portion of said gas out of the outlet of said jet while passing a portion of said gas out of the yarn inlet end of said jet, whereby there is produced a continuous filament yarn having loops of individual filaments projecting from the main body of said yarn, impinging said yarn against a smooth solid surface whereby the frequency of said loops along the length of said yarn is increased and the size of said loops is made more uniform, and twisting said loopy yarn.

4. Process of claim 3 in which the gas is air and in which the smooth surface is at an angle of about 45° to the path of said yarn.

5. A process for making bulky continuous filament yarn which comprises passing a bundle of filaments through a high velocity air jet under conditions such that the filaments are separated and whipped about sufficiently to form convolutions, removing the filaments abruptly from the air jet, bringing the filaments together to form a twisted yarn, and throughout the process avoiding tension which would straighten out the convolutions of the filaments, said bundle of filaments being fed along a path into contact with the turbulent air in said jet in a chamber and being withdrawn from said chamber together with said air along a second path parallel with but out of alignment with the first mentioned path.

6. Process as set forth in claim 5 in which the filaments leaving said chamber along said second path are impinged against a solid surface.

7. Process as set forth in claim 6 in which a portion of the air leaves said chamber along said first mentioned path at a velocity less than the air leaving along said second path, and said solid surface is arranged at an acute angle of 15 to 75° to said second path, the filaments being withdrawn from said surface in generally the same direction, projected on said surface, as the direction of impingement.

8. Apparatus for making bulky continuous filament yarn which comprises a fluid nozzle adapted to create a turbulent zone, means for feeding yarn continuously through the turbulent zone, means for supplying fluid to said nozzle under a pressure which will provide sufficient turbulence to separate the yarn filaments and form them into convolutions, and means for withdrawing the separated filaments from the turbulent zone and reforming them into yarn, said nozzle comprising a filament inlet passage terminating in a chamber connected to said means for supplying fluid under pressure, and a filament outlet passage connected to said chamber and out of alignment with said filament inlet passage, said filament outlet passage being parallel to said filament inlet passage.

9. Apparatus for making bulky continuous filament yarn which comprises a fluid nozzle adapted to create a turbulent zone, means for feeding yarn continuously through the turbulent zone, means for supplying fluid to said nozzle under a pressure which will provide sufficient turbulence to separate the yarn filaments and form them into convolutions, and means for withdrawing the separated filaments from the turbulent zone and reforming them into yarn, said nozzle comprising a filament inlet tube for receiving the yarn from said feeding means, said tube opening within a chamber connected to said means for supplying fluid under pressure, said chamber being of greater cross-section than said tube, and a filament outlet passage connected to said chamber and out of alignment with said filament inlet tube.



10. Apparatus for making bulky continuous filament yarn which comprises a fluid nozzle adapted to create a turbulent zone, means for feeding yarn continuously through the turbulent zone, means for supplying fluid to said nozzle under a pressure which will provide sufficient turbulence to separate the yarn filaments and form them into convolutions, and means for withdrawing the separated filaments from the turbulent zone and reforming them into yarn, said nozzle comprising a tubular yarn inlet passage opening within a chamber of larger cross-section than said passage, an inlet connected to said chamber for receiving fluid under pressure, and a yarn outlet passage connected to said chamber and out of alignment with said yarn inlet passage.

11. Apparatus as set forth in claim 9 in which the filament inlet tube extends into said chamber in a direction generally parallel to the longitudinal axis of said chamber.

12. Apparatus as set forth in claim 9 in which said tube terminates within said chamber.

13. Apparatus as set forth in claim 12 in which the interior of said chamber adjacent to the end of said tube is tapered.

14. Apparatus as set forth in claim 11 and including an air inlet passage at substantially right angles to said longitudinal axis.

15. Apparatus as set forth in claim 9 and including a solid surface against which the filaments and fluid leaving said outlet passage are impinged.

16. Apparatus as set forth in claim 15 in which said solid surface is spaced from said outlet passage a distance on the order of ¼ inch to 1 inch.

17. A process for making bulky continuous filament yarn which comprises passing a bundle of filaments through a high velocity gas jet under conditions such that the filaments are separated and whipped about sufficiently to form convolutions, removing the filaments abruptly from the gas jet, taking up the filaments as a twisted yarn, and throughout the process avoiding tension which would straighten out the convolutions of the filaments, said bundle of filaments being fed into contact with said gas through an enclosed passage terminating within a confined zone, said confined zone being of larger cross section than said passage and being supplied with gas under pressure, and said filaments being withdrawn from said confined zone along a path out of alignment with said passage.

18. Process as set forth in claim 17 in which a minor portion of said gas is passed out of said chamber through said passage in a direction counter to the direction of said filaments.

19. Process as set forth in claim 18 in which said filaments are impinged against a solid surface after leaving said confined zone.

20. In an apparatus for the production of voluminous yarn comprising a nozzle for subjecting said yarn to the action of a turbulent stream of air to form a yarn having loops of individual filaments projecting from the main body of said yarn, means for supplying compressed air to said nozzle, means for feeding the yarn to the nozzle and means for withdrawing the yarn from said nozzle at a lower linear speed than the feed speed, said nozzle comprising an inlet tube for receiving the yarn from said feeding means, said tube opening within a chamber connected to said means for supplying compressed air, said chamber being of greater cross-section than said tube and having a filament outlet passage connected to said chamber, the improvement which com-

prises having said filament outlet passage out of alignment with said inlet tube.

21. In the process for making bulky continuous filament yarn which comprises subjecting a yarn of continuous filaments to the action of a turbulent stream of air to produce a yarn having loops of individual filaments projecting from the main body of said yarn, in which process the yarn is fed into contact with said air through an enclosed passage within a confined zone, said confined zone being of larger cross section than said passage and being supplied with air under pressure, and said filaments being withdrawn from said confined zone and then taken up as a twisted yarn having said projecting loops at a lower linear speed than the speed at which the yarn is fed to said confined zone, the improvement which comprises withdrawing said filaments from said confined zone along a path out of alignment with said passage, said filaments being accompanied, along said path, by a stream of said air.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 2,125,230 | Hofmann | July 26, 1938 |
| 2,224,923 | Pool | Dec. 17, 1940 |
| 2,379,824 | Mummery | July 3, 1945 |
| 2,638,146 | Rounseville et al. | May 12, 1953 |
| 2,783,609 | Breen | Mar. 5, 1957 |
| 2,807,862 | Griset | Oct. 1, 1957 |
| 2,874,443 | Griset | Feb. 24, 1959 |
| 2,884,756 | Head | May 5, 1959 |