

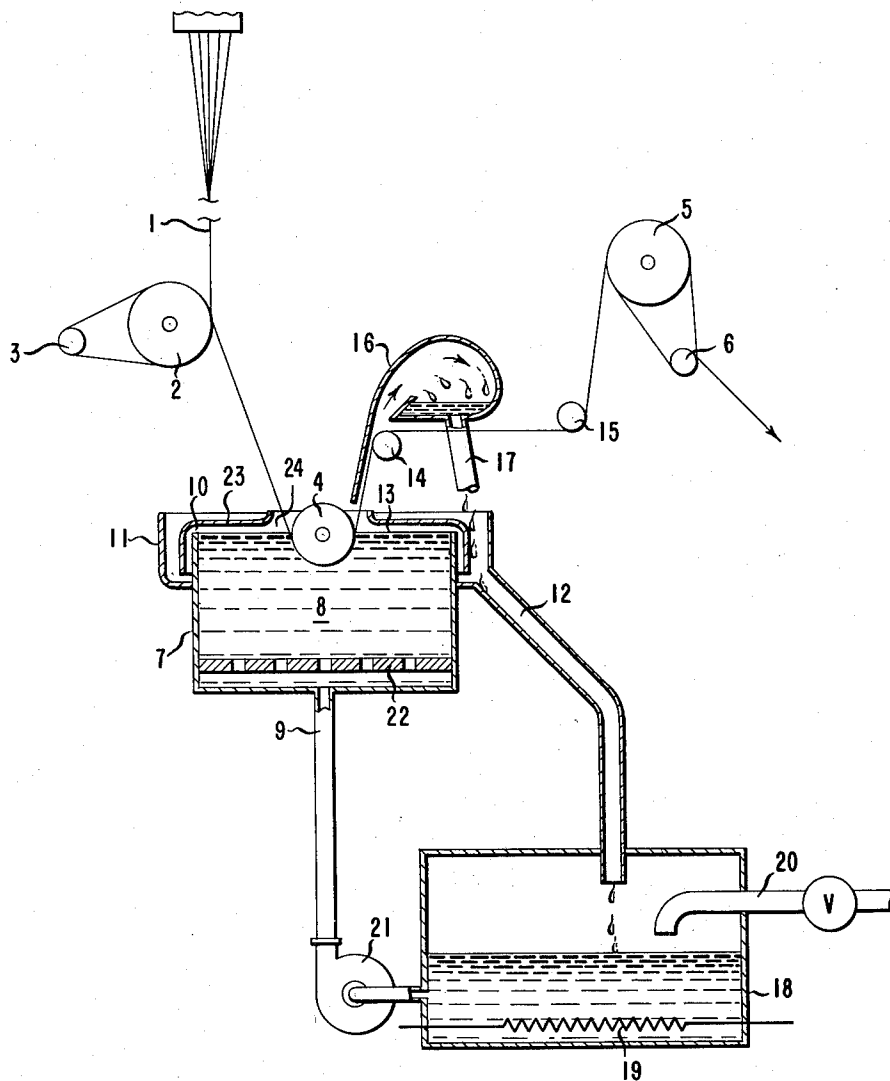
July 24, 1962

C. E. DUSENBURY

3,045,315

APPARATUS FOR ORIENTING CONTINUOUS FILAMENT YARNS

Filed Nov. 2, 1960



INVENTOR
CHARLES E. DUSENBURY

BY *Frank C. Hilberg*
ATTORNEY

1

3,045,315

APPARATUS FOR ORIENTING CONTINUOUS FILAMENT YARNS

Charles E. Dusenbury, Kinston, N.C., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

Filed Nov. 2, 1960, Ser. No. 66,813

7 Claims. (Cl. 28—59.5)

This invention relates to an apparatus for orienting synthetic continuous filament yarns, especially at high speeds. More particularly, it is concerned with apparatus for the high-speed orientation of continuous filament yarns composed of a synthetic linear condensation polymer in a highly uniform manner to yield a product having improved yarn properties.

It is well known that synthetic yarns, and especially the melt-spun yarns such as those produced from the synthetic linear condensation polymers in the conventional range of spinning speeds, have relatively low tenacities as spun. However, when such yarns are stretched or drawn, they undergo orientation and become highly tenacious. Various types of apparatus have been developed in the past for the purpose of carrying out the step of orienting the synthetic yarns. For achieving a high degree of uniformity in the yarn product, it has been found desirable to employ apparatus in which the orientation step takes place in a bath of liquid, usually an aqueous bath. However, control of yarn uniformity with such apparatus is dependent upon maintaining the temperature and liquid level of the bath constant. At speeds on the order of 2000 yards per minute and above, it has been found difficult to maintain the bath temperature constant, especially in commercial practice where a large number of draw positions are in simultaneous use and the yarn product from each position must conform to a common standard. This results from temperature variations within each individual bath caused by foaming of the bath and return to the bath of a stream of liquid carried out by the moving filament bundle. In addition to causing temperature transients in the bath, liquid returning to the bath may result in excessive time to reach equilibrium. Attempts to solve this problem by using a higher inlet flow rate of liquid simply leads to excessive non-uniformities resulting from turbulence.

It is an object of this invention to provide a novel apparatus for orienting synthetic continuous filament yarns in a liquid bath. Another object is to provide an orientation apparatus provided with a liquid bath with improved means for controlling the uniformity of bath temperature and level. Additional objects will be apparent from the following description and claims.

In accordance with this invention, the above objects are achieved by an apparatus comprising a vessel having an inlet for liquid in the lower part of the vessel and an outlet for liquid comprising a rim disposed entirely within a horizontal plane; means circumferential of the vessel for collecting liquid overflow from the rim and carrying said overflowing liquid away; means for passing liquid at constant temperature into said vessel through said inlet; a draw pin disposed such that at least part of the pin is located below the horizontal plane containing the rim of the vessel; a spray collection container located above the vessel for collecting liquid sprayed up from the vessel; and means for carrying liquid away from said spray collection container. In its preferred form, the apparatus includes a reservoir to which the liquid overflowing from the vessel and the liquid from the spray collection container are delivered, means for adding fresh liquid to the reservoir to maintain the reservoir at constant volume, and means for heating the liquid in the reservoir to maintain it at constant temperature. In commercial practice,

2

the reservoir usually serves as a supply for a plurality of vessels.

The nature of the apparatus of the present invention will be more fully understood with reference to the accompanying FIGURE, which is a somewhat diagrammatic side view of the apparatus.

Referring now to the FIGURE, undrawn yarn 1 is supplied to feed roll 2 from a suitable source (not shown), preferably by being forwarded directly from a spinneret from which the yarn is being produced by the extrusion of a plurality of filaments together. To prevent slipping, several wraps are usually taken around feed roll together with its associated separator roll 3, the axis of which is usually slightly canted from that of the feed roll to assure separation of each wrap from the preceding wrap. The yarn is then passed under cylindrical snubbing pin or draw pin 4 and, without being passed over the top of the pin to complete one or more wraps, is passed on to draw roll 5 and its canted separator roll 6. After taking several wraps around the draw roll and its separator roll, the yarn is wound up on a suitable package (not shown). The draw roll is preferably adapted to be heated so that the shrinkage of the yarn may be reduced by crystallization of the polymer in the yarn; or, if desired, separate heated rolls (not shown) between the draw roll and the windup may be supplied to reduce the shrinkage of the yarn. If separate heated rolls are used, they may be operated at the same surface speed as that of the draw roll, or higher or lower speeds may be used to stretch or relax the yarn, respectively. A vessel 7 containing a bath 8 of liquid is provided in contact with the draw pin. The liquid is introduced continuously through inlet tube 9 and leaves the vessel by flowing continuously over rim 10 of the vessel, the rim being located entirely within a horizontal plane so that the flow of liquid over the rim is substantially uniform at each point around the rim. The overflowing liquid is collected in cup 11, which surrounds vessel 7, and passes out through drain 12. By these means the liquid level 13 is readily maintained constant with respect to the draw pin 4.

Between the draw pin and the draw roll, the yarn is passed around cylindrical guide pins or stripper pins 14 and 15, which are so disposed with respect to the draw pin and draw roll that the yarn is caused to undergo a sharp change in direction. Sharply changing the direction of yarn travel in this way causes the liquid which normally clings to the yarn to become separated from the yarn as spray, so that the amount of liquid remaining on the yarn is less than about 15% by weight. Spray collection container 16, consisting of an elongated shield mounted above the draw pin approximately parallel to the yarn as it leaves the pin and curved downward upon itself above the stripper pin 14 to form a receptacle, serves to collect the liquid which is sprayed from the yarn above the first stripper pin 14 as the rapidly moving yarn changes direction. The collected spray passes out through drain 17. As indicated in the FIGURE, the collected spray is conveniently drained into cup 11 and thence into drain 12. Direct return of the collected spray into bath 8 is avoided, since this leads to the formation of zones of different temperatures within the bath.

In the preferred form of the apparatus, a reservoir 18 is provided to receive the liquid overflowing from the vessel and the liquid collected in the spray collection container via drain tube 12. Heating means 19 adapted to maintain the liquid in the reservoir at constant temperature is provided, together with inlet means 20 for providing a supply of fresh liquid as required. Addition of the liquid is usually carried out in a continuous manner so as to maintain the reservoir at constant volume. Recirculation of the liquid from the reservoir to the draw

bath is provided for by means of pump 21 connected to inlet tube 9.

Perforated plate 22 is preferably provided to reduce turbulence in the liquid as it enters the vessel. An annular cover 23 is also preferably provided to minimize evaporation of the liquid. Slot 24 in the cover, which accommodates the draw pin and permits the yarn to enter and leave the bath, extends to one side of the cover so that the cover may be placed in position after the apparatus has been strung up.

The inlet 9 for passing liquid into the vessel is located in the lower part of the vessel, preferably in the bottom of the vessel substantially at the center of the vessel. The vessel is preferably circular in cross-section, so that the rim comprises a horizontal circle. In operation, the flow of liquid into the vessel is maintained at a constant value such that the liquid flows evenly over the rim around its entire circumference. The yarn passing under the draw pin also carries with it a considerable amount of the liquid; however, amounts of the liquid in excess of a thin, stable film clinging to the yarn are deflected into the spray collection container and discharged into the bath recirculation system in such a way that the amount of liquid returning to the draw bath after being cooled by contacting the air is minimized. The apparatus is thus highly adapted for maintaining an extremely uniform bath temperature in all parts of the vessel. Temperature non-uniformities are further minimized by reduction of turbulence with the aid of perforated plate 22 in the lower part of the vessel above the liquid inlet. Cover 23 similarly reduces air turbulence in the vicinity of the bath.

The angle of entry of the yarn into the bath, proceeding from the feed roll to the draw pin, may vary within the range of 90° (vertical entry) to 45°. Within this range, wetting of the yarn as it contacts the draw pin can be achieved without an excessive tension drop as it enters the water. To preclude foam formation and permit easy collection of spray, the exit angle of the yarn should be within the range of 75° to 85°. The diameter of the draw pin is usually in the range of about 0.25 to 2 inches. Although it will usually be a right circular cylinder in form, it may be a cylinder having a convex curved cross-section other than circular, such as an elliptical cross-section. The pin is mounted in such a way that at least a portion of it is immersed in the bath; i.e., at least a part of the draw pin lies below the horizontal plane defined by the rim of the vessel. The depth of immersion should be sufficient to permit wetting of the yarn by the bath at or prior to the time the yarn first touches the draw pin. The maximum depth to which the draw pin is immersed in the liquid is preferably on the order of about 1 inch with a two-inch pin. In general, the draw pin should be immersed in the bath to at least about half its diameter. Complete immersion of smaller pins is not excluded, but the 1 inch limitation should not be exceeded.

The apparatus of the present invention is particularly useful when employed with yarns composed of a synthetic linear condensation polyester, such as polyethylene terephthalate. The production of highly useful fibers composed of polyethylene terephthalate, including the steps of preparing the polymer, melt spinning the polymer to form substantially unoriented filaments, and drawing the filaments to a permanent increase in length to yield tenacious oriented fibers, is disclosed in U.S. 2,465,319 to Whinfield and Dixon. Other synthetic linear condensation polyesters may be prepared in a manner similar to polyethylene terephthalate, such as by substituting other glycols for ethylene glycol, and subsequently formed into tenacious oriented fibers. In the case of the synthetic linear condensation polyesters, it has been found that control of the orientation step is an especially critical factor in achieving uniformity of product, since small variations in the temperature and other process conditions lead to significant variations in the dyeability of the yarn and other uniformity parameters. Variations in uniformity are usually

found along the length of any given yarn being processed as well as between two or more yarns which are being processed separately. The high degree of uniformity of draw bath temperature achievable with the apparatus of the present invention is thus of especial significance in the orientation of filaments composed of the synthetic linear condensation polyesters.

During the drawing step, prior to winding up the oriented yarns, the yarns must be heated to dry them and it is generally desired that the heating step be of sufficient duration and at a sufficient temperature to relax or set the yarns which have just been oriented. By causing excess liquid to be removed from the yarn and returned to the bath recirculation system in accordance with the apparatus of the present invention as described above, the heat load on heated draw rolls or other heated rolls is greatly reduced.

It is usually desired, especially in the case of the linear condensation polyesters, to add lubricants or finish oils to the draw bath. Staining of the yarn, attributable to contact with the yarn by spray droplets having a higher concentration of finish oils than the bath itself as the result of evaporation of water from the droplet, is also avoided by employing the apparatus of the present invention.

The following example illustrates the use of the apparatus of the present invention in actual practice. However, the example is not intended to be limitative.

Example

Polyethylene terephthalate having a relative viscosity of 27 is spun at 290° C. through a spinneret plate containing 34 round orifices. The filaments are gathered into a yarn bundle and the bundle is lubricated with a commercially available textile finishing agent comprising a cationic alkyl fatty amine derivative. The yarn is then passed from a feed roll and an associated separator roll at 660 yards per minute vertically downward and under a draw pin 1/2 inch in diameter, and then upward at an angle of 82° to a stripper pin 3/8 inch in diameter. The apparatus employed is shown in the figure. The draw pin is immersed to a depth of 1/4 inch in an aqueous bath containing 1% of the alkyl fatty amine derivative finishing agent and maintained at 90° C. The yarn is passed over the first stripper pin at an angle of about 90°, under a second pin at about the same angle, and is then wrapped around a pair of heated rolls maintained at 130° C. and operated at 2750 yards per minute surface speed, after which it is finally wound on a suitable package. The contact arc of the yarn under the draw pin is approximately 172°. The draw ratio applied to the yarn is 4.16 and the drawn yarn has a denier of 70 (7.8 tex). The yarn has a tenacity of 4.1 g.p.d., an elongation of 27%, an initial modulus of 104 g.p.d., a boil-off shrinkage of 7.6%, and a Uster value of 1.0% for denier uniformity. The yarn exhibits no "flashes" when woven and dyed. Woven samples of the yarn exhibit a Monsanto crease recovery value of 62%.

In the example above, the presence of "flashes," or segments of undrawn filament in the yarns, is determined by weaving a few quills of the test yarn into a filling fabric using standard warp yarns, followed by dyeing the fabric with Celanthrene Brilliant Blue FFS dye (C.I. No. 61505). The filling of the fabric is then examined for the presence of flashes, which are readily observed owing to the greater affinity of the flashes for dyes than is exhibited by the remainder of the yarn.

Numerical values for the Monsanto crease recovery, an important fabric parameter, are determined in accordance with the method described as the "vertical strip crease recovery test" in the American Society for Testing Material Manual, Test No. D1295-53T. In determining wet crease recovery by this method, the specimens are soaked for at least 16 hours in distilled water containing 0.5% by weight of "Tween 20," a polyoxyalkylene derivative of sorbitan monolaurate, a wetting agent marketed by the Atlas Pow-

der Company, Wilmington, Delaware. Immediately prior to testing, excess water is removed from the test fabric by blotting between layers of a paper towel. Results are reported as percent recovery from a standard crease in 300 seconds.

Yarn uniformity values are determined with the Uster Evenness Tester, Model C, sold by Zellweger Ltd., Uster, Switzerland, which measures variation in denier electronically by means of a capacitance gauge (ref.: "Evenness Testing" by P. W. Mullen, Textile Industries, vol. 7, p. 118 ff., July 1953). Uster values as reported are percentage unevenness values, based on the deviation from the average value.

The apparatus and process herein disclosed result in synthetic linear condensation polymer yarns which have surprisingly good uniformity when dyed. They are particularly free from flashes and other types of unevenness. The invention offers as a further advantage improved uniformity of finish together with satisfactory spinning speeds.

It will be apparent that many widely different embodiments of this invention may be made without departing from the spirit and scope thereof, and therefore it is not intended to be limited except as indicated in the appended claims.

I claim:

1. An apparatus for drawing synthetic linear condensation polymer yarns which comprises a vessel having an inlet for liquid in the lower part of the vessel, said vessel having an upper rim lying entirely within a horizontal plane; means at the rim of the vessel for collecting liquid flowing over the said rim and means connecting therewith for carrying the overflowing liquid away; means for passing liquid into said vessel through the said inlet; means for maintaining the incoming liquid at a constant tempera-

ture; a substantially horizontal draw pin at least partly disposed beneath the surface of the liquid in the upper part of the said vessel; means for passing the yarn to be drawn in contact with the under surface of the draw pin; a spray collection container located above the vessel for collecting liquid thrown from the yarn, and means for draining the liquid from the said spray collection container.

2. The apparatus of claim 1 which also contains means for collecting the liquid leaving the spray collection container and the overflow from the said vessel, and means for recirculating such liquid through the said inlet.

3. The apparatus of claim 1 in which a perforated plate is provided in the lower part of the said vessel.

4. The apparatus of claim 1 in which the said vessel is provided with a cover having slits above the said draw pin for allowing the yarn to enter and leave the said vessel.

5. The apparatus of claim 1 which includes means located outside of the vessel for passing the yarn to the said draw pin at an angle between 45° and 90° from the horizontal and from the draw pin at an angle from 75° to 85° from the horizontal.

6. The apparatus of claim 1 in which the said draw pin is immersed about one-half its diameter in a liquid within the said vessel.

7. The apparatus of claim 1 in which the diameter of the said pin is between 0.25 and 2 inches.

References Cited in the file of this patent

UNITED STATES PATENTS

2,385,894	Taylor	Oct. 2, 1945
2,627,084	Ryan	Feb. 3, 1953
2,789,315	Pistor et al.	Apr. 23, 1957