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APPARATUS FOR MANUFACTURE OR TREATMENT OF ARTIFICIAL FILAMENTARY MATERIALS

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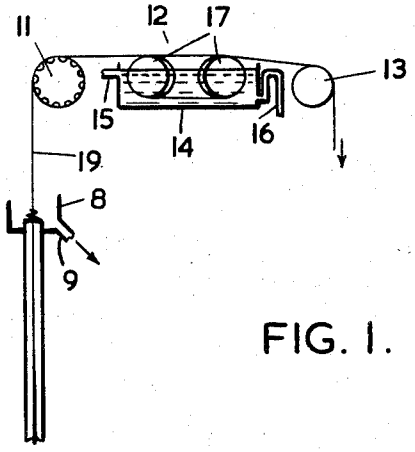


FIG. 1.

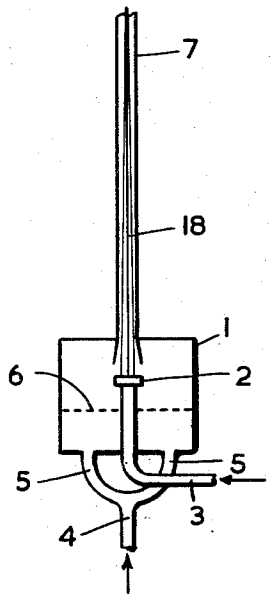
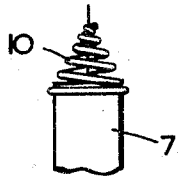


FIG. 2.



P. F. C. SOWTER
F. B. HILL
INVENTORS

Salter & Davison
ATTORNEYS

United States Patent Office

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APPARATUS FOR MANUFACTURE OR TREATMENT OF ARTIFICIAL FILAMENTARY MATERIALS

Percy Frederick Combe Sowter and Frank Brentnall Hill, Spondon, near Derby, England, assignors to British Celanese Limited, a corporation of Great Britain

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5 Claims. (Cl. 18—8)

This invention relates to the manufacture or treatment of artificial filamentary materials and especially to their production by wet-spinning processes.

In U. S. applications S. Nos. 323,788, filed December 3, 1952 and 451,191, filed August 20, 1954, there are described wet-spinning processes in which the filaments formed travel under specified conditions in the same direction as a coagulating liquid up a narrow tube, and are drawn from the tube as a bundle such as a yarn or tow (hereinafter referred to as a yarn). The bulk of the coagulating liquid overflows at the top of the tube and may be collected and drawn off in any suitable way, but a substantial proportion is carried up to a considerable height by the travelling yarn unless some means for preventing this is adopted. This phenomenon is indeed observed in any process in which a yarn is drawn fairly fast upwardly out of a narrow tube containing a liquid, e. g. a tube of diameter less than about 1.5 inches. The tension imparted to the yarn by the weight of the liquid carried up may have an adverse effect on its textile properties.

One way of removing a considerable part of the liquid from the yarn, and so preventing the yarn from carrying up a large weight of the liquid, is to fix a yarn guide or the like directly above the open end of the tube to "wipe" the liquid off the yarn, but we have found that this also can be undesirable in that it tends to increase the number of broken filaments in the yarn.

U. S. application S. No. 217,816, filed March 27, 1951, now Patent No. 2,786,737, describes a device comprising a pulley set skew with respect to the plane of the yarn over which the yarn passes after leaving the tube; this pulley has the effect of inserting a false twist in the yarn, by virtue of which the amount of liquid carried up is very much reduced. However, the insertion of this false twist is not always desirable, nor is the presence of the skew pulley always convenient.

It is shown in U. S. application S. No. 451,191, filed August 20, 1954, that the filament breakage which often occurs when a yarn guide is used to wipe adherent liquid from the yarn is due, at least in large part, to disturbances in the surface of the liquid welling up out of the tube, caused by the liquid which has been wiped off the yarn falling back into the tube. According to U. S. application S. No. 451,190 filament breakage is greatly reduced by the use of a device which first wipes adherent liquid off the yarn, and then directs it clear of the upper end of the tube; the device particularly described comprises an inverted conical funnel above and coaxial with the tube, through which the yarn passes after leaving the tube, the diameter of the base of the funnel being greater than that of the upper end of the tube. The diameter of the apex of the funnel may be sufficiently small to enable the funnel itself to wipe adherent liquid from the yarn, or some other means for doing this, such as a pigtail yarn guide, may be provided above the funnel.

According to the present invention, filamentary material (for example a multi-filament yarn), which has passed

up and out of a narrow tube containing a liquid and is carrying with it a column of the liquid, is caused to travel through a stripping device comprising a conical wire spiral coaxial with the tube, the base of the said spiral having an external diameter equal to or greater than that of the upper end of the tube, the apex of the said spiral being below the level at which the greater part of the liquid carried up by the material would fall away under the action of gravity alone, and adjacent turns of the said spiral being so spaced that liquid carried up with the filamentary material is impelled between them by its own momentum, and then runs mainly or entirely down the outside of the spiral and so is led clear of the upper end of the tube. Advantageously, the base of the conical spiral may fit tightly over the top of the tube, so that it needs no other support. The internal diameter of the conical spiral at its apex may be about 0.05–0.15 inch, and the apex may be for example between about 1 and 2 inches above the upper end of the tube, the optimum height depending on the rate of travel and the denier and structure of the material (e. g. the number of filaments in a multi-filament yarn), the internal and external diameters of the top of the tube, and the other circumstances of the case. Usually a spacing of about 0.05–0.15 inch between adjacent turns is suitable.

While the invention is applicable to any process in which filamentary material and a liquid pass up and out of a narrow tube, its greatest importance is probably in wet spinning processes for the manufacture of filamentary material. It is of particular value in the manufacture of cellulose acetate filamentary material by extruding an acetone solution of cellulose acetate into a coagulating liquid consisting of an aqueous solution of diethylene glycol diacetate or of acetone and passing the filaments so formed with the coagulating liquid up a narrow tube, for example as described in U. S. applications S. Nos. 323,788; 451,191; 451,193, filed August 20, 1954; 457,684, filed September 22, 1954; 451,192, filed August 20, 1954; 488,868, filed February 17, 1955 and 510,754, filed May 24, 1955. It may however also be used with advantage in other wet-spinning processes, for example in the wet-spinning of acetic acid solutions of cellulose acetate, using as coagulant aqueous acetic acid which may contain in solution a high concentration of a salt, e. g. an alkali metal acetate; the acetic acid solutions of cellulose acetate may be primary or secondary acetylation solutions in which the catalyst has been neutralised and if necessary the concentration of cellulose acetate adjusted, as by the addition of further acetic acid, to give the solution a suitable spinning viscosity.

The invention also comprises apparatus for the production or treatment of filamentary material, in particular wet spinning apparatus, comprising a substantially vertical narrow tube, means for causing filamentary material and a liquid to pass up and out of the tube, and a stripping device comprising a conical wire spiral coaxial with the tube, the external diameter of the base of said spiral being equal to or greater than that of the upper end of the tube and the spiral being mounted mainly or wholly above the upper end of the tube. Forms of wet spinning apparatus in which the conical wire spiral may be employed are described in U. S. applications S. Nos. 323,788; 451,191; 451,298 now Patent No. 2,811,479; 457,684; 451,192; 488,868 and 510,754 now abandoned.

A wet spinning apparatus in accordance with the invention is illustrated in the accompanying drawing, in which

Figure 1 is a diagrammatic sectional view of the apparatus as a whole, and

Figure 2 is a side view on an enlarged scale of the upper end of the tube and the stripping device shown in Figure 1.

Referring to the drawing, the wet spinning apparatus illustrated comprises a cylindrical extrusion chamber 1 of relatively large diameter, e. g. about 8 inches, containing an upwardly facing spinning jet 2 fed by a pipe 3. A feed pipe 4 for coagulating liquid leads to the base of the extrusion chamber 1 via branches 5, two of which are shown. A metal gauze 6 extends across the extrusion chamber 1 below the level of the jet and serves to even out the flow of coagulating liquid and render it substantially non-turbulent.

A setting tube 7 extends vertically upwards from the extrusion chamber 1, into which it opens directly opposite, and between 0.25 and 4 inches from, the face of the jet 2. The lower end of the setting tube is flared so as to promote streamline and non-turbulent flow of coagulating liquid into the tube. The setting tube may be of uniform diameter throughout its length, or its diameter may decrease in one or more stages as described in U. S. application S. No. 451,191. At its upper end the setting tube carries a collector head 8 for liquid, provided with a liquid run-off 9.

A conical wire spiral 10, the basal internal diameter of which is substantially equal to the external diameter of the upper end of the tube 7, fits over and is supported by the upper end of the tube. The diameter of the apex of the spiral is between 0.05 and 0.15 inch, and its height above the upper end of the tube is 1–2 inches. The spacing between adjacent turns of the spiral is 0.05–0.15 inch, and the spiral is constructed of wire of 14–18 S. W. G.

Above the stripping device is a godet 11, which preferably has a fluted surface as described in U. S. application S. No. 451,193, now abandoned, and beyond this a washing device 12 and a second godet 13. The washing device 12 comprises a bath 14 for a washing liquid, provided with an inlet 15 for fresh washing liquid and an outlet 16 for contaminated liquid; a pair of driven thread-advancing rollers 17, having their axes skew with respect to each other, are mounted in the bath partly above and partly below the operating level of the liquid surface.

In operation a coagulating liquid, for example aqueous diethylene glycol diacetate, is caused to flow through the pipe 4 and its branches 5 into the extrusion chamber 1, past the jet 2, and up through the setting tube 7, from the top of which it overflows into the collector head 8 which it leaves by the run-off 9. At the same time a spinning solution, for example an acetone solution of cellulose acetate, is fed to the jet 2 by the feed pipe 3 and extruded in the form of filaments 18 into the coagulating liquid in the extrusion chamber 1. The filaments formed travel with, but faster than, the coagulating liquid up the setting tube 7, from which they are drawn under tension by means of the godet 11. After leaving the setting tube 7 the filaments, now in the form of a bundle or yarn 19, pass through the stripping device 10; as they do so coagulating liquid carried up by them is impelled by its own momentum through the spaces between adjacent turns of the wire spiral and then, at least for the most part, flows down the outside of the wire spiral into the collector head 8 and clear of the upper end of the setting tube 7. From the godet 11 the yarn 19 passes to the washing device 12 in which it is washed, for example

with water. It is then forwarded by the second godet 13 to a further treating device or to a collecting device of any suitable and desired type.

The invention is of particular importance in the production of relatively fine multi-filament yarns, e. g. yarns of denier between about 20 and 80, although it may also be used in the production of heavier yarns and of tow suitable for conversion into staple fibre. For example, when spinning in accordance with Example III of U. S. application S. No. 323,788 a conical wire spiral of height 1.25 inches, in which the turns are spaced about 0.075 or 0.1 inch apart, may be fitted tightly over the open upper end of the setting tube.

Having described our invention what we desire to secure by Letters Patent is:

1. Apparatus for the production of filamentary material, comprising a substantially vertical narrow tube, means for causing filamentary material and a liquid to pass up and out of the tube, and a stripping device comprising a conical wire spiral coaxial with the tube, the external diameter of the base of the said spiral being at least equal to that of the upper end of the tube and the spiral being mounted at least mainly above the upper end of the tube.

2. Apparatus for the production of filamentary material by a wet spinning method, which comprises an extrusion chamber, an upwardly facing spinning jet in the said chamber, a feed pipe for supplying a spinning solution to the said jet, a feed pipe for introducing a coagulating liquid into the said chamber, a vertical tube coaxial with the spinning jet extending upwardly from and opening into the said chamber, means for drawing filamentary material through and out of the said tube, and a stripping device comprising a conical wire spiral coaxial with the tube, the external diameter of the base of the said spiral being at least equal to that of the upper end of the tube, and the spiral being mounted at least mainly above the upper end of the tube.

3. Apparatus according to claim 2, wherein the internal diameter of the apex of the spiral is 0.05–0.15 inch, the height of the apex above the upper end of the tube is 1–2 inches, and the spacing between adjacent turns of the spiral is 0.05–0.15 inch.

4. Apparatus according to claim 2, wherein the wire spiral fits over and is supported by the upper end of the tube.

5. Apparatus according to claim 3, wherein the wire spiral fits over and is supported by the upper end of the tube.

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