United States Patent

[11] 3,633,256

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[21] Appl. No. **850,452**
[22] Filed **Aug. 15, 1969**
[45] Patented **Jan. 11, 1972**

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[54] **ORIENTATION DRAWING CHAMBER FOR FIBERS**
3 Claims, 1 Drawing Fig.

[52] **U.S. Cl.** **28/71.3,** 28/62, 34/155
[51] **Int. Cl.** **D02j 1/22**
[50] **Field of Search** 28/1.4, 72.12, 62, 71.3; 34/155, 48; 264/290

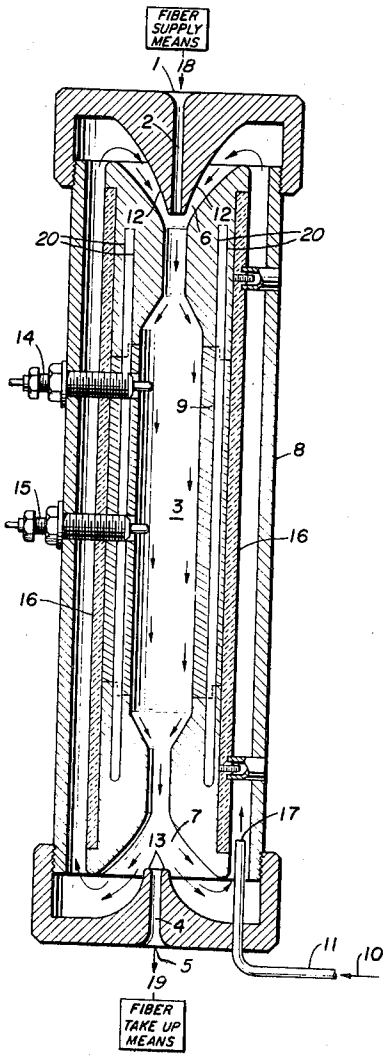
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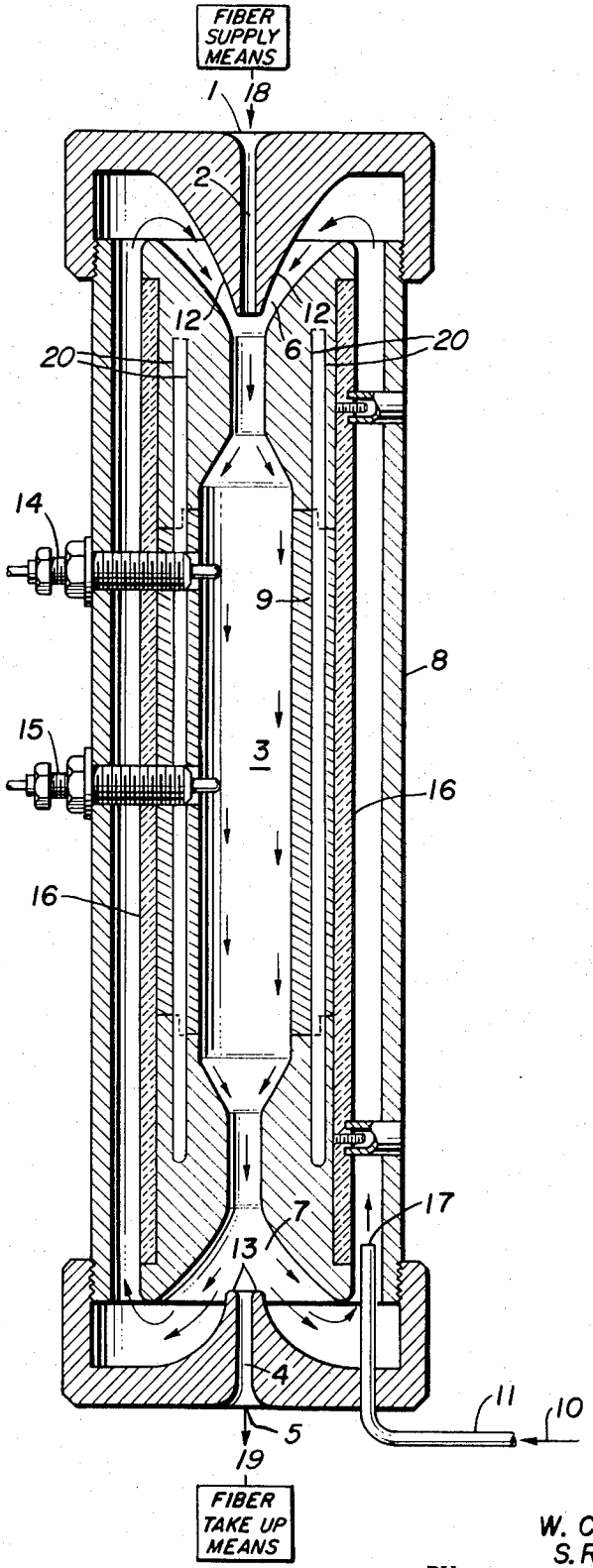
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ABSTRACT: A recirculating gas chamber for drawing fiber is comprised of a longitudinally disposed inner chamber defined by an inner tubular jacket having flared throats forming a venturi at each end with heating means for the chamber, a generally cylindrical outer jacket surrounding the inner jacket extending to within the flared throats of the inner jacket and spaced apart therefrom, and fiber entry and exit channels extending to within the flared throats, whereby the outermost of the inner jacket and the inner lining of the outer jacket are cooperatively shaped to provide a recirculating passage for a gaseous medium cocurrent with fiber movement through the inner chamber and countercurrent of fiber movement between the inner jacket and the outer jacket.





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ORIENTATION DRAWING CHAMBER FOR FIBERS

This invention relates to the manufacture of artificial filaments, yarn and thread, and more particularly to improvements in apparatus for the thermal orientation stretching of filaments of thermoplastic polymeric materials, such as nylon, polyester, acrylics, and the like.

Orientation drawing of synthetic filaments in heated tubes is not unknown in the prior art. U.S. Pat. No. 1,921,426, for example, discloses a process for increasing the tensile strength of artificial yarns by heating the yarn in a dry state while passing it through a relatively long, narrow stretching cell wherein the yarn is subjected to dry heat produced by any suitable means inside or out of the cell. U.S. Pat. No. 2,456,384 discloses the insertion of a small tube in a thermal stretching cell through which the yarn is passed into the cell as a means of overcoming the effects of static charges.

This method of drawing has shown great promise, particularly where composite fibers are involved because of the tendency of these fibers to show variances in the location of the point of "neck down;" and where hot shoes or draw pins are employed the application of heat is difficult to adjust for optimum thermal effect on the stretching fiber.

The introduction and use of preheated gas in a drawing chamber would, of course, permit selection of the most effective gases for the convection of heat; but prior art gas or dry heat drawing devices have failed to provide efficient recirculation means in a drawing cell for the most effective use of preselected, preheated gas in the drawing process.

It is an object of this invention to provide an apparatus for drawing fibers, filaments, yarns and the like in a heated gas medium in a chamber in which the fiber can be stretched at a uniformly high temperature.

It is another object of this invention to provide an apparatus for orientation drawing whereby fiber properties are improved.

It is yet another object of this invention to provide an apparatus for drawing fiber in a heated, gaseous medium wherein the gas is recirculated through the drawing chamber, thus providing a maximum of efficiency and a minimum of gas loss.

Briefly, these objects are accomplished by the use of a drawing chamber with venturi ends, and heating means; and with an outer jacket cooperatively shaped to provide a recirculating passage for a gaseous medium concurrent with fiber movement through the longitudinally disposed inner chamber and countercurrent of fiber movement between the outer walls of the inner chamber and the outer jacket.

These and other objects will become more clearly apparent from the following description in which the FIGURE of the drawing is a cross-sectional view of a preferred embodiment of the apparatus of this invention.

Referring now in detail to the figure, the fiber is fed to the apparatus from controlled speed supply means **18**, enters at fiber entry aperture **1**, passing through entry channel **2**. The fiber progresses through inner chamber **3** where drawing occurs, and exits through exit channel and exit aperture **5** being taken up by controlled speed takeup means **19**. Inner chamber **3** is provided with flared throats **6** and **7**, the flares of the throats forming a venturi opening into the chamber. An outer jacket **8** surrounds and is spaced apart from inner jacket **9** which surrounds inner chamber **3**, and the two elements are cooperatively shaped to provide a recirculating passage for the gaseous medium which is introduced from preheated gas source **10** through tube **11** and gas entry port **17**. Cooperating with venturi openings **6** and **7** in the formation of this recirculating passage are projections **12** and **13** of the inner lining of outer jacket **8** which protrude into the flared throat venturi-type openings **6** and **7** of inner chamber **3**. The inner chamber may be provided with heating means which, in this preferred embodiment, consists of electrical heating filaments **20** controlled by thermocouple **14** and thermocouple thermister controller **15**, readily available commonly used commercial devices. Inner jacket **9** may also be provided with a layer of insulation **16** on its periphery.

In operation, the fiber takeup means operates at a speed at least twice that of the fiber feed means, the orientation stretching of the fiber occuring in inner chamber **3**. The preheated gas is introduced under pressure in a longitudinally flowing direction, and the circulation of the gas, as shown by the directional arrows on the drawing, is facilitated by the venturi effect at the entry and exits of the inner chamber. There is some gas loss in the operation of this apparatus, but the loss is minimized by the generally cone-shaped projections **12** and **13** which house fiber entry channel **2** and fiber exit channel **5**, respectively. The fiber exit and entry channels are, of course, relatively small in diameter compared to that of the inner chamber. The following examples further illustrate the practice and attendant advantages of this invention:

EXAMPLE 1

Nylon 66 of a relative viscosity of 100 was drawn in the apparatus depicted in the FIGURE in helium gas at a temperature of 175° C. as measured by the gas temperature in the center of the inner chamber at a point half way along the chamber. Another sample of the same fiber was orientation drawn over a hot draw pin at 110° C. and a hot shoe at 120° C. About half the draw was on the pin and about half on the shoe. Comparative results are shown at table I.

TABLE I

	control drawn	hot gas tube drawn
drawn denier, dpf	13.4	13.2
tenacity, g/d	7.0	8.3
elongation, %	18.5	16.5
modulus, g/d	41.9	57.4
theoretical draw ratio	5.3:1	5.3:1
undrawn denier	670	670
drawn denier	134	132
actual draw ratio	5.0:1	5.1:1
birefringence, s.b.i. $\times 10^{-3}$	59.2	59.1
draw speed, f.p.m.	530	220

EXAMPLE 2

A sample of a composite fiber of 75 percent nylon 66 of a relative viscosity of 100 and 25 percent of a styrene-acrylonitrile copolymer (about 26 percent acrylonitrile) was drawn in the apparatus depicted in FIG. I in helium at 185° C. As a control, another sample of the same fiber was drawn over a hot pin and hot shoe as in example **1**. Comparative results are shown at table II.

TABLE II

	control drawn	hot gas tube drawn
drawn denier, dpf	13.9	11.3
tenacity, g/d	4.3	7.3
elongation, %	41.0	17.9
modulus, g/d	38.4	57.2
theoretical draw ratio	4.0	5.5
undrawn denier	534	534
drawn denier	139	113
actual draw ratio	3.85:1	4.74:1
draw speed, f.p.m.	400	220

EXAMPLE 3

To observe the effects of the gas at the same draw ratio as the control drawn fiber, the fiber used for example 2 was drawn in hot gas at a ratio of 3.9:1. Properties of the resulting fiber were: tenacity - 4.7 g./d.; elongation - 40.7 percent; modulus - 45.9 g./d. The increase in draw ratio of the fiber drawn in gas over the draw ratio of the fiber drawn over the hot pin and hot shoe might account for the improvement in

tenacity and reduction of elongation; but the increase in modulus could only be accounted for as an effect of the hot gaseous atmosphere.

From the foregoing, it will be manifest that the improvement constituting the present invention is easily applied in production, is inexpensive to construct, simple and trouble-free in operation, and permits the preparation of high-quality, heat-stretched thermoplastic filaments of uniform properties.

As many widely different embodiments of our invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not to be restricted in any way except as defined in the appended claims.

We claim:

1. A recirculating gas chamber for orientation drawing of fibers comprised of:

1. supply means for the fiber,
2. a longitudinally disposed inner chamber defined by an inner jacket having flared throats forming a venturi at each end,
3. heating means for said chamber,
4. a generally cylindrical outer jacket surrounding said inner jacket extending to within said flared throats of said inner tube and spaced apart therefrom,
5. fiber entry channel at one end of said outer jacket extending to within one flared throat of said inner chamber,
6. a fiber exit channel at the opposite end of said outer jacket from said fiber entry channel, extending to within the other flared throat of said inner chamber,
7. supply means for said gas,
8. takeup means for said fiber,

whereby the outermost of said inner jacket and the inner lining of said outer jacket are cooperatively shaped to provide a recirculating passage for a gaseous medium cocurrent with fiber movement through said inner chamber and countercurrent of fiber movement between said inner chamber and outer jacket.

2. The apparatus of claim 1 wherein said inner jacket is lined with insulation.

3. The apparatus of claim 1 wherein said heating means comprises electrical heating filaments.

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