Jan. 25, 1966 D. F. BITTLE ETAL 3,230,745

CONTINUOUS ANNEALER

Filed Oct. 3, 1963 2 Sheets-Sheet 1

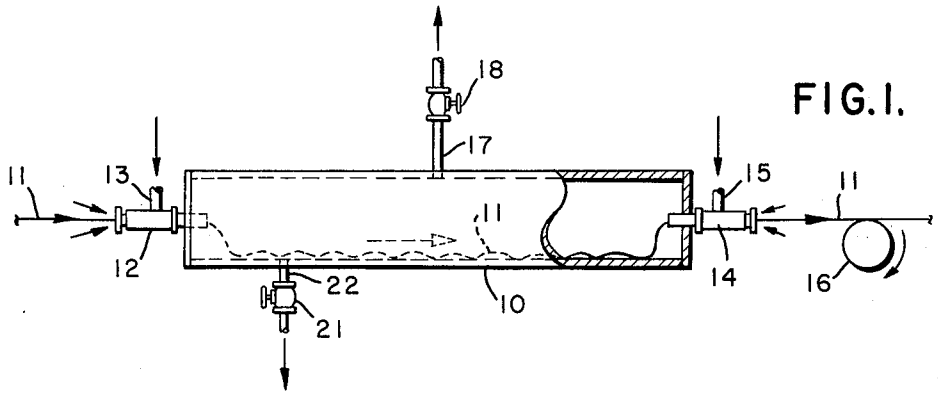


FIG. 1.

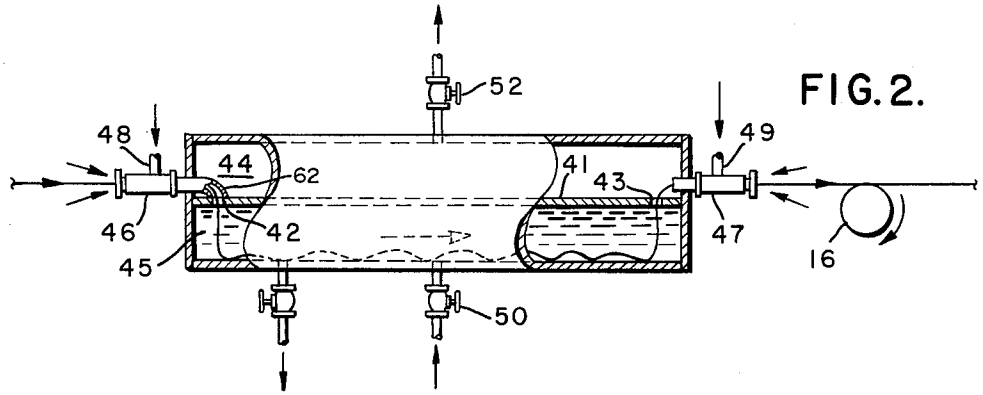


FIG. 2.

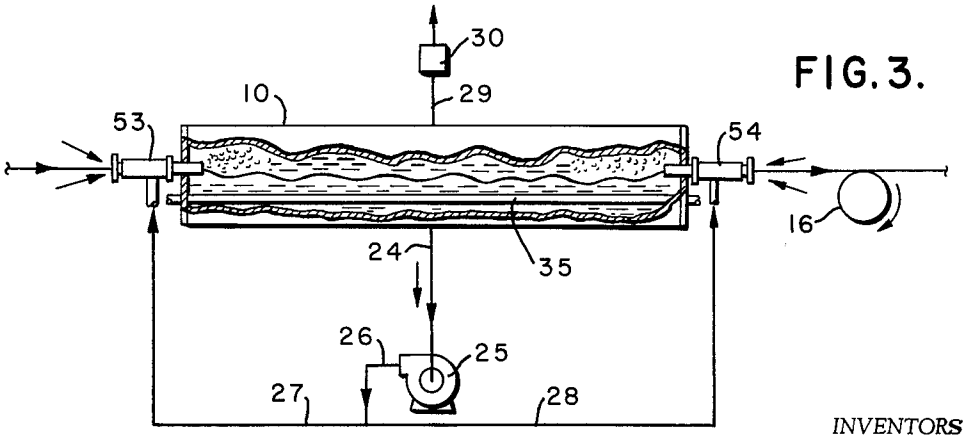


FIG. 3.

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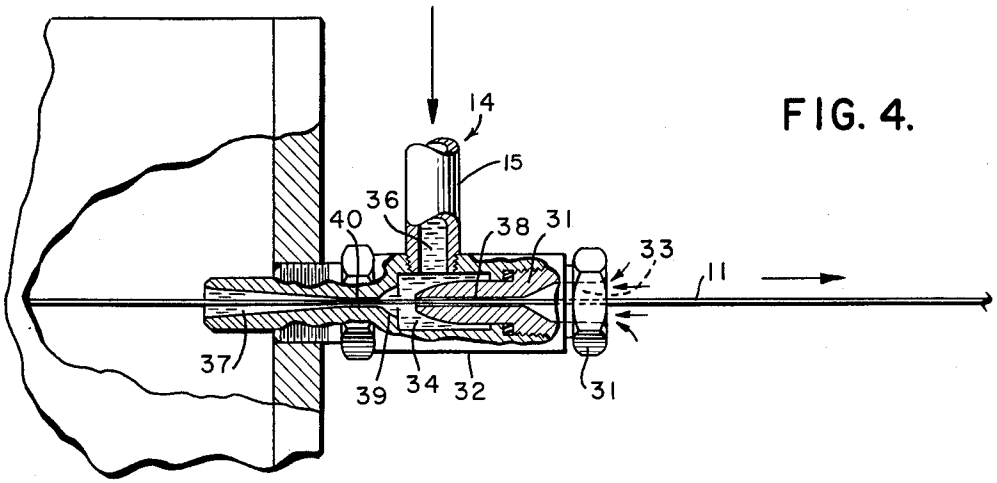


FIG. 4.

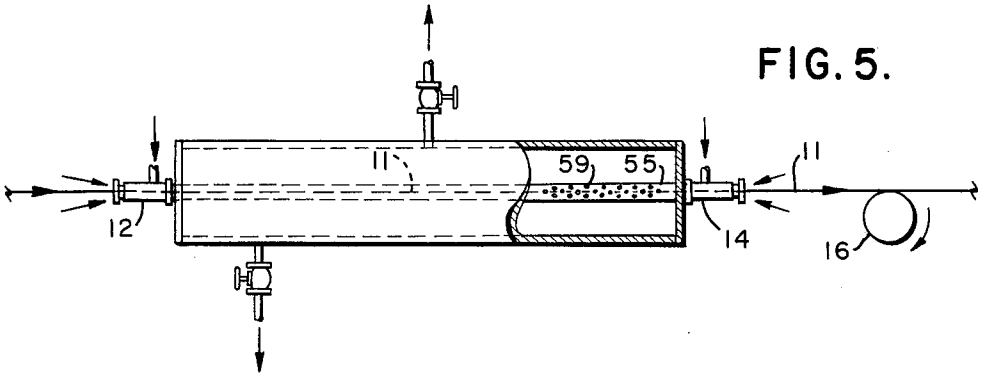


FIG. 5.

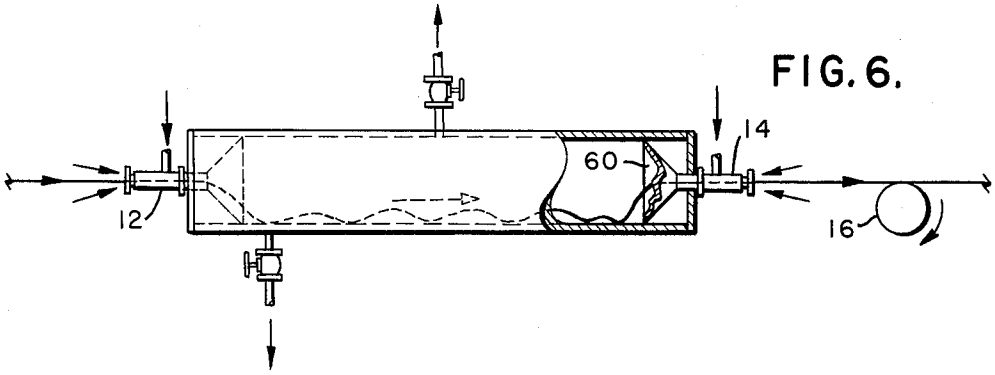


FIG. 6.

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CONTINUOUS ANNEALER

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3 Claims. (Cl. 68—5)

This invention relates to apparatus for the fluid treatment of yarn, and more specifically, for the continuous relaxing (or annealing) of acrylic and other synthetic fibers or yarn.

Acrylic fibers, such as acrylonitrile and methacrylate or acrylonitrile and vinylacetate, must be relaxed in order that they may be used by the textile industry, otherwise, the acrylic fiber is too brittle to be of any commercial value. A fabric made of unrelaxed arcylic fibers fibrillates when subjected to any abrasive action or tensile stress, therefore, the acrylic fiber must undergo some relaxing process.

The acrylic fiber composed of acrylonitrile and methylacrylate can be relaxed merely by removing any tension thereon and applying heat. The acrylic fiber composed of acrylonitrile and vinylacetate can be relaxed only by removing any tensile stress applied thereto and by subjecting the fiber to heat and pressure. This invention will deal with apparatus for annealing or relaxing the acrylic fiber composed of acrylonitrile and vinylaceate and other synthetic fibers or yarns where both heat and pressure are required in the relaxing process. The most used method of annealing these fibers is to place the fiber to be annealed in a closed container and to apply heat and pressure thereto. The annealing process would be much more functional if the annealing could proceed on a continuous basis. Previous continuous annealers either have been too mechanically complex or have had excesssive leakage of the high pressure from the container. Accordingly, a primary object of this invention is to provide a receptable which continuously anneals a synthetic textile fiber or yarn.

Another object of this invention is to provide a high pressure cylinder with an orifice which permits a high pressure fluid and an acrylic fiber to enter through the same aperture without any loss of pressure in the cylinder.

A further object of this invention is to provide a high pressure cylinder or chamber with an orifice which permits a high pressure fluid to enter and a continuous filament to exit through the same aperture without any loss of pressure on the cylinder.

A still further object of this invention is to provide a continuous annealer with a simple lace-up device which can easily guide a tow or yarn through the annealing cylinder and out through an exit orifice. Other objects will become apparent from the description of the invention and the appended claims.

In the accompanying drawings which illustrate preferred embodiments of the apparatus of this invention:

FIGURE 1 is a cross-sectional fragmentary side view of the apparatus, basically illustrating the filament flow through the cylinder;

FIGURE 2 is a side view of another embodiment of the invention employing two fluid containing chambers;

FIGURE 3 is a side view of another embodiment of the invention having a fluid circulating pump and an air trap.

FIGURE 4 is an enlarged sectional elevation view of the orifice used in the invention;

FIGURE 5 is a sectional elevational view of the invention employing a perforated tube as a lace-up apparatus; and

FIGURE 6 is a fragmentary view of the invention showing the employment of a funnel as a lace-up apparatus.

One embodiment of the present invention contemplates using a fluid containing pressure receptacle in conjunction with fluid-supplying orifices for annealing acrylic and other fibers or yarns. The receptacle is in the shape of an elongated cylinder with each end having a jet-sealing orifice and the acrylic fiber is drawn through an incoming jet-sealing orifice into the pressure receptacle and through the outgoing jet-sealing orifice without any loss of fluid from the pressure receptacle. This invention employs an air jet compressor as the sealing device which admits the fiber to the receptacle without leaking the pressurized fluid in the receptacle. The fluid under high pressure, usually steam, enters the jet-sealing orifice through a suitable opening and fills a receiving chamber therein. The fluid in the receiving chamber has a high pressure and a low velocity. The fluid then enters a venturi-shaped orifice where the velocity increases and the pressure decreases. The reduction in pressure sucks outside air into the jet-sealing orifice through an aperture oppositely disposed from the venturi-shaped orifice. Along with the outside air, acrylic fibers in tow or yarn form are pulled by the outside air through the entering aperture through the venturi-shaped orifice and into a fluid-containing receptacle. In the receptacle, all tensile stresses are removed from the fiber and the high pressure fluid anneals acrylic fiber. The fluid in the receptacle does not escape to the outside atmosphere through the jet-sealed orifice because the pressure times the velocity in the receptacle is less than the pressure times the velocity in the jet-sealed orifice.

The acrylic tow after being annealed in the pressure receptacle is drawn out of the receptacle through the outgoing jet-sealed orifice by a godet. The outgoing jet-sealed orifice is identical in construction and operation to the entering jet-sealed orifice. The acrylic fibers are being drawn out of the pressure cylinder by the godet against the force exerted on it by the mixture of incoming fluid and air.

The fluid retaining receptacle has an exhaust pipe through which the exhaust fluid and air escape. Mounted on the exhaust pipe is a pressure control valve and vent which controls the pressure of the fluid and the air in the pressure receptacle.

The invention is illustrated in connection with the accompanying drawings, in which the figures are illustrative of preferred embodiments of the invention.

As shown, a synthetic fiber **11** in tow or yarn form passes through a jet-sealed orifice **12** and into a pressure receptacle **10**. The pressure receptacle **10** is shaped as an elongated cylinder and is adapted to threadably engage the jet-sealed orifice **12** at one end and jet-sealed orifice **14** at the other. The jet-sealed orifices **12** and **14** are identical in structure an include a housing **32** adapted to threadably receive at one end an inlet orifice **31**. Inlet orifice **31** has a cone-shaped shamber **33** which receives the tow **11** and incoming air and a cylindrical passage **38** which carries the incoming air and the fiber **11** to a housing chamber **34**. The housing **32** is adapted to threadably engage a fluid carrying line **15**. The fluid carrying line **13** transports a fluid **36** under high pressure into the housing chamber **34**. The housing **32** has a venturi-shaped aperture which includes a converging cone **39**, a tubular portion **40** and a diverging cone **37**. The fluid **36** as it passes through the fluid carrying line **15** and into housing chamber **34** is under high pressure but its velocity is relatively low. As the fluid **36** enters the converging cone **39**, its velocity is greatly increased and its pressure in the converging cone **39** is decreased below atmospheric pressure. Since the inlet orifice **31** is adjacent to the con-

verging cone 39, the pressure of the air in the cylindrical passage 38, being atmospheric, is greater than the pressure of the fluid 36 in the converging cone 39. This differential in pressure causes the air to flow from the cylindrical passage 38 into the converging cone 39 where it mixes with the fluid 36. The acrylic fiber 11 is sucked by the air into the cone-shaped chamber 33 through the cylindrical passage 38 and into the converging cone 39 in the case of jet-sealed orifices 12 and 53. When the air and the fluid 36 reach the tubular portion 40, they are thoroughly mixed and proceed therethrough into the diverging cone 37 at the same velocity and under the same pressure. The pressure on the aid and the fluid 36 is increased and their velocity is reduced proportionately as they proceed down the diverging cone 37. When the air and the fluid 36 enter the pressure receptacle 10, their velocities rapidly drop to approximately zero and their pressures increase to the poundage set by a pressure control valve 18.

The fiber 11, which is generally a thermoplastic fiber in tow form enters the jet-sealed orifice 12, proceeds therethrough and is passed through the pressure receptacle 10. In the pressure receptacle 10, the inherent tensile stresses in the fiber 11 are removed, the pressurized fluid 36 acting on the fiber 11 to anneal it. After being annealed, the fiber 11 is pulled through the jet-sealed orifice 14 by a godet or wheel 16 and then proceeds to be subjected to more processes not herein important.

The fluid 36, which generally will be steam is supplied to the jet-sealed orifices 12 and 14 by high pressure fluid lines 13 and 15, respectively, where they then enter pressure receptacle 10. The steam 36 is then drawn out of the pressure receptacle 10 through exhaust line 17 to pressure control valve 18. The pressure control valve 18 controls the pressure in the pressure receptacle 10 by limiting the amount of exhaust steam 36 that is drawn off. Since the exhaust fluid is drawn off by the pressure control valve 18, it can be deposited in some waste apparatus rather than emptying it in the atmosphere surrounding the annealer, which is currently the practice. Where steam is used as the fluid 36, a portion of it will condense when striking the walls of the pressure receptacle 10. This condensate is bled off by bleeder valve 21 through condensate line 22.

Referring generally to FIGURE 2, another embodiment of this invention contemplates using a pressure receptacle 10 having a plate 41 which internally divides the pressure receptacle 10 into pressure chamber 44 and annealing chamber 45.

Jet-sealed orifices 46 and 47 are identical to jet-sealed orifices 12 and 14 in construction and function except that orifice 46 includes an extended curved portion 62 exiting into hole 42 for forming, in combination with hole 42, a guide directing the fibers into annealing chamber 45. The high pressure air lines 48 and 49 carry air to jet-sealed orifices 46 and 47 rather than an annealing fluid which high pressure fluid lines 13 and 15 carried to jet-sealed orifices 12 and 14. The annealing fluid, which generally will be steam, is carried to a fluid inlet valve 50 which monitors the fluid entering the annealing chamber 45. The fiber 11 enters the pressure chamber 44 through jet-sealed orifice 46 and passes through pressure chamber 44 through hole 42 in plate 41 into annealing chamber 45 where all tensile stresses on the fiber 11 are removed. After being annealed, the fiber 11 is drawn out of the annealing chamber 45 through hole 43 in plate 41 and out jet-sealed orifice 47 by godet 16. The pressure control valve 52 operates in the same manner as did pressure control valve 18.

The annealing process is complete when the fiber is heated while under no tensile stress. The fiber can be made more brittle by heating it while under a tensile stress. Putting the fiber under tension in the absence of heat has no effect upon the fiber. In this second embodiment, the fiber after leaving the annealing chamber 45 is cooled by the incoming air being forced into pressure chamber 44 by jet-sealed orifice 47. Therefore, when godet 16 pulls the fiber 11 through the jet-sealed orifice 47, the incoming air which induces a tensile stress in the fiber 11 does not change the characteristics of the fiber 11. As between the former embodiment and the latter embodiment of the invention, the embodiment used wgould be dictated by the consumer since each embodiment produces a fiber with different characteristics.

A third embodiment of the invention contemplates using a superheated liquid such as water for the annealing fluid. Referring generally to FIGURE 3, the pressure receptacle 10 is adapted to receive two jet-sealed orifices 53 and 54 which are similar both in structure and in the operation thereof to jet-sealed orifices 12 and 14. The fiber 11 is drawn through the annealer in the same manner as has been previously described. The superheated liquid is pumped through feeder lines 26, 27 and 28 to jet-sealed orifices 53 and 54 by a pump 25 which receives the liquid from the pressure receptacle 10 and adds additional pressure thereto. The liquid is superheated by a heating element 35 which is energized by a source not shown. As the superheated liquid is forced through the jet-sealed orifices 53 and 54 into the pressure receptacle 10, it also brings air into the pressure receptacle. The air in the pressure receptacle 10 escapes through an air trap conduit 29 and is drawn into air trap 30 which regulates the quantity of air in the pressure receptacle 10. The liquid in pressure receptacle 10 is superheated by heating element 35.

In order to facilitate lacing-up the fiber 11, i.e., running the leading end of the fiber through the annealer, a perforated tube 55 is attached to jet-sealed orifices 12 and 14 as shown in FIGURE 5. The fiber 11 is drawn through the jet-sealed orifice 12 and the perforated tube 55 by energizing inlet orifice 12 while leaving outlet orifice 14 in an inoperative state. The incoming air and fluid carry the fiber 11 along the length of the perforated tube 55 and out jet-sealed outlet orifice 14 where fiber 11 is mounted on godet 16. The annealing fluid enters the perforated tube 55 through the apertures 59 and makes contact with the fiber 11.

The fiber 11 can also be laced-up by attaching a funnel 60 to the outlet jet-seal orifice 14. The fiber 11 is laced-up by energizing inlet jet-sealed orifice 12 while leaving jet-sealed outlet orifice 14 in an inoperative state. The incoming air and fluid carry the fiber 11 the length of the pressure receptacle 10 where the fiber 11 strikes funnel 60 and is thereby funneled into outlet jet-sealed orifice 14 under the force of pressure built up within the receptacle 10.

While the preferred embodiments of the invention have been disclosed, it is to be understood that changes and variations may be made without departing from the spirit and scope of the invention as defined by the appended claims.

We claim:

1. An apparatus for continuously annealing a fiber comprising:

(a) a pressure receptacle,

(b) a plate having an aperture therein mounted in said pressure receptacle and positioned to form first and second chambers therein,

(c) a first jet-sealed orifice mounted in communication with said second chamber of said pressure receptacle the exiting portions of said jet-sealed orifices being mounted internally in said pressure receptacle,

(d) a second jet-sealed orifice mounted in communication with the second chamber the exiting portion of said jet-sealed orifice being mounted internally in said pressure receptacle,

(e) means for supplying air under pressure to said jet-sealed orifices,

(f) means for supplying a fluid to said first chamber,
(g) means for withdrawing said fiber from said first chamber by way of said aperture, said second chamber and said second jet-sealed orifice.

2. An apparatus for continuously annealing synthetic fibers comprising:
(a) a pressure receptacle,
(b) a plate being mounted in said pressure receptacle and positioned to form a first and second chamber therein, said chambers being connected by a plurality of apertures located in said plate,
(c) a first jet-sealed orifice mounted in communication with said second chamber of said pressure receptacle,
(d) a second jet-sealed orifice mounted in communication with said second chamber, said second jet-sealed orifice having its exiting passageway mounted internally with respect to said pressure receptacle,
(e) means for supplying air under pressure to said jet-sealed orifices,
(f) means for supplying an annealing fluid under pressure to said first chamber,
(g) means including one of said apertures for guiding said fiber through said first jet-sealed orifice into said first chamber, and
(h) means for withdrawing said fiber from said pressure receptacle by pulling said fiber from said first chamber through another of said apertures in said plate, through said second jet-sealed orifice and against said incoming pressurized air.

3. An apparatus for continuously annealing a synthetic fibrous tow comprising:
(a) a pressure receptacle,

(b) a plate being mounted in said pressure receptacle and positioned to form a first and a second chamber therein, said plate having apertures therein thereby connecting said first chamber with said second chamber,
(c) a first jet-sealed orifice mounted in a wall of said pressure receptacle having its exiting portions in communication with said second chamber, said exiting portion of said jet-sealed orifice being extended to contact one of said apertures in said plate,
(d) a second jet-sealed orifice mounted in communication with said second chamber, said exiting portion of said jet-sealed orifice being housed by said pressure receptacle,
(e) pressurized air lines being connected to each of said jet-sealed orifices,
(f) a pressurized line being connected to said first chamber for supplying said first chamber with an annealing fluid, and
(g) a waste line being in communication with said first chamber.

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