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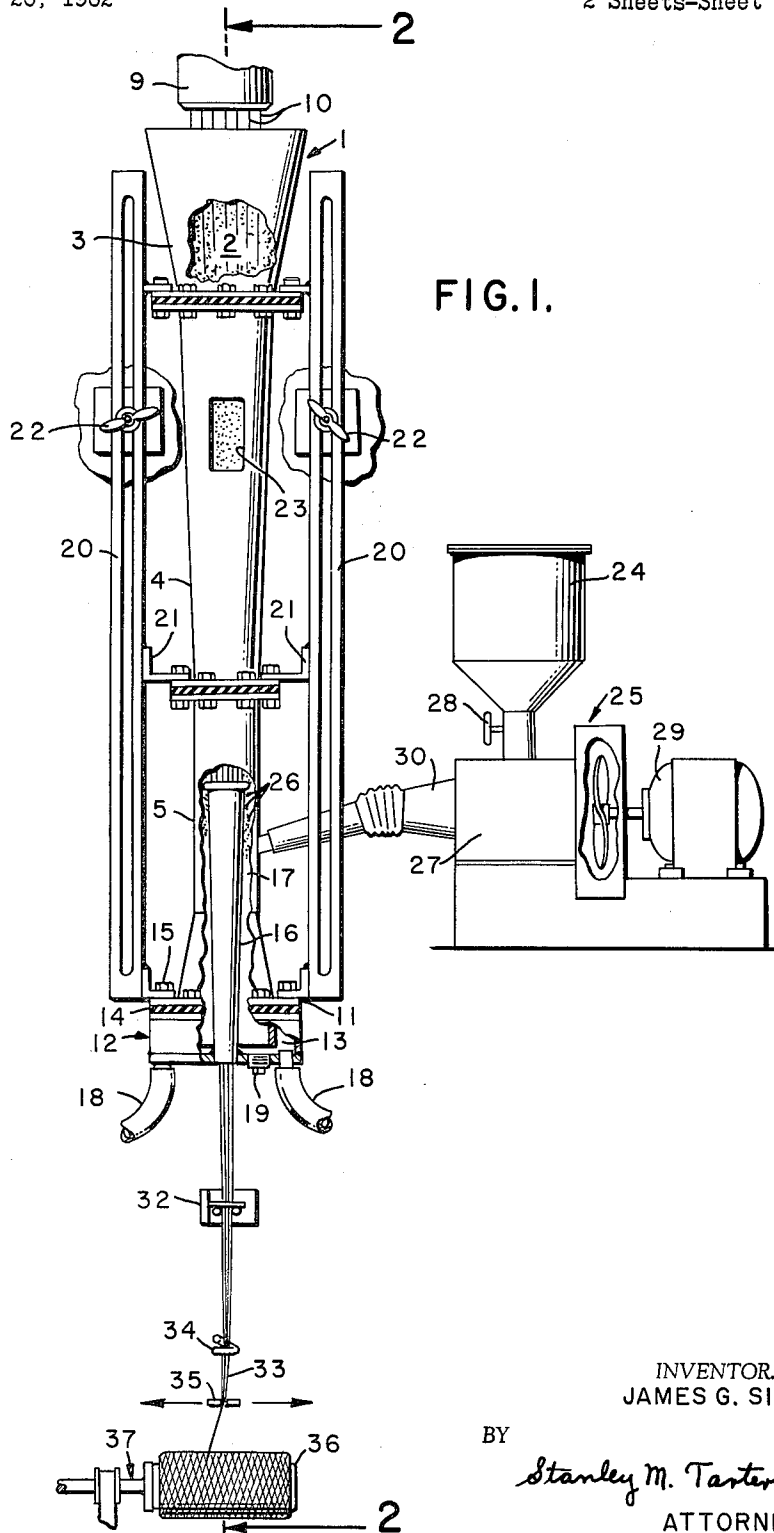
J. G. SIMS

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APPARATUS FOR SPINNING SPECIAL YARNS

Filed Dec. 26, 1962

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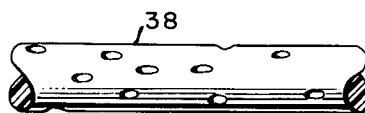
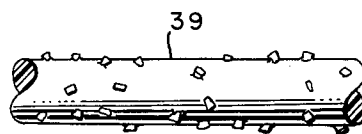
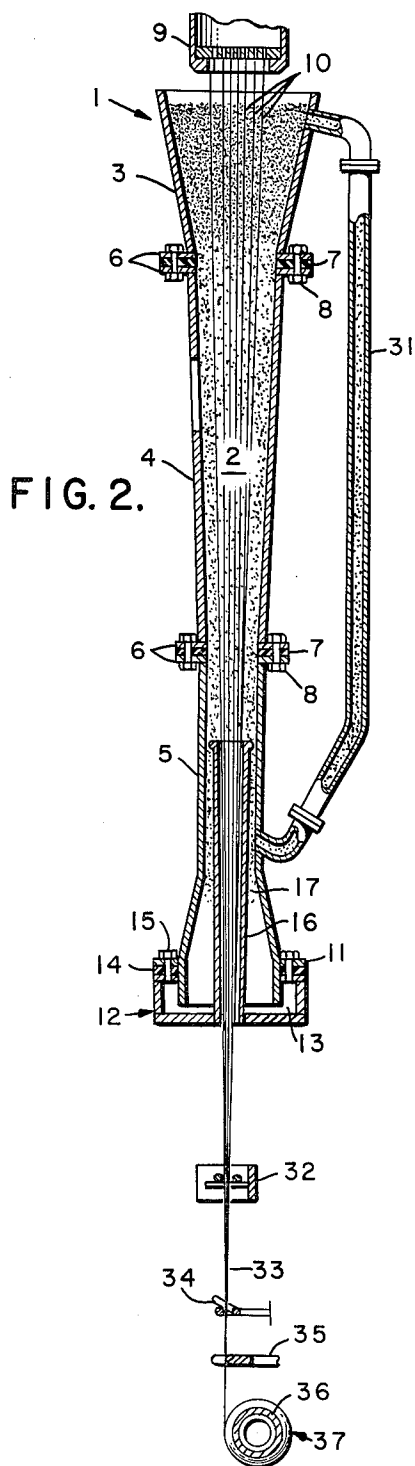
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2 Sheets-Sheet 2



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APPARATUS FOR SPINNING SPECIAL YARNS

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Filed Dec. 26, 1962, Ser. No. 247,006
4 Claims. (Cl. 18—8)

This invention relates to an apparatus for spinning synthetic filament yarns and to special filament yarns produced therefrom. More particularly, this invention relates to a novel apparatus for quenching thermoplastic filaments and to special bumpy filament yarns produced therefrom.

Conventionally, freshly spun molten filaments are quenched by passing them through a cooling unit referred to as a quench chimney, a quench chamber, or a quench box. Freshly spun molten filaments issuing from a spinneret pass through the quench chimney and extend to a convergence guide mounted at the bottom thereof where the filaments are bundled into a yarn. One side of the chimney is open to a plenum chamber from which air under pressure is cross-directed into the path of the filaments. The filaments are cooled by the airstream, and the air is then exhausted through an open side of the chimney. In the conventional process and method, heat from the filaments is transferred by convective circulation of air and depends on the film coefficient and the temperature difference between the filament surface and the ambient gas.

Endeavors to improve upon the described filament yarn spinning process and equipment with objectives of providing more uniform cooling and higher quenching rates of filaments are constantly being made.

Further efforts are directed toward adapting filament yarn spinning practices for the production of novelty yarns which have become commercially attractive for their refractive and ornamental effects.

It is an object of this invention to provide a novel apparatus adapted to rapidly and uniformly quench freshly spun filaments of polymeric structure by passing the filaments through a fluidized bed of fine heat-conducting particles.

According to the novel apparatus embodying the invention, an elongated, tapered tube is adapted to be uprightly positioned beneath a spinneret to receive freshly spun molten filaments issuing therefrom. The tapered tube is adapted by joining an air manifold and an air induction means therewith to effect a fluidized bed of fine particles in the path of the filaments as they pass through the tube. The air manifold means provides an airstream in the tube which flows counter to the direction of the filaments and the air induction means provides a source of fine particles which are entrained within the airstream. By controlling pressure and velocity of the airstream, a stable fluidized bed of fine particles is established in the tube.

If inert type particles are used, the particles contact the filaments and absorb the heat therefrom, thus promoting cooling of the filaments. Where fine inert particles of harder structure than the spun filaments are used, the filaments are impinged upon and are dented so that the resulting filaments are pitted or pockmarked. Where a fusible type fine particle is used, the particles fuse to the filaments and provide a novel nubby yarn.

The detailed description of the novel quench method and apparatus and of the novelty yarns produced therefrom which follows taken in conjunction with the accompanying drawing provides a better understanding of the apparatus invention.

In the drawing,

FIGURE 1 is an elevation view with parts cut away showing the novel quench apparatus and method,

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FIGURE 2 is a cross section view taken through 2—2 of FIGURE 1,

FIGURE 3 is an elevation view showing a nubby type novel yarn of the invention, and

FIGURE 4 is an elevation view showing a pockmarked type of novelty yarn of the invention.

The embodiments shown in the various figures in the drawing are illustrations of the invention and are not intended to be limitative thereof.

Referring to the drawing, a preferred construction of the novel spinning apparatus embodying the invention, as shown in FIGURES 1, 2, comprises an elongated vertically positioned tapered tube or vessel 1 having an axial chamber 2 extending therethrough. Tube 1 can be of integral construction but, preferably, is constructed in three sections: an upper section 3, an intermediate section 4, and a lower section 5. The sections 3, 4, and 5 are sealingly and clampingly connected therebetween by means of flanges 6 provided at the joining ends of the sections, gaskets 7, and bolts and nuts 8. Upper section 3 is relatively short in length and has a wide funnelform mouth at its top and extends downwardly therefrom at a high degree of taper to join with intermediate section 4. A spinneret 9 for extruding filaments 10 of thermoplastic material is positioned adjacent the funnelform mouth of section 3. Section 4 is the longest section and is tapered. The smaller end of section 4 joins with section 5. Section 5 is substantially of the same width along most of its length. Section 5 extends from the lower end of section 4 for a distance and then is provided with a flared portion that terminates at its lower end in a cylindrical portion having a flange 11 formed about its outer periphery inwardly from the end thereof.

An air manifold 12 having a pressure chamber 13 defined therein is sealingly and clampingly connected to the flange 11 surrounding the cylindrical portion of section 5 by a gasket 14 and bolts 15. The cylindrical portion of section 5 depends into the pressure chamber 13 and has a space defined therearound. Manifold 12 has a chimney or sleeve member 16 of a smaller diameter than tube 1 which is coaxially arranged therewith. Manifold 12 extends upwardly into section 5 and defines an annular space 17 between chimney 16 and the wall of section 5. Preferably, chimney 16 is tapered so that it gets progressively wider as it extends into section 5. A smooth surfaced collar is provided at the inner end of chimney 16 to prevent damage to filaments that normally enter the chimney. Annular space 17 permits communication between chamber 13 in manifold 12 and chamber 2 of tube 1.

A gas, such as air under pressure from a source thereof, is normally delivered to pressure chamber 13 of manifold 12 by lines 18 adapted to be connected to suitable connectors press-fitted in ports provided in manifold 12.

Drain plug 19 is provided in manifold 12 to permit removal of particles which settle therein.

Longitudinal, slotted support members or braces 20 are affixed to tube 1 at opposite sides thereof by suitable bracket 21 and bolt and nut assemblies. Support members 20 are mounted on respective fixed clamps 22 which extend through the slots of support members 20 and which provide vertical adjustment of tube 1 to permit access to spinneret 9.

To permit a constant check to be made of the process and operation in the interior of tube 1, covered aperture or window 23 is provided in section 4 of tube 1.

An induction device 25 is provided to introduce fine particles or other particulate matter into annular space 17. Induction device 25 comprises a hopper 24 normally supplied with fine particles 26, a mixing chamber 27, a gate 28 for admitting the particles into the mixing chamber 27, and a blower and motor assembly 29 that

generates an airstream for transporting the particles from the mixing chamber 27 to the annular space 17 of tube 1 via duct 30 having a flexible joint. Duct 30 is connected at its one end to an air inlet fitting fixed to the lower end of section 5 and opening into annular space 17 and at its opposite end the duct is connected and open to mixing chamber 27.

A recirculating pipe 31 is connected at one end to an adapter mounted in an inlet port formed at the upper end of section 3; and at its opposite end the recirculating pipe is connected to an adapter mounted in an inlet port formed in section 5. The recirculating pipe 31 is provided to stabilize the level of the bed and to collect fluidized particles which become disengaged from the bed and to return them to space 17.

Filaments 10, after passing through tube 1, are directed through a convergence guide 32 which converges the filament bundle for forming a yarn 33. Yarn 33 is then advanced through a pigtail guide 34 and thence through a traverse guide 35 before being collected on a bobbin 36 of a take-up device 37.

In operation, it will initially be assumed that the apparatus and method of the invention is operated to quench filaments; i.e., primarily to cool freshly spun filaments. In this case tube 1 is adjusted by clamps 22 to be axially aligned with spinneret 9, with the top end of tube 1 approximately two feet below the spinneret 9. A polymer compound such as nylon for forming filaments is pumped through spinneret 9 and a bundle of filaments 10 are extruded therefrom. By employing a vacuum device, such as an aspirator gun inserted within chimney 16, filaments 10 are pulled downwardly through chamber 2 of tube 1 and through chimney 16. Filaments 10 are then threaded through the convergence guide 32, advanced through pigtail guide 34, forwarded to the traverse guide 35 and then laid on driven bobbin 36 of the take-up device 37. Air under pressure is then delivered to pressure chamber 13 of manifold 12 through lines 18. The air will flow upwardly from chamber 13 into annular space 17 in section 5 of tube 1 at a high velocity because of the narrow dimensions of annular space 17 and will continue to rise into section 4 with a slight decrease in velocity because section 4 widens as it extends upwardly. Flowing into section 3, the airstream will decrease further in velocity due to the progressively rapidly widening of section 3.

Having established an airstream of predetermined velocity and pressure flowing counter to the flow of filaments 10, fine inert particles of glass material and of 5-15 micron size are dispensed from hopper 24 to the mixing chamber 27 past gate 28. The airstream produced by blower 29 then forces the inert glass particles into annular space 17 of tube 1. The particles are entrained within the high velocity airstream traveling through annular space 17 and are carried rapidly upward into section 4. The particles are further transported upwardly through section 4 at a progressively decreasing velocity due to the configuration of this section and the particles are thereafter further lifted into section 3. At this level a pressure drop is realized; and a coefficient of the air pressure to weight of the particles is attained such that the particles do not rise further but are suspended by the airstream and form a stable fluidized bed.

As is characteristic of fine particles in a fluidized state, the particles move at random within the bed and consequently collide or impinge upon the filaments 10 traveling therethrough. The differential in temperature—the filaments being relatively hot and the particles having a lower temperature—causes heat from the filaments to be transferred to the particles thus promoting cooling of the filaments. The particles having gained heat from the filaments then transfer the heat one to another and to the airstream as well as to the walls of tube 1 upon contact therewith. A high rate of heat transfer results from the large particle surface available for fluid-solid contact.

The temperature within the bed remains substantially uniform.

Should the particles be pneumatically carried from the fluidized bed, they will be returned to the system by recirculating pipe 31.

Where it is desired to spin pockmarked or pitted filaments, fine inert infusible particles such as crushed quartz having sharp edges and a higher degree of hardness than the molten filaments is used to establish the fluid bed. Yarn of this type is shown in FIGURE 4 and is denoted by reference numeral 38. In this case the particles upon contact with the filaments dent and deform the surface of the filament but do not adhere firmly thereto so that upon solidification the filaments have small indentations at random points on the filaments.

Where it is desired to spin nubby filament yarn 39, as shown in FIGURE 3, fine particles such as polyethylene powder or powdered sugar of fusible characteristic are used to establish the fluidized bed. Under this condition, the particles partially fuse to the filaments and when the filaments are cooled a nubby type yarn is produced. Various effects and profiles can be provided by using particles of different shapes: spheroidal, cubical, cylindrical, etc. Dissolution of soluble particles adhering to the filaments (such as sugar) have irregular craters in the yarn surface, resulting in yarn illustrated in FIGURE 4.

Aerosol fogs of water, inorganic, or organic liquids may be generated and delivered to the quench tube 1. Highly volatile liquid droplets provide great heat absorption capacity. Localized surface nubs are formed at the point of droplet impingement upon the still molten filament to yield a pimples or wart-like surface.

It will be understood that changes and variations may be made without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. Fluidized bed spinning apparatus comprising,

- (a) an elongated tapered tube having an axial chamber extending therethrough and being adapted to be uprightly positioned with its widest end at the top,
- (b) a spinneret normally positioned near the upper end of said elongated tapered tube for extruding a bundle of filaments of a thermoplastic material into said tapered tube,
- (c) a convergence guide positioned near the lower end of said tube for converging said bundle of filaments to form a yarn after said filaments have passed downwardly through said tapered tube,
- (d) said tapered tube being functionally divided into a lower narrow blending section having a small degree of taper, an intermediate lifting section having a larger degree of taper than said blending section, and an upper fluidized bed section of widest girth having the highest degree of taper,
- (e) means associated with said blending section for providing an airstream flowing counter to the direction of said downwardly passing filaments,
- (f) said upward flowing airstream having a diminishing velocity from said blending section to said fluidized bed section,
- (g) means arranged with said blending section for introducing fine particles into said upstream flow of air established therein,
- (h) said fine particles being entrained within said upstream flow of air and being transported rapidly through said blending section of high velocity air flow and propelled upwardly through said lifting section at a gradually diminishing rate of climb into said fluidized bed section where the particles are suspended by said airstream to form a fluidized bed in surroumdment of said filaments passing therethrough.

2. Fluidized bed spinning apparatus comprising,

- (a) elongated vessel means defining an axial chamber

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extending therethrough and opening outwardly therefrom at opposite ends thereof, said axial chamber increasing in cross-section from one end to the opposite end thereof,

- (b) spinneret means for extruding freshly spun filaments in open bundle formation into said open opposite end of said axial chamber, 5
- (c) means for establishing an airstream flowing from said one end of said axial chamber to said opposite end thereof counter to the direction of passage of the filaments therethrough and at a progressively decreasing velocity, and 10
- (d) means for introducing fine particles into said one end of said axial chamber, the particles being entrained in the airstream and buoyed near said opposite end of said axial chamber where the particles become suspended in a stable fluidized particle bed. 15
- 3. Fluidized bed spinning apparatus comprising,
 - (a) means defining a longitudinal open-ended tapered quench chamber smaller at one end thereof, 20
 - (b) spinneret means for extruding a bundle of filaments into the larger end of said tapered quench chamber,
 - (c) means for establishing a flow of air through said tapered quench chamber in a direction from the smaller end to the larger end thereof counter to the normal passage of filaments therethrough, 25
 - (d) means for introducing particles into the airstream at the smaller end of said tapered quench chamber to entrain the particles in the counter flow of air therein, 30
 - (e) wherein, said means establishing said airstream, said means defining said tapered quench chamber, and said means for introducing particles into the counter flow of air cooperate to effect a fluidized particle bed near the larger end of said tapered quench chamber. 35
- 4. Fluidized bed spinning apparatus comprising,
 - (a) first means defining a longitudinal tapered quench chamber having a larger upper end and a smaller lower end, 40
 - (b) tubular means of smaller dimension than said smaller lower end of said tapered quench chamber

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telescoping into the latter to define with said first means an annular space therebetween,

- (c) spinneret means for extruding a bundle of filaments into the larger end of said longitudinal tapered quench chamber, said filaments normally passing through said tapered quench chamber and through said tubular means,
- (d) convergence guide means for converging the filaments, said convergence guide means positioned adjacent said tubular means,
- (e) second means for establishing an airstream through said tapered quench chamber flowing counter to the direction of travel of said filaments, said second means opening into said annular space,
- (f) third means for introducing particles into said airstream, said third means opening into said annular space,
- (g) wherein, said first, second and third means and said tubular means cooperate to establish a stabilized fluidized particle bed near the larger end of said longitudinal tapered quench chamber.

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