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Schmid et al.

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[54] **APPARATUS FOR TEXTURIZING FILAMENTS**

[75] Inventors: **Hans Schmid,** Limburgerhof; **Heinrich Feldhoff,** Bad Duerkheim, both of Germany

[73] Assignee: **BASF Aktiengesellschaft,** Ludwigshafen (Rhine), Germany

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[30] **Foreign Application Priority Data**

June 19, 1973 Germany 2331045

[52] **U.S. Cl.** **28/1.4**

[51] **Int. Cl.**[2] **D02G 1/16**

[58] **Field of Search** 28/1.4, 72.12

[56] **References Cited**

UNITED STATES PATENTS

3,714,686	2/1973	Schmid et al.	28/1.4
3,808,652	5/1974	Elliott et al.	28/1.4

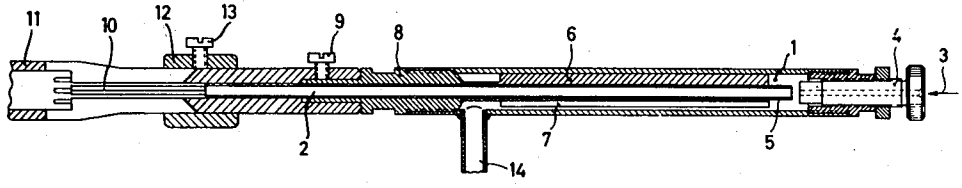
Primary Examiner—Louis K. Rimrodt

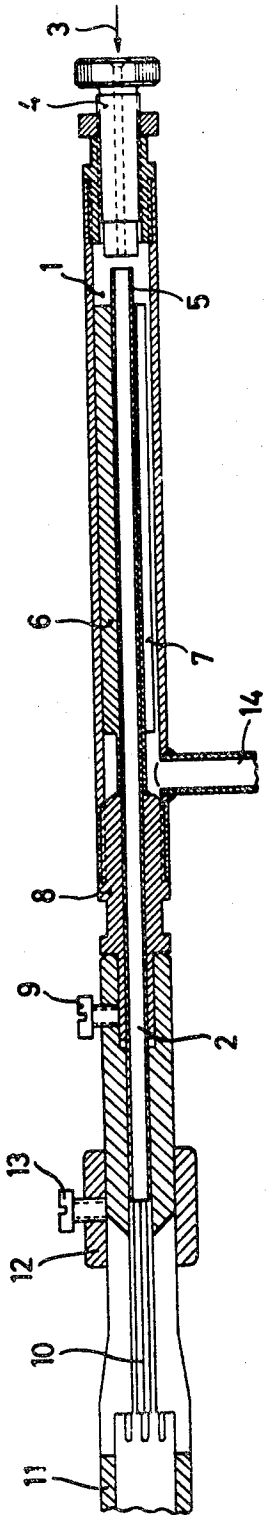
Attorney, Agent, or Firm—Johnston, Keil, Thompson & Shurtleff

[57] **ABSTRACT**

Apparatus for the manufacture of texturized filaments of synthetic linear high molecular weight materials using hot fluids consisting of a closed first processing chamber having an inlet for the fluid, a filament inlet channel at one of said processing chamber, a filament guide channel projecting into the processing chamber from its other end, and a second duct-like processing chamber mounted at the free end of the filament guide channel and having radial slots extending in the longitudinal direction of the duct of said processing chamber, wherein said second processing chamber shows, over its lower portion, a conical or stepwise increase in its external diameter and a sudden increase in its internal diameter to from 2 to 10 times the internal diameter of the duct, the longitudinal slots extending into said enlarged region to terminate in a closed ring.

4 Claims, 1 Drawing Figure

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APPARATUS FOR TEXTURIZING FILAMENTS

BACKGROUND OF THE INVENTION

German Published Application Pat. No. **2,006,022** describes an apparatus for the manufacture of texturized filaments of synthetic linear material of high molecular weight using hot fluids comprising a closed first processing chamber having an inlet tube for the supply of flowing medium, a filament inlet channel at one end of the said first processing chamber, a filament guide channel projecting into said processing chamber from its other end, said filament guide channel being rigidly attached to the said first processing chamber and the ratio of the internal diameter of the filament guide channel to that of the filament inlet channel being from **1.1:1** to **4:1** and the distance between the filament guide channel and the filament inlet channel being from **0.1** to **3** mm, and a second duct-like processing chamber mounted at the free end of the filament guide channel and provided with slots. In this prior art apparatus the slots in the second processing chamber extend radially and in the longitudinal direction of the cylindrical nozzle. Such slotted nozzles generally have from **2** to **20** slots, which may beincreased in number depending on the denier of the filaments and the circumference of the nozzle. The width of the slots is from **0.2** to **1** mm. Such slotted nozzles are comparatively sensitive to physical stresses. For this reason, German Published Application Pat. No. **2,006,022** itself recommends the use of a muzzle cover. Use of the texturizing apparatus has shown that it is advantageous when the slots extend right to the end of the apparatus, as shown in the drawing of German Published Application Pat. No. **2,006,022,** i.e. when the lamellae between the slots have free ends. On the other hand, the sensitivity of such nozzles, particularly to thermal stresses, is increased in such a case and changes in cross-section of the nozzle occur relatively quickly, resulting in variations in the texturizing effect. Crimping becomes nonuniform and it is necessary to re-adjust the operating conditions to accommodate for said changes in the slotted nozzle. There is thus a need for a nozzle design in which the above drawbacks occur either not at all or at least to a lesser extent.

SUMMARY OF THE INVENTION

We have now found that in an apparatus for the manufacture of texturized filaments of synthetic linear materials of high molecular weight using hot fluids and consisting of a closed first processing chamber having an inlet tube for the supply of fluid, a filament inlet channel at one end of said first processing chamber, a filament guide channel projecting into said first processing chamber from its other end, said filament guide channel being rigidly mounted on said first processing chamber and the ratio of the internal diameter of the filament guide channel to that of the filament inlet channel being from **1.1:1** to **4:1** and the distance between the filament guide channel and the filament inlet channel being from **0.1** to **3** mm, and a second duct-like processing chamber mounted at the free end of the filament guide channel and provided with radial slots extending in the longitudinal direction of the duct, the above drawbacks appear to a substantially lesser extent when the second, cylindrical processing chamber having radial slots extending in the longitudinal direction of the duct shows, over its lower portion, a conical or stepwise increase in its external diameter and a sudden increase in its internal diameter to from **2** to **10** times and in particular from **2** to **5** times the internal diameter of the duct, the longitudinal slots extending into said enlarged region to be terminated by a closed ring located at the end of said enlarged region.

The drawing illustrates diagrammatically a complete texturizing apparatus equipped with a slotted nozzle of the invention.

The first processing chamber **1** with filament inlet channel **4** and filament guide channel **5** corresponds to the prior art design. It consists of a cylindrical tube. At one end of this tube there is mounted the filament inlet channel **4** for the supply of filaments **3** to processing chamber **1,** and at its other end the filament guide channel **5** is mounted, these channels being mounted by screw connections or other means. The filament guide channel is surrounded, at its end near the filament inlet channel **4,** by a centering element **6** provided with longitudinal or rifled air channels **7,** whilst the other end of the said channel **5** is provided with a male-threaded bush **8.** The second processing chamber **2** is disposed on the free end of the filament guide channel **5** projecting from the processing chamber **1.** This consists of an outwardly cylindrical slotted nozzle which fits coaxially over the filament guide channel **5** and is fixed in position thereon by means of a set-screw **9.** That portion of the nozzle which projects beyond the end of the filament guide channel **5** is provided with slots **10** which extend radially through the wall of the tube. The distance between the end of the filament guide channel **5** and the point of commencement of the slots **10** is from **0.1** to **3** times and preferably from **0.8** to **1.4** times the external diameter of the filament guide channel **5.** It is advantageous to cause the interior of said chamber **2,** in the region of the slots, to taper outwardly slightly, for example at a gradient of from **1:20** to **1:100** and in particular from **1:40** to **1:60.** The texturizing effect increases with the number of slots, from **4** to **18** slots having been found to give favorable results, the number generally used being from **10** to **16.** The width of the slots is conveniently from **0.3** to **1** mm and preferably from **0.4** to **0.6** mm. This slotted nozzle shows a conical or stepwise increase in its external diameter, the length of the cylindrical portion upstream of the said enlarged portion being from about **6** to **8** tenths of the total length. The total length is generally from about **80** to **150** mm. The slots also extend radially outwardly in the conically or stepwise enlarged portion of the second processing chamber. Internally, the cross-section of the duct passing through the slots shows a sudden increase by from **2** to **10** times and preferably from **2** to **5** times, at a point where the maximum external diameter exists. The slots then pass radially outwardly through the enlarged portion of the cylinder in its longitudinal axis over a length approximately equal to the enlarged internal diameter. The cylindrical portion of enlarged diameter is terminated by a solid ring **11.** Ring **11** is a solid exit portion of the tube which adds structural strength at the termination of slots **10.** In order to vary the length of the slots, it is advantageous to push a cylindrical metal element **12** over the slotted nozzle, which element **12** may be fixed in position by means of a screw **13.**

The mode of operation of the texturizing apparatus is the same as in the prior art apparatus designed for the same purpose. The filaments or bundles of filaments to

be crimped are fed through the filament inlet channel 3 to the chamber 1 and are thence conveyed through the filament guide channel to the processing chamber 2 by the hot stream of gaseous fluid, preferably air, introduced through the inlet tube 14. The internal diameter of the filament inlet channel 4 and that of the filament guide channel 5 bear a relationship to each other such that the major portion of the fluid passes into the filament guide channel 5 and conveys the filaments 3 introduced through the filament inlet channel 4. The ratio of the internal diameter of the filament guide channel 5 to that of the filament inlet channel 4 is thus conveniently from 1:1 to 1:4 and advantageously from 1:1.8 to 1:2.2, the actual dimensions depending on the thickness of the filaments or bundle of filaments to be crimped. It is generally convenient to use internal diameters which are not greater than necessary for filament transport. The distance between the filament guide channel 5 and the filament inlet channel 4 is from 0.1 to 3 mm and preferably from 0.15 to 0.3 mm. Suitable fluids for conveying the filaments are those normally used in the treatment of filaments, for example nitrogen, carbon dioxide, steam and air, the latter being particularly preferred for economical reasons. It may be desirable to filter the gaseous media to remove solid particles therefrom. The filaments are heated by the heated gaseous medium in the filament guide channel to a temperature at which re-orientation and recrystallization occur. Bundles of filaments are disentangled and are transported to the second processing zone, i.e. the slotted nozzle.

In said second processing zone the filaments are texturized further by the turbulence of the fluid as it leaves the zone in radial directions. The conditions of flow, i.e. the degree of turbulence, are controlled by the length of the slots, which may be advantageously adjusted by means of a displaceable metal element, and also by the distance between the end of the filament guide channel and the point of commencement of the filament guide channel and the point of commencement of the longitudinal slots, and may be set such that the flowing medium is subjected to a resonance amplifying effect. The resonance peak may be ascertained from the noise produced and is readily determined by simple experiment. At the point of commencement of the slots, as considered in the direction of flow, subatmospheric pressure occurs. The resulting suction effect causes (cold) ambient air to be sucked in leading to a sudden temperature drop in the fluid, which results in fixing of the crimped filaments decelerated by friction.

No special equipment is required to withdraw the treated filaments from the apparatus. However, as the filaments leaving the slotted nozzle have relatively high temperatures, it is advantageous to cool them either hanging freely or under slight tension, before they are wound up. A suitable cooling device, for example, is one in which the filaments are cooled between a feed roll and a coolant-cooled cooling sleeve. To ensure that the filaments are entrained by the rotating feed roll, the latter is provided with a special surface, for example a covering of velvet. The surface of the cooling sleeve is advantageously of polished metal. Alternatively, the filaments may fall freely onto a rotary screen through which air is sucked. The filaments are then wound up in the usual manner. In order to impart a permanent crimp, the filaments must be softened when passing through the crimping apparatus without adhering to each other. The necessary temperature of the gaseous fluid may vary within certain limits. In general, a temperature of from 80° to 550°C has been found useful. The optimum conditions depend on the melting or softening range of the fiber-forming materials, on the period of action of the fluid on the filaments, on any preheating which may have taken place and on the thickness of the filaments. It will be appreciated that the temperatures used must be such as to cause the filaments to melt under the conditions used, even though the temperatures themselves may be well above the melting or decomposition point of the fiber-forming materials used when the filaments are passed through the processing zones at high speeds giving short residence times. If the bundle of filaments is fed through the crimping apparatus at a relatively low speed, for example at from 50 to 100 m/min., it is advantageous to use the gaseous medium at a temperature which is only slightly above the softening range of the high molecular weight material used, for example from 10° to 30°C above said softening range. Examples of softening ranges are: linear polyethylene 80°–90°C, polypropylene 80°–120°C, nylon 6,6 210°–240°C, nylon 6 165°–190°C, polyacrylonitrile 215°–255°C and polyethylene terephthalate 190°–230°C. If the bundle of filaments is fed to the first processing zone at higher speeds, the resulting shorter residence times of the filaments in the zones call for higher temperatures of the gaseous medium. For example, where a bundle consists of 268 filaments of nylon 6 and has a total denier of 4,400 and is fed to the apparatus at a speed of about 800 m/min., the gaseous medium must be at a temperature of from 350° to 430°C, and at an inlet speed of 1,200 m/min., the temperature of the fluid should be from 440° to 520°C, the bundle of filaments not being preheated in either case. The upper limit of the temperature of the fluids used is at about 550°C and is set by the thermal resistance of the materials of which the crimping apparatus is made.

It will be appreciated that the temperature of the fluid may be lowered when the bundles of filaments are preheated before introduction into the apparatus. For example, it is advantageous to feed filaments or filament bundles, which have just been drawn at the temperature most suitable for the filament material concerned, to the texturizing apparatus while still hot. The rate of flow of the fluid is determined by the pressure at which it is passed into the apparatus used and by the size of the apparatus. Initial gas pressures of from 3 to 7 atmospheres gage and particularly from 4 to 6 atmospheres gage have proved satisfactory for internal diameters of from 1.5 to 3 mm. The gas throughput is then from 3 to 7 m^3/hr (S.T.P.). The special advantage of the present apparatus is that it remains virtually unchanged in its dimensions over long on-stream times and may thus be operated for long periods without it being necessary to adjust the conditions, the crimping effect achieved being very uniform.

By filaments we mean continuous structures such as yarns, bundles of filaments, individual filaments or tapes, flat filaments and split fibers obtained from sheeting, and strips of sheeting. The filaments denier may be for example from 1 to 30 and preferably from 10 to 30. The number of individual filaments in a bundle or yarn may be from 2 to several thousand. The filaments in the filament bundles or yarns may be stretched or partially stretched before being subjected

to crimping. It is also possible to use filaments having a round cross-section or a profiled, for example trilobate, crosssection. It may be convenient for the bundles of filaments or yarns to exhibit a certain amount of twist, for example a twist of up to **30** turns per meter and in particular of up to **25** turns per meter. Such a twist serves to hold the bundles of filaments or yarns together to a certain extent to make the structure easier to handle.

Suitable synthetic linear or substantially linear fiber-forming organic high molecular weight polymers for the production of the filaments are, in particular, conventional linear synthetic high molecular weight polyamides having recurring carbamoyl groups in the backbone, linear synthetic high molecular weight polyesters having recurring ester groups in the backbone, filament-forming olefin polymers, filament-forming polyacrylonitrile or filament-forming acrylonitrile copolymers containing a major proportion of acrylonitrile units, and cellulose derivatives such as cellulose esters. Suitable high molecular weight compounds are, for example, nylon **6**, nylon **6,6**, polyethylene terephthalate, linear polyethylene and isotactic polypropylene.

We claim:

1. Apparatus for the manufacture of texturized filaments of synthetic linear high molecular weight materials using hot fluids and consisting of a closed first processing chamber having an inlet tube for the supply of fluid, a filament inlet channel at one end of said processing chamber, a filament guide channel projecting into said processing chamber from its other end, said filament guide channel being rigidly mounted on the said processing chamber and the ratio of the internal diameter of the filament guide channel to that of the filament inlet channel being from **1:1** to **1:4** and the distance between the filament guide channel and the filament inlet channel being from **0.1** to **3** mm, and a second, duct-like processing chamber located at the free end of the filament guide channel and provided with radial slots extending in the longitudinal direction of the duct, wherein the second, cylindrical processing chamber having radial slots extending in the longitudinal direction of the duct shows, over its lower portion, stepwise increase in its external diameter and a sudden increase in its internal diameter to from **2** to **10** times the internal diameter of the duct, the longitudinal slots extending into said enlarged region to be terminated by a closed ring located at the end of said enlarged region.

2. Apparatus as claimed in claim **1**, wherein the second processing chamber provided with radial slots extending in the longitudinal direction of the duct tapers outwardly in the region of the slots at a gradient of from **1:20** to **1:100** in the direction of transport of the filaments.

3. The apparatus of claim **1** wherein said sudden increase in the internal diameter of said cylindrical processing chamber is a stepwise increase.

4. Apparatus for the manufacture of texturized filaments of synthetic linear high molecular weight materials using hot fluids and consisting of a closed first processing chamber having an inlet tube for the supply of fluid, a filament inlet channel at one end of said processing chamber, a filament guide channel projecting into said processing chamber from its other end, said filament guide channel being rigidly mounted on the said processing chamber and the ratio of the internal diameter of the filament guide channel to that of the filament inlet channel being from **1:1** to **1:4** and the distance between the filament guide channel and the filament inlet channel being from **0.1** to **3** mm, and a second, duct-like processing chamber located at the free end of the filament guide channel and provided with radial slots extending in the longitudinal direction of the duct, wherein the second, cylindrical processing chamber having radial slots extending in the longitudinal direction of the duct shows, over its lower portion, a conical increase in its external diameter and a sudden increase in its internal diameter to from **2** to **10** times the internal diameter of the duct, the longitudinal slots extending into said enlarged region to be terminated by a closed ring located at the end of said enlarged region.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,908,248

DATED : September 30, 1975

INVENTOR(S) : SCHMID et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In Column 2, Lines 7-10, delete

" The drawing illustrates diagrammatically a complete texturizing apparatus equipped with a slotted nozzle of the invention.

The first processing chamber 1 with filament inlet..."

and substitute

-- DISCRIPTION OF THE PREFERRED EMBODIMENT

The drawing illustrates diagrammatically a complete texturizing apparatus equipped with a slotted nozzle of the invention. The first processing chamber 1 with filament inlet... --

Signed and Sealed this

Second Day of November 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks