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PRODUCTION OF ARTIFICIAL FILAMENTARY MATERIALS

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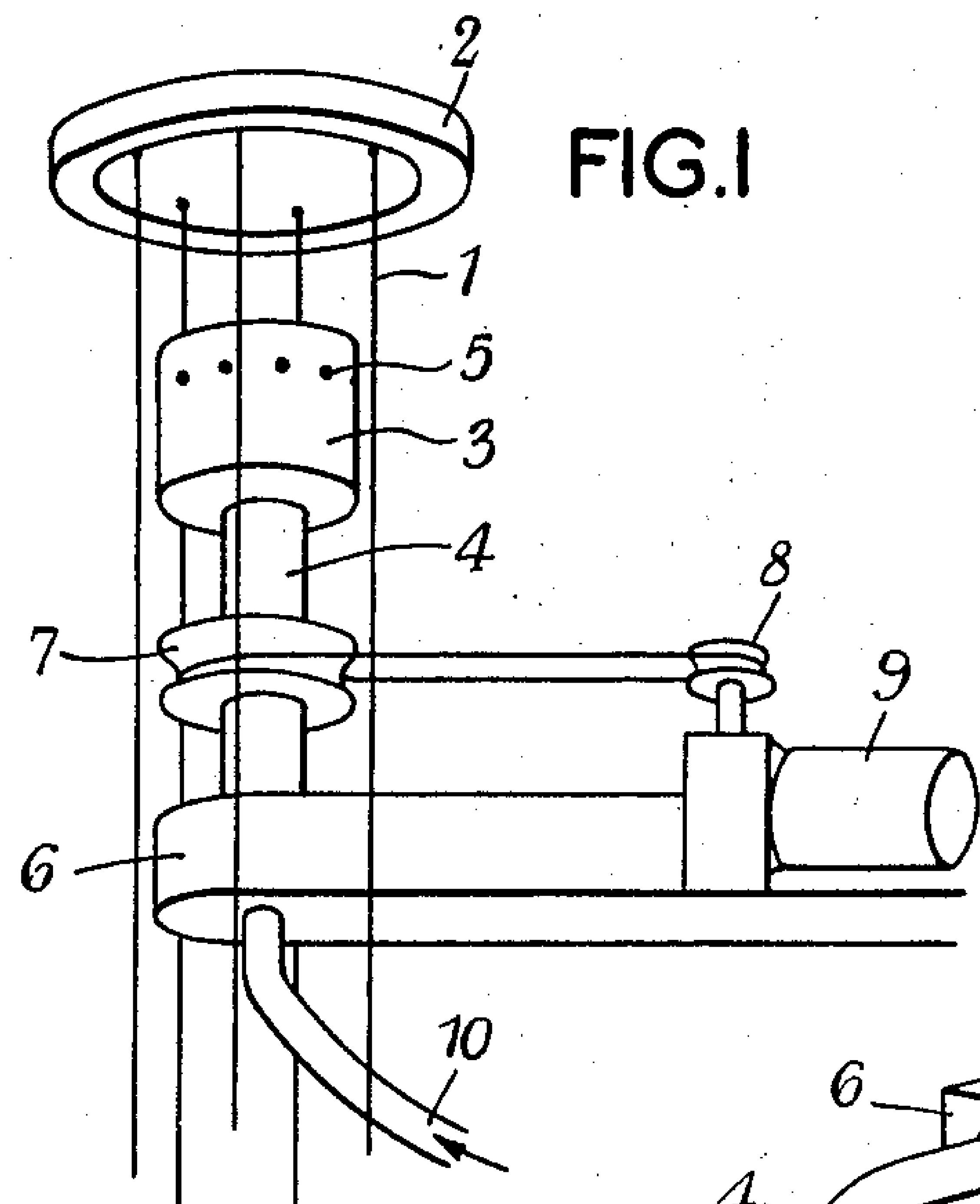
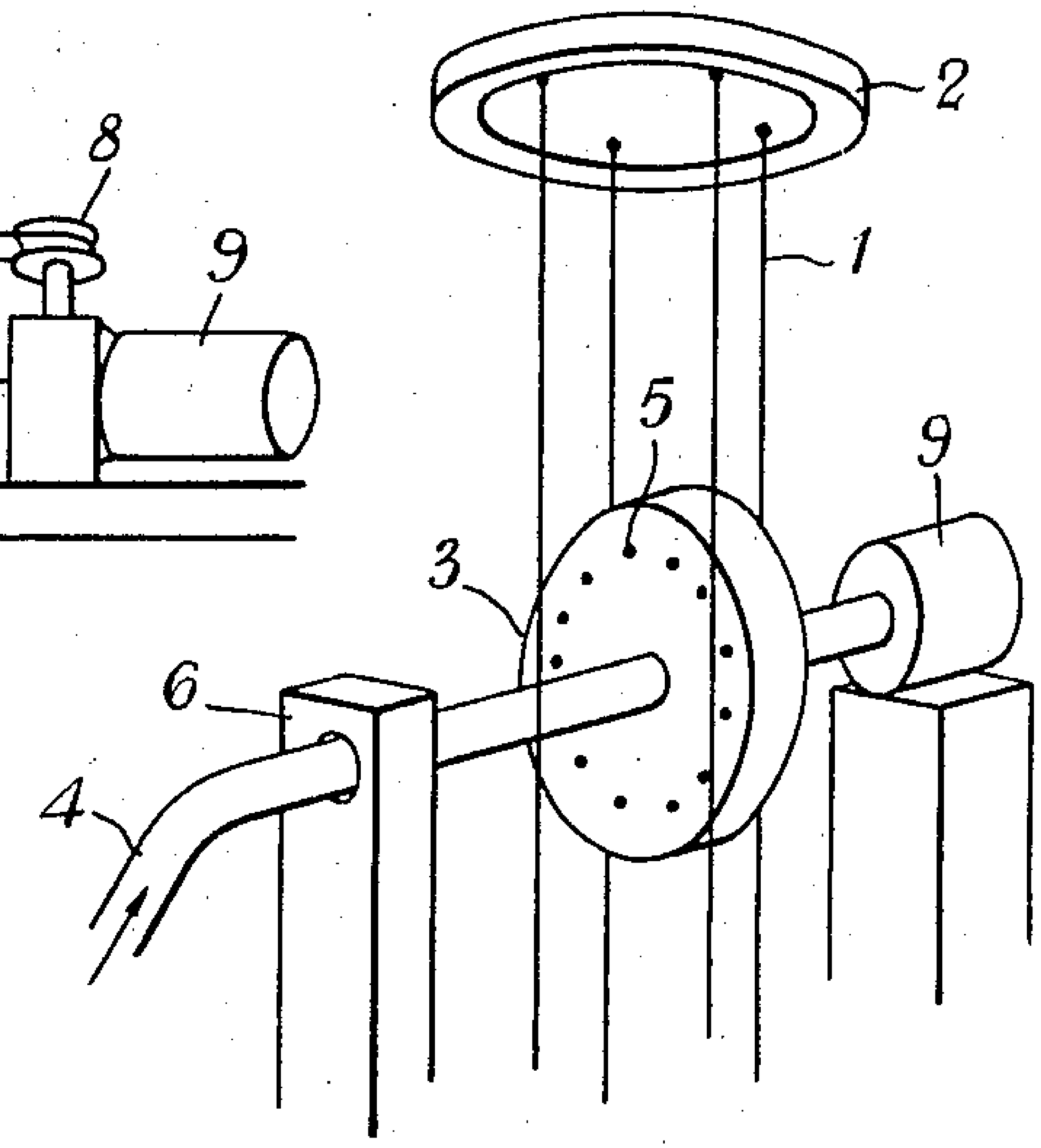


FIG.1

FIG.2



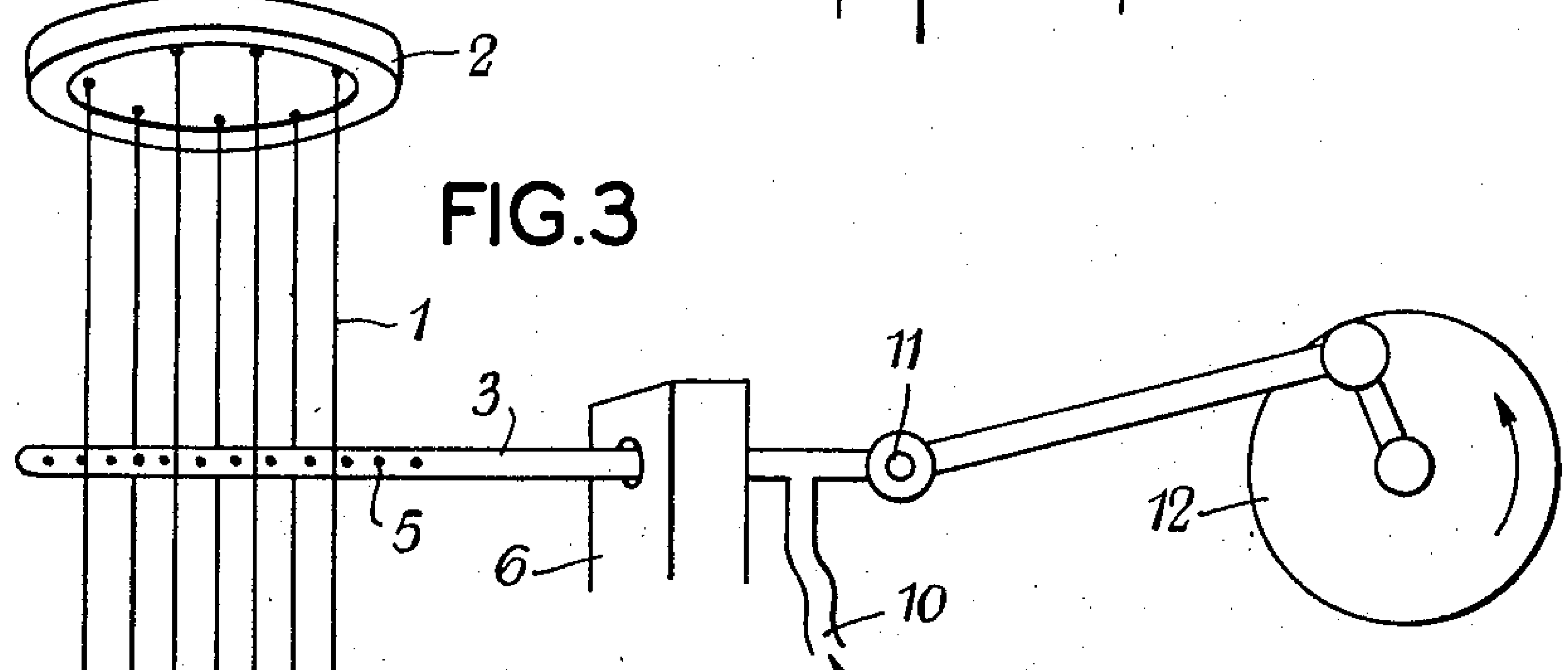


FIG.3

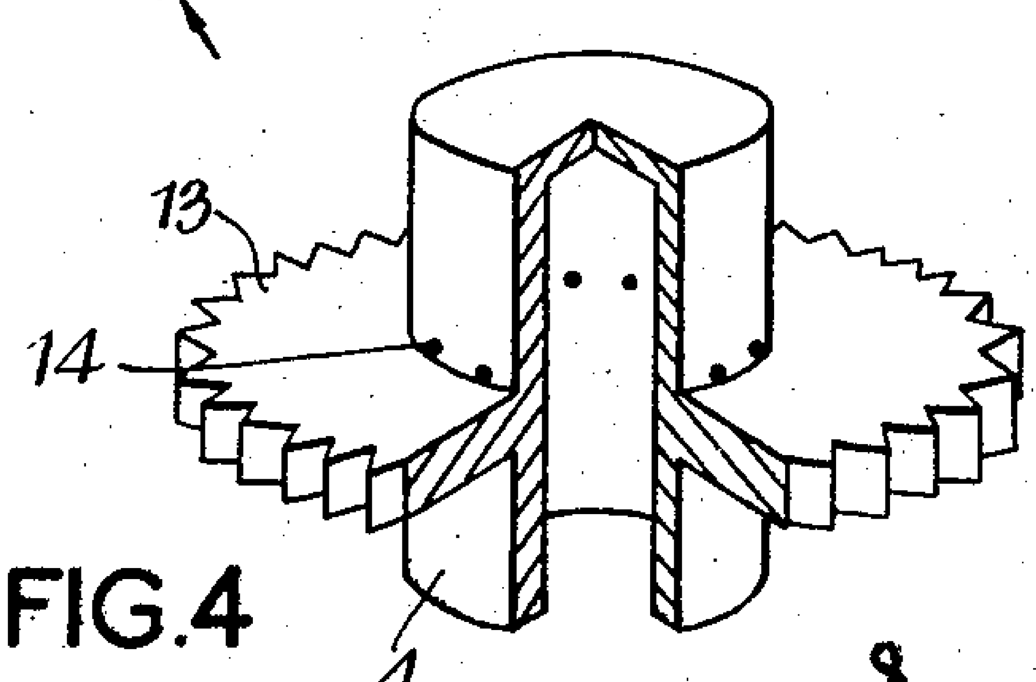


FIG.4

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PRODUCTION OF ARTIFICIAL FILAMENTARY MATERIALS

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This invention relates to a process and apparatus for the production of artificial filamentary materials made by melt spinning and having local enlargements in cross-sectional area in an irregular sequence.

It is known that artificial filamentary materials can be made from fusible filament-forming materials by forcing the molten material through nozzle orifices, drawing the extruded material in the form of continuous filaments through a cooling zone in which it solidifies, and conducting the filaments to a collecting means.

It is an object of the invention to provide a method for so carrying out the melt spinning operation that the resulting filaments have knops, i.e. local enlargements in cross-section area, irregularly distributed along their length, and also to provide apparatus for carrying out the melt spinning by such a method.

According to the invention a molten filament-forming material is extruded through one or more spinning orifices, the extruded material is drawn in the form of filaments away from the orifices through a zone in which it is solidified by cooling, and a stream or streams or discrete particles of a fluid coolant are caused to travel in paths which themselves move transversely to the direction of travel of the filaments and to impinge on at least some of the filaments before they are completely solidified and while they are spaced apart, whereby local increases in the cross-sectional area of the filaments are produced at irregular intervals along their lengths.

The invention comprises also apparatus for carrying out the process described above, which comprises means for extruding a molten filament-forming material through orifices, means for drawing the extruded material from the said orifice in the form of filaments, and auxiliary cooling means for forming a stream or streams or discrete particles of a fluid coolant and causing them to travel in paths which themselves move transversely to the direction of travel of the filaments and which intersect the paths followed by the filaments between the extrusion means and the drawing means, at a distance from the extrusion means such that the filaments are still spaced apart. Preferably but not necessarily the stream or streams or discrete particles of fluid coolant travel outwardly from a source inside a group of filaments.

Yarns containing filaments having such local enlargements in cross-section, i.e. thickened portions, are used as so-called knop yarns and flake yarns, particularly in the weaving industry, for producing fashionable surface patterns on fabrics.

The invention is illustrated in the accompanying drawing, in which

Figures 1, 2 and 3 show diagrammatically three different forms of apparatus in accordance with the invention, and

Figure 4 shows diagrammatically and partly in section a form of coolant-distributor that may be substituted for that in Figure 1.

Referring now to the drawing, in Figure 1 the reference numeral 1 designates five filaments, i.e., separate fibres,

which are forced out through five circularly disposed nozzle apertures of the spinning nozzle 2 of a melt-spinning apparatus not shown in the figure, and are drawn vertically downwards by means of a drawing member which also is not shown in the figure. Situated inside the group of filaments 1 is an auxiliary cooling device comprising a cylindrical hollow member 3, carried on a shaft 4 extending coaxially of the said group of filaments and rotatably mounted on a support 6. The shaft 4 also has secured thereon a V-belt pulley 7, by means of which the member 3 can be set in rotation by a motor 9 by means of a cord 8. Fine nozzle apertures 5 are drilled in the cylindrical surface of the member 3 around the latter, the said apertures extending radially outwards from the space inside said member. The support 6 and the shaft 4 also comprise an axial bore which is not shown in the drawing and through which a cooling medium from the supply pipe 10 can be introduced into the internal space of the member 3.

The operation of the apparatus will be apparent from the following example.

Example

Five separate polyamide filaments (nylon 66-monofilament) were drawn at a speed of 450 metres/min. from five nozzle apertures in the spinning nozzle 2 of the apparatus referred to above, the said apertures each having a diameter of 0.62 mm. The rates of spinning and take-up were so adjusted that the individual filaments obtained before the auxiliary cooling means of the invention was set in operation had a count of 18 den. in the stretched condition. The rotatably mounted cylindrical member 3 contained 15 apertures (5) drilled at regular intervals on a circular line on the cylindrical surface of said member, each having a diameter of 0.1 mm., spaced at a distance of 2.5 cm. from the spinning nozzle. De-ionised water at room temperature was introduced through the supply pipe 10 at a pressure of 0.2 atm. gauge into the member 3, from which it was sprayed out radially through the apertures 5. By means of the motor 9, the member 3 was given a rotational movement of 690 r.p.m. The water spraying outwardly in a manner similar to that produced with a lawn sprinkler thus impinged on changing points of the spun filaments passing by it, which were still largely liquid, local thickened portions being produced by the sudden cooling at the places where the water struck. After a subsequent stretching by 410% carried out in a known manner, the filaments had a count of 14 den. between the thickened portions and comprised knops with a diameter of 0.5 mm. and a length of about 1 mm. irregularly distributed over their lengths. The mean spacing between these thickened portions was 20 cm., the distances varying in random distribution between 2 cm. and 50 cm. The separate filaments after stretching had a tensile strength of 5.3 grams per denier and a breaking elongation of 25%. The stretching was normal, i.e. the thickened portions did not cause any difficulties during the stretching.

The diameter and mean spacing of the knops can be varied widely by altering the spinning conditions. For example, when the member 3 was at a distance of 9 cm. from the spinning nozzle 2, and was run, under otherwise unchanged conditions, at 230 r.p.m., the filaments had a count of 16.5 den. between the thickened portions after stretching, whereas the knop diameter was 0.45 mm. and the mean knop spacing 60 cm. The nature of the knop formation can also be influenced by varying the size and number of the nozzle apertures 5 in the member 3. Furthermore, these apertures 5 can as desired be regularly or irregularly arranged on the cylinder surface, or they can for example be arranged on a zig-zag line or in a helix instead of on a circular line.

Figure 2 shows another form of apparatus according to the invention, in which once again the reference **1** designates the filaments, which are drawn vertically downwards from a spinning nozzle **2** of a melt-spinning apparatus (not shown). Positioned inside this group of filaments **1** is a member **3** which is constructed as a hollow circular disc, and is rotatably mounted on a shaft **4** carried by a support **6**, the said shaft **4** being disposed on a plane at right angles to the direction of travel of the filaments and driven by a motor **9**. The member **3** is provided on its two circular surfaces with fine apertures **5** leading outwardly from the inside of the member, through which a cooling medium fed into the member **3** from a supply pipe **10** through an axial bore in the shaft **4**, can be sprayed onto the filaments travelling past the said member.

A third form of apparatus according to the invention is shown diagrammatically in Figure 3. In this case, the member **3** consists of a tube closed at its ends and extending transversely through the group of filaments **1**, the said tube having lateral nozzle apertures **5** towards one end. A flexible pipe **10** leading from below leads into the tube, which is movably mounted in a guide way in the support **6** and is given a reciprocating motion through a ball joint **11** by means of a driven eccentric disc **12** and crank **13**. In operation, the pipe allows the cooling medium to discharge laterally during its transverse movement and to strike perpendicularly on the filaments **1** passing thereby.

The manner in which the forms of apparatus illustrated in Figures 2 and 3 operate is similar to that described in connection with Figure 1. In all three cases, the coolant impinges on the spun material from moving nozzle apertures arranged transversely to the direction of travel of the filaments.

In another form of apparatus according to the invention the coolant is caused to impinge on the spun material, not by spraying nozzles and under the action of pressure, but by means of centrifugal force. This arrangement is of course restricted to the use of liquid cooling media. This apparatus used is identical with that shown in Figure 1, except that the cylindrical member **3** shown in Figure 1 is replaced by the arrangement shown in Figure 4, in which the axially bored shaft **4** carries a toothed disc **13** below its closed end. Drilled immediately above the disc **13** are a number of openings **14** which extend from the upper side of the toothed disc into the interior of the shaft, but these openings do not have the fineness necessary for spraying nozzles.

In operation, the cooling liquid supplied by the pipe **10** travels upwardly through the bore in the shaft and discharges through the holes **14** onto the upper side of the disc **13**. As a result of the rapid rotation of the shaft **4** and disc **13**, the discharging liquid is forced radially outwards under the action of centrifugal force, and is flung off in the form of fine droplets by the points of the toothed disc to strike the travelling filaments according to the laws of chance.

The forms of apparatus described above can be modified in many different ways. In particular, the member **3** in the form of a pipe as shown in Figure 3 can for example also be given an up-and-down movement in addition to the to-and-fro movement. The number, size and distribution of the knops can in all cases be varied within very wide limits by altering the number, arrangement and regularity or irregularity in the distribution of the apertures **5**, or of the teeth of the disc **13** in the embodiment shown in Figure 4, and also by unsymmetrical arrangement of the entire member **3** in relation to the group of filaments **1**, altering its speed of rotation, and controlling the supply of coolant. The said member can for example also be arranged outside the groups of filaments, and in such a case knops of different sizes are produced on the different individual filaments.

A liquid with high heat of evaporation, such for example as water, is preferably used as coolant; it is however also possible to use gases, such for example as cold air. A liquid coolant can moreover contain dissolved dyestuffs, suspended pigments, colour-intensifying or colour-resisting substances, whereby coloured knops, or knops darker or brighter in colour than the remainder of the filament, can be obtained, and additional variegated effects are produced in the fabrics woven from such filaments.

Knop yarns as such have long been known. When spinning stape textile fibres, such as wool, cotton or rayon yarns, they are for example produced by complete knops being admixed as small fibre tufts with the spinning batch in the willowing or being scattered in the feed material of the spinning card, or the knops may be produced with the aid of twisting frames giving special effects. With the arrival of the artificial textile fibres spun in as continuous filaments from nozzles, it was an obvious question whether local thickenings in the fibres could be produced as during the manufacture of the fibres by intentional fluctuations in the supply to the spinning nozzle of the material to be spun or in the speed of the drawing or take-up device. It has however been shown that adequate thickening could not easily be produced in this manner, and, still more important, because aperiodic changes in speed of the spinning pumps and drawing or take-up devices cannot be obtained with simple means, it proved to be extremely difficult to obtain irregularly distributed knops in this manner, although this is essential for the effects which are required, since periodic enlargements in cross-section would occur in pattern form in the finished fabric and produce tedious designs.

It was surprising that thickened portions distributed in a very irregular fashion throughout the length of the filaments can be produced in a simple manner by the process of the invention. Moreover, it was also unexpected that the thickened portions obtained in the filaments would survive a subsequent stretching without interfering in any way with the stretching process.

The process can be used with all fibres capable of being spun from the melt, e.g. with fibres obtained from polyamides, polyurethanes, polyesters and polymers of vinyl compounds. Continuous filaments comprising knops in accordance with the invention can be used as such or can be subsequently cut and used as staple fibres.

I claim:

1. Process for the manufacture of artificial filamentary materials having knops by melt spinning which comprises extruding the molten filament-forming material through spinning orifices, drawing the extruded material in the form of filaments away from the orifices through a zone in which it is solidified by cooling and, before the filaments are completely solidified and while they are still spaced apart, directing liquid coolant at substantially atmospheric temperature in paths which move transversely to and thus intersect the paths of the filaments, so as to cause a sudden liquid cooling of the filaments over short irregularly spaced lengths thereof and, under the action of the drawing operation, formation of thickened places at the irregularly spaced places where the liquid impinged on the filaments.

2. Process for the manufacture of artificial filamentary materials having knops by melt spinning which comprises extruding the molten filament-forming material through spinning orifices, drawing the extruded material in the form of filaments away from the orifices through a zone in which it is solidified by cooling and, before the filaments are completely solidified and while they are still spaced apart, directing streams of liquid coolant at substantially atmospheric temperature in paths which move transversely to and thus intersect the paths of the filaments, so as to cause a sudden liquid cooling of the filaments over short irregularly spaced lengths thereof and, under the action of the drawing operation, forma-

tion of thickened places at the irregularly spaced places where the liquid impinged on the filaments.

3. Process for the manufacture of artificial filamentary materials having knops by melt spinning which comprises extruding the molten filament-forming material through spinning orifices, drawing the extruded material in the form of filaments away from the orifices through a zone in which it is solidified by cooling and, before the filaments are completely solidified and while they are still spaced apart, directing drops of liquid coolant at substantially atmospheric temperature in paths which move transversely to and thus intersect the paths of the filaments, so as to cause a sudden liquid cooling of the filaments over short irregularly spaced lengths thereof and, under the action of the drawing operation, formation of thickened places at the irregularly spaced places where the liquid impinged on the filaments.

4. Process according to claim 2, wherein the sudden cooling of the filaments over short irregularly spaced lengths is effected by radiating streams of liquid coolant directed towards the filaments from a rotating source.

5. Process according to claim 2, wherein the sudden cooling of the filaments over short irregularly spaced lengths is effected by substantially parallel streams of liquid coolant directed towards the filaments from a reciprocating source.

6. Process according to claim 3, wherein the sudden cooling of the filaments over short irregularly spaced lengths is effected by drops of liquid coolant impelled towards the filaments by centrifugal force.

7. Process for the manufacture of artificial filamentary materials having knops by melt spinning which comprises extruding the molten filament-forming material through spinning orifices, drawing the extruded material in the form of filaments away from the orifices through a zone in which it is solidified by cooling and, before the filaments are completely solidified and while they are still spaced apart, directing water at substantially atmospheric temperature in paths which move transversely to and thus intersect the paths of the filaments, so as to cause a sudden liquid cooling of the filaments over short irregularly spaced lengths thereof and, under the action of the drawing operation, formation of thickened places at the irregularly spaced places where the water impinged on the filaments.

8. Process according to claim 7, wherein the sudden cooling of the filaments over short irregularly spaced lengths is effected by radiating streams of water directed towards the filaments from a rotating source.

9. Process according to claim 7, wherein the sudden cooling of the filaments over short irregularly spaced lengths is effected by substantially parallel streams of water directed towards the filaments from a reciprocating source.

10. Process according to claim 7, wherein the sudden cooling of the filaments over short irregularly spaced lengths is effected by drops of water impelled towards the filaments by centrifugal force.

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