July 24, 1956 H. WEBER 2,755,506

BAND SPINNING

Filed Aug. 20, 1952

FIG.2.

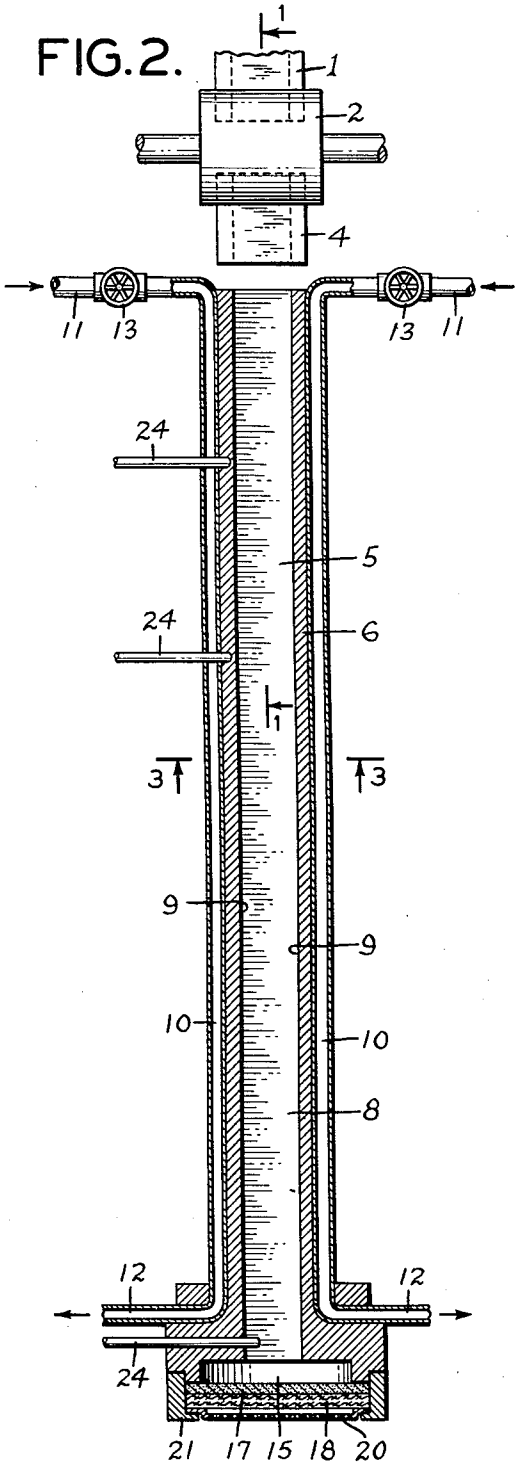
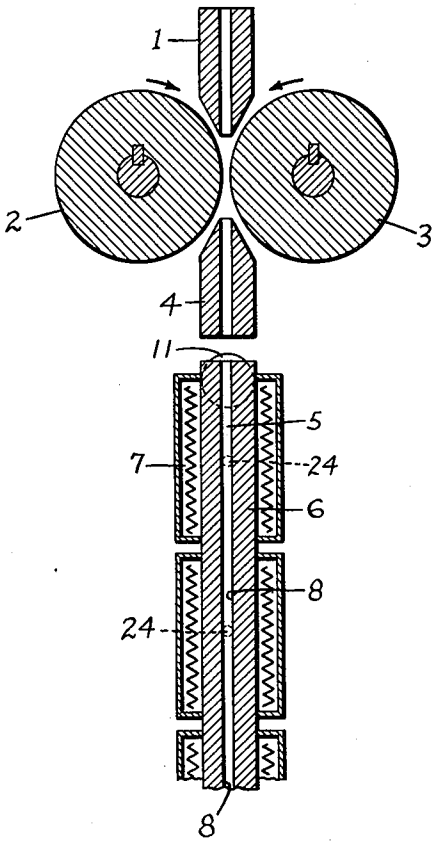


FIG.1.



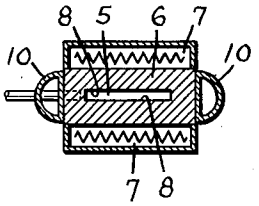


FIG.3.

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BAND SPINNING

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11 Claims. (Cl. 18—8)

This invention relates to the preparation of filamentary material and relates more particularly to the preparation of filamentary material by the band spinning process.

In the preparation of filamentary material such as yarns, filaments, ribbons and the like by the band spinning process, a band, generally a relatively wide flat band, of filament-forming material is forced, by means such as feed rollers, into a heated melting tube having a passageway extending therethrough, the passageway being of approximately the same size and shape as the band. This passageway leads to a spinning jet containing one or more spinning orifices. As the filament-forming material passes through the melting tube to the spinning jet, it melts and is brought to the proper temperature for spinning. The molten filament-forming material is forced through the spinning orifice by the pressure applied to the incoming band, which pressure is transmitted through the band to the molten material. Thus, the band acts as a continuously renewed piston, pushing the molten material before it. Among the filament-forming materials which may be spun in this manner are, for example, the polycarboxamides, polysulfonamides, polyurethanes, polytriazoles and the like.

In the use of this band spinning process for the production of filamentary materials, it has been observed that there is a tendency for the band to jam in the passageway. This jamming is highly objectionable since it interrupts the spinning process and makes it impossible to spin filamentary material continuously under uniform conditions. When such jamming takes place, it is not possible to move the band even by exerting pressures as high as 13,000 pounds per square inch thereon by means of the knurled or toothed feed rollers, which are used to force the band into the melting tube. If these feed rollers are allowed to continue operating when the band is thus jammed, they merely chew up the band of polymer without moving the band down into the melting tube. Moreover, when spinning is thus interrupted there is frequently a tendency for the molten filament-forming material remaining in the melting tube to decompose or degrade so that the melting tube must be disassembled and cleaned before spinning can be resumed.

In conventional band spinning processes there is also a tendency for the filament-forming material to be heated unevenly so that portions thereof are above their melting points for comparatively long periods while other portions are still unmolten. This results in objectionable degradation and decomposition of filament-forming material in the melting tube.

It is an object of this invention to provide a process and apparatus for preparing filamentary material by band spinning which will be free from the foregoing and other disadvantages and which will be especially efficient in operation.

A further object of this invention is the provision of a process and apparatus for the preparation of filamentary material by band spinning whereby spinning may be carried on for extended periods of time without interruption.

Other objects of this invention, together with certain details of construction and combinations of parts, will be apparent from the following detailed description and claims.

I have discovered that excessive decomposition of the filament-forming material may be avoided and that the jamming of the band in the passageway of the melting tube may be eliminated if the heat transferred to the band from the walls of the passageway is transferred to only the wide faces of said band, i. e. the heat is transferred from only the wide opposite walls of the passageway. This is done by supplying heat to these wide opposite walls so as to maintain them at a temperature above the melting temperature of the filament-forming material, while at the same time maintaining the narrow opposite walls of the passageway at about the same temperature as the narrow sides of the band so that substantially no heat transfer, or very little heat transfer, takes place between these narrow walls and the corresponding narrow sides of the band.

In practice this differential heat transfer may be effected by heating the wide walls and applying a cooling medium to the narrow walls of the passageway. The cooling medium acts to draw off any heat supplied by conduction from the wide walls to the narrow walls.

Since the temperatures of the narrow sides of the band are increasing as the band travels along the tube, due to heat transfer from the wide walls of the passageway, the temperatures of the corresponding narrow walls of the passageway must likewise be increased along the length of the passageway in order that there be substantially no heat transfer between these narrow walls and the narrow sides of the band. This increase in narrow wall temperature may be brought about by the introduction, at a controlled rate, of the cooling fluid into one end of a cooling tube which runs along the length of the melting tube adjacent the narrow walls of the passageway, so that the cooling fluid becomes heated during its passage along the cooling tube.

This invention is applicable to a band-spinning process employing a band whose width is at least twice its thickness, for example, a band 0.60 inch in width and 0.08 inch in thickness.

One form of band spinning apparatus in accordance with the present invention will now be described in greater detail with reference to the accompanying drawings in which:

Fig. 1 is a sectional elevation of the upper portion of the melting tube and associated feed mechanism along the line 1—1 of Fig. 2, in the direction of the arrows;

Fig. 2 is an elevation, partly in section, of the melting tube, spinning jet, and associated feed mechanism; and

Fig. 3 is a sectional plan view of the melting tube along the line 3—3 in Fig. 2, in the direction of the arrows.

Referring now to the drawing, the reference numeral 1 designates a guide member into which a band of filament-forming material of substantially uniform cross-section is entered continuously. The guide member 1 leads the band of filament-forming material between feed rollers 2 and 3, one or both of which are positively driven by any suitable means. These feed rollers grip the band and feed the same downward at a constant rate. To prevent slippage of the band between the feed rollers 2 and 3, the surface of one or both of said rollers may be serrated, knurled, toothed or otherwise roughened. The feed rollers may be spring-pressed toward each other in a manner well understood in the art.

After passing between the feed rollers 2 and 3 the band enters a guide member 4 which directs it into the passage-

way 5 of the melting tube, designated generally by reference numeral 6. This passageway 5 has a cross-section of substantially the same size and shape as the cross-section of the band, which is rectangular. The melting tube 6 is provided with a number of heating elements, such as electric heating coils 7 which are positioned adjacent to the opposite wider walls 8 of the melting tube 6 and along the length of said melting tube. These heating coils 7 may be individually controlled. Adjacent to the opposing narrower end walls 9 of the melting tube are positioned cooling tubes 10 having inlets 11 for the introduction of cooling fluid, such as oil, and outlets 12. Valves 13 are provided in inlet lines 11 for regulating the flow of cooling fluid.

During its passage down through the melting tube the filament-forming material becomes completely molten. This molten material collects in a well 15 and is forced, by the pressure on the band, through the well, then through a sand pack 17 and a filter screen 18 and through suitable orifices in the spinning jet 20 to form filaments. The outer or exposed surface of the spinning jet 20 may be given a high polish, which serves to reduce the heat radiated to the filaments from the surface of said jet and also to conserve the heat in the mass of molten material. The sand pack 17 and filter screen 18 are held securely in position by means of a retaining ring 21 which is fastened to the body of the melting tube in any suitable manner. Thermocouples 24 are provided along the length of melting tube 6 for measuring the temperature. After leaving the jet 20, the filaments of thermoplastic material are cooled and solidified in the conventional manner.

Example

In employing the apparatus described above for the band spinning of a polyurethane made by reacting butanediol-bis-chloroformate and tetramethylene diamine and having a melting point of about 200° C., the wide walls of the passageway are maintained at a constant temperature of about 204° C. along the length of the melting tube by means of the heating elements. Cooling oil is introduced into the cooling tube at a temperature of about 20° C. In this manner uniform filaments are spun for long periods without jamming or other interruptions.

It is to be understood that the foregoing detailed description is given merely by way of illustration and that many variations may be made therein without departing from the spirit of my invention.

Having described my invention what I desire to secure by Letters Patent is:

1. In an apparatus for the preparation of filamentary material by the band spinning process, a melting tube having a passageway in which a band of filamentary material is received and melted, said passageway having wide opposing side walls and narrow opposing end walls, means for supplying heat to said wide walls and means for abstracting heat from said narrow walls.

2. In an apparatus for the preparation of filamentary material by the band spinning process, a melting tube having a passageway in which a band of filamentary material is received and melted, said passageway having wide opposing side walls and narrow opposing end walls, heating means adjacent to said wide walls to supply heat thereto and cooling means adjacent to said end walls.

3. In an apparatus for the preparation of filamentary material by the band spinning process, a melting tube having a passageway in which a band of filamentary material is received and melted, said passageway having wide opposing side walls and narrow opposing end walls, heating means adjacent to said wide walls to supply heat thereto and a cooling tube running substantially the length of the melting tube adjacent to each of said end walls.

4. In an apparatus for the preparation of filamentary material by the band spinning process, a melting tube having a passageway in which a band of filamentary material is received and melted, said passageway having wide opposing side walls and narrow opposing end walls, heating means adjacent to said wide walls to supply heat thereto and a cooling tube running substantially the length of said melting tube adjacent to each of said walls and having an inlet at the end of said melting tube where the band is received and an outlet at the opposite end of the melting tube.

5. A band spinning apparatus comprising a melting tube having a passageway for the reception and melting of a continuous band of filament-forming material, said passageway having wide opposing side walls and narrow opposing end walls, means for supplying heat to said wide walls, means for abstracting heat from said end walls, a spinning jet at one end of said melting tube and means, at the other end of said melting tube, for continuously forcing said band and resulting molten material through said melting tube and spinning jet.

6. A band spinning apparatus comprising a melting tube having a passageway for the reception and melting of a continuous band of filament-forming material, said passageway having wide opposing side walls and narrow opposing end walls, heating means for said wide walls, a cooling tube running substantially the length of the melting tube adjacent to each of said end walls, a spinning jet at one end of said melting tube and means, at the other end of said melting tube, for continuously forcing said band and resulting molten material through said melting tube and spinning jet.

7. In a process for the band spinning of thermoplastic filament-forming material, the steps which comprise passing a flat band of said thermoplastic material through a passageway of approximately the same cross-section as said band, and supplying heat directly to only the wide faces of said band to effect melting of said thermoplastic material.

8. A process for the production of filamentary material, comprising the steps of passing a continuous flat band of thermoplastic filament-forming material through a passageway of approximately the same cross-section as said band, supplying heat directly to only the wide faces of said band to effect melting of said thermoplastic material in said passageway and extruding, by pressure exerted through the band, the resulting molten thermoplastic material into filamentary form.

9. A process for the production of filamentary material, comprising the steps of passing a continuous flat band of thermoplastic filament-forming polyurethane through a passageway of approximately the same cross-section as said band, supplying heat directly to only the wide faces of said band to effect melting of said thermoplastic polyurethane in said passageway and extruding, by pressure exerted through the band, the resulting molten thermoplastic polyurethane into filamentary form.

10. Process for the melting of a flat band of thermoplastic filament-forming material which comprises supplying heat directly to only the wide faces of said band to effect melting of the band throughout its cross-section.

11. Process for the melting of a flat band of thermoplastic filament-forming material which comprises supplying heat directly to only the wide faces of said band to effect melting of the band throughout its cross-section while maintaining the narrow sides of the band in substantial thermal equilibrium with their surroundings.

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