

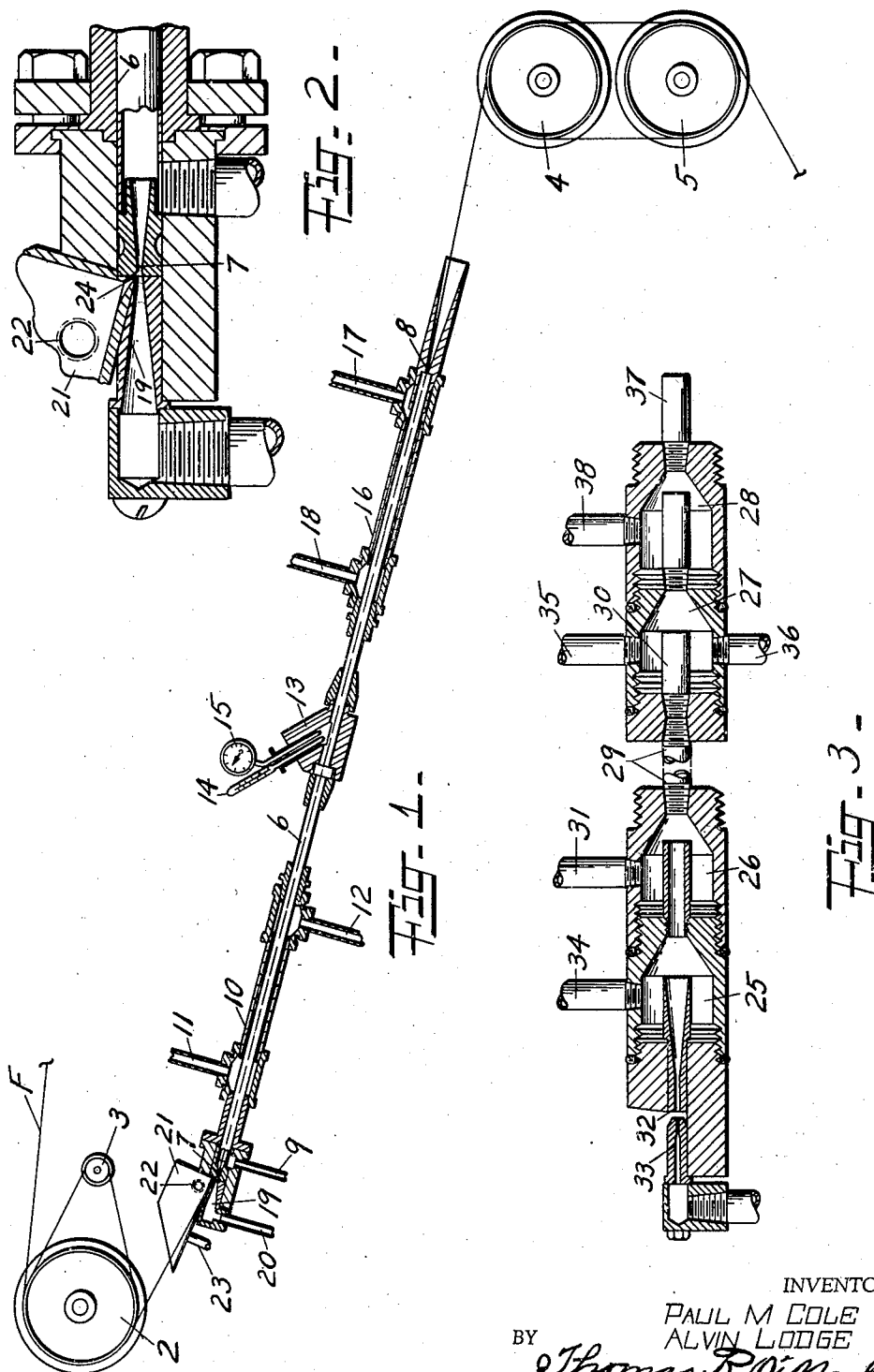
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P. M. COLE ET AL

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METHODS AND APPARATUS FOR TREATING FILAMENTARY MATERIAL

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INVENTOR.

PAUL M COLE
ALVIN LODGE

BY

Thomas R. Malby
ATTORNEY

UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR TREATING
FILAMENTARY MATERIAL

Paul M. Cole, Auburn, N. Y., and Alvin Lodge,
Meadville, Pa., assignors to American Viscose
Corporation, Wilmington, Del., a corporation
of Delaware

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This invention relates to improved methods and apparatus for treating filamentary material in fluids at elevated temperatures and more particularly to stretching treatment at elevated temperatures.

It is frequently desirable to treat filamentary material with or in superheated liquids, that is liquids heated above their normal boiling points under ordinary conditions of pressure and when so treating the filamentary material, it is necessary to seal the treatment chamber to prevent the escape of the vapors of the liquids that would otherwise escape to the atmosphere while introducing the filamentary material into the treatment chamber. It is also necessary to prevent any conversion of the superheated liquid into vapor form which would give rise to a mixture of liquid and vapor thereby resulting in irregularity of treatment wherever such a mixture should come into contact with the filamentary material. It is further highly desirable to provide for concurrent flow of the filamentary material with the superheated liquid in order to avoid irregularities.

It is an object of the invention to provide for treating filamentary material with a superheated liquid into which the filamentary material is introduced by means of the flow of a body of liquid which also serves to seal the treatment liquid to prevent its escaping from the treatment chamber. A further object is to provide for concurrent flow of the filamentary material and the injecting of treatment fluids into, throughout, and out of the treatment chamber. Further objects of the invention are to provide methods and apparatus for treating filamentary material in the manners and for the purposes hereinafter described.

In the drawing,

Figure 1 illustrates in cross-section one preferred embodiment of the invention.

Figure 2 shows a detail in cross-section of the embodiment of Figure 1, and

Figure 3 shows a modified embodiment of the invention.

As shown in Figure 1, the filamentary material F is supplied to a godet or roller 2 and the guide 3 associated therewith, passes through the treatment apparatus, and thence to the godets 4 and 5. This embodiment will be described with reference to a stretching treatment in which the godets 4 and 5 rotate at a higher peripheral speed than the godet 2, as the result of which stretching of the filamentary material occurs within the treatment apparatus.

While the treating chamber 6 may be of any shape, it is preferably of relatively long tubular shape as shown in Figure 1, and is provided with orifices 7 and 8 respectively at each end thereof.

As shown in Figure 2, the orifice 7 through which the filamentary material enters preferably has a gradually increasing diameter in order to reduce turbulence of the liquids therein introduced for the purposes hereinafter described. The orifice 8 at the exit end of the apparatus is also preferably provided with increasing inside diameter for the same reason. The entrance end of the chamber 6 may have a pipe 9 connected thereto for introducing the superheated liquids. If desired, the end of the chamber 6 adjacent the point of entering of the filaments may be provided with a jacket 10 connected with entrance and exit pipes 11 and 12 respectively for a heating fluid, such as steam. Similarly, the chamber 6 may be provided with a well 13 for accommodating a thermometer 14 and a pressure gage 15. The chamber 6 is also provided near its exit end with a second jacket 16 connected with the pipes 17 and 18 for entrance and exit respectively of cooling means, such as cold water.

Just outside of the entrance orifice 7, and in alignment therewith there is arranged a nozzle 19 connected with the pipe 20 to which a heated liquid is supplied under pressure. The flow of the heated liquid through nozzle 19 forms a jet through the orifice against the pressure of the superheated liquid in the chamber 6. There is fastened in superposition over the nozzle 19, a sort of hopper 21 into which heated liquid may be introduced through the pipe 22 and from which any overflow may enter the pipe 23. This hopper or funnel, in effect, may be open to the atmosphere, and is provided with an opening 24 in alignment with the orifice 7 so that filamentary material may proceed through it and the orifice. The heated liquid within the hopper or funnel 21 serves to prevent entrapment of air by the jet or filamentary material.

The filamentary material, after entering the chamber, comes into contact with the mixture of the hot liquid introduced by the jet and the superheated liquid introduced through the pipe 9 and upon being heated while in contact with the mixture of liquids undergoes stretching. As stated above, the steam jacket 10 may be omitted provided the temperature of superheat of the liquid entering pipe 9 is sufficiently high so that the resulting mixture has the desired temperature to effect stretching. As the superheated liquid approaches the lower regions of the treat-

ing chamber, its temperature is lowered by the cooling liquid within the jacket 16 to such a degree that it is below the boiling point at atmospheric pressure, and consequently when the liquid flows out of the orifice 8, no violent evaporation into the atmosphere takes place.

In the modification of Figure 3, the apparatus comprises a series of chambers 25, 26, 27 and 28, and treating by the superheated liquid takes place mainly in the pipe 29 (broken off to facilitate illustration), chamber 27, and a portion of the pipe 30. In this arrangement, the superheated liquid enters pipe 31 and the filamentary material is introduced through the orifice 32 by the jet from the nozzle 33. A pipe 34 is provided as a vent. The chamber 27 is provided with pipes 35 and 36 connected to the temperature and pressure gauges. To prevent escape of steam or vapor to the atmosphere through the discharge pipe 37, cold water is fed directly into the stream of superheated fluid about the filamentary material through pipe 38 in such a manner that concurrent flow of the liquids and filamentary material takes place.

As an illustration of the operation of the device, the apparatus of Figure 3 may be interposed between two stretching godets and it may be supplied with filamentary material composed of Vinyon, a copolymer of vinyl chloride and vinyl acetate. The nozzle 33 is supplied with water at a temperature of 98° C. while the pipe 31 is provided with water under pressure at a temperature of 110° C., and pipe 38 is provided with cooling water at a temperature of about 90° C.

The apparatus may be employed for treating filamentary material of other constitution, such as cellulose esters or ethers, e. g. cellulose acetate, regenerated cellulose, polyvinyl chloride, chlorinated polyvinyl chloride, chlorinated Vinyon or other natural or artificial filaments. The treatment fluids may be water superheated above its boiling point, other inert liquids superheated above their boiling points, steam itself, vapors of other inert liquids, or even for some purposes, vapors or superheated liquids having a swelling effect upon the filamentary material being treated. The apparatus may also be employed for carrying out chemical processes, such as saponification of cellulose acetate, or it may be used to wash filamentary material. Such other treatments may be performed upon the filamentary material with stretching rollers or without stretching. In the latter case, of course, the godets placed at either end of the chamber are driven at the same speed.

While preferred embodiments of the invention have been disclosed, the description is intended to be illustrative only, and 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.

What we claim is:

1. A process of treating filamentary material comprising providing a stream of superheated liquid under pressure flowing in substantially only one general direction throughout its length, maintaining the stream under sufficient pressure to prevent ebullition substantially throughout its length, continuously introducing the filamentary material into said stream with a jet of heated liquid directed at high velocity in substantially the same general direction to prevent escape of the superheated liquid to the atmosphere at the material entrance and continuously passing the

material through said stream concurrent with the general direction of flow.

2. A process of treating filamentary material comprising providing a stream of superheated liquid under pressure flowing in substantially only one general direction throughout its length, continuously introducing the filamentary material into said stream with a jet of heated liquid directed in substantially the same general direction and continuously passing the material through said stream concurrent with the general direction of flow and maintaining the stream under sufficient pressure to prevent ebullition substantially throughout its length by continuously cooling a portion of said stream adjacent the point of exit of the filamentary material therefrom to a temperature below the boiling point of the liquid.

3. The process of treating filamentary material composed of a copolymer of vinyl chloride and vinyl acetate comprising providing a stream of superheated liquid under pressure flowing in substantially only one general direction throughout its length, continuously introducing the filamentary material into said stream with a jet of heated liquid directed in substantially the same general direction, continuously passing the material through said stream concurrent with the general direction of flow, maintaining the stream under sufficient pressure to prevent ebullition substantially throughout its length by continuously cooling a portion of said stream adjacent the point of exit of the filamentary material therefrom to a temperature below the boiling point of the liquid, and stretching said material during its passage through said superheated liquid.

4. The process of treating thermoplastic filamentary material comprising providing a stream of superheated liquid under pressure flowing in substantially only one general direction throughout its length, continuously introducing the filamentary material into said stream with a jet of heated liquid directed in substantially the same general direction and continuously passing the material through said stream concurrent with the general direction of flow, maintaining the stream under sufficient pressure to prevent ebullition substantially throughout its length by continuously cooling a portion of said stream adjacent the point of exit of the filamentary material therefrom to a temperature below the boiling point of the liquid, and stretching said material during its passage through said stream.

5. In apparatus for treating filamentary material, a substantially closed pressure chamber provided with two openings for permitting entrance and exit respectively of filamentary material, means for introducing a superheated fluid into said chamber, means for forcing a liquid with said filamentary material through said entrance opening and means for cooling the fluid adjacent said exit opening.

6. In apparatus for treating filamentary material, a substantially closed pressure chamber provided with two openings for permitting entrance and exit respectively of filamentary material, means for introducing a superheated fluid into said chamber, means for forcing a liquid with said filamentary material through said entrance opening, means for cooling the fluid adjacent said exit opening and means for stretching the filamentary material as it passes through the chamber.

7. In apparatus for treating filamentary material, a substantially closed pressure chamber

provided with two openings for permitting entrance and exit respectively of filamentary material, means for introducing a superheated fluid under pressure into said chamber, a nozzle in substantial alignment with the entrance opening for forcing a liquid into the chamber, and means for cooling the fluid adjacent said exit opening.

8. In apparatus for treating filamentary material, a substantially closed pressure chamber provided with two openings for permitting entrance and exit respectively of filamentary material, means for introducing a superheated fluid under pressure into said chamber, a nozzle in substantial alignment with the entrance opening for forcing a liquid into the chamber, means for cooling the fluid adjacent said exit opening, and additional nozzles at said entrance and exit openings having internal diameters gradually increasing in the direction of flow to reduce turbulence.

9. In apparatus for treating filamentary material, a substantially closed pressure chamber provided with two openings for permitting entrance and exit respectively of filamentary material, means for introducing a superheated fluid under pressure into said chamber, means for forcing a liquid with said filamentary material through said entrance opening, and means for introducing a cooling fluid into said chamber adjacent the exit opening.

10. In apparatus for treating filamentary material, a substantially closed pressure chamber provided with two openings for permitting entrance and exit respectively of filamentary material, means for introducing water heated above its boiling point into said chamber, means for forcing water below its boiling point with said filamentary material through said entrance opening and means for cooling the water to a point below its boiling point adjacent said exit opening.

11. In apparatus for treating filamentary material, a substantially closed pressure chamber provided with two openings in opposite walls thereof for permitting entrance and exit respectively of filamentary material, an injector comprising said entrance opening and a passage for conducting a fluid through said opening thereby to force the material into the chamber, and means comprising a conduit connected to the chamber and opening thereinto in proximity to said entrance opening, said means being arranged to conduct a treating fluid into the chamber and to direct it about the material in substantially the same direction of travel as that of the material.

12. In apparatus for treating filamentary material, a substantially closed pressure chamber provided with two openings in opposite walls thereof for permitting entrance and exit respectively of filamentary material, an injector comprising said entrance opening and a passage for conducting a fluid through said opening thereby to force the material into the chamber, means comprising a conduit connected to the chamber and opening thereinto in proximity to said entrance opening, said means being arranged to conduct a treating fluid into the chamber and to direct it about the material in substantially the same direction of travel as that of the material, and means for stretching the material as it passes through the chamber.

13. A process of treating filamentary material comprising providing a stream of superheated

liquid under pressure flowing generally in the direction of its length, maintaining the stream under sufficient pressure to prevent ebullition substantially continuously throughout its length, continuously passing the filamentary material through the stream longitudinally thereof, continuously introducing into the stream adjacent one end thereof a jet of heated liquid directed in substantially the same general direction to prevent escape of the superheated liquid at such end, and continuously cooling the stream adjacent the other end thereof to a temperature below the boiling point of the liquid to prevent escape of the liquid in the superheated condition at this other end.

14. A process of treating filamentary material comprising providing a stream of superheated liquid under pressure flowing generally in the direction of its length, maintaining the stream under sufficient pressure to prevent ebullition substantially continuously throughout its length, continuously passing the filamentary material through the stream longitudinally thereof, continuously introducing into the stream adjacent one end thereof a jet of heated liquid directed in substantially the same general direction to prevent escape of the superheated liquid at such end, and continuously cooling the stream adjacent the other end thereof to a temperature below the boiling point of the liquid to prevent escape of the liquid in the superheated condition at this other end, and stretching the material during its passage through the stream.

15. In apparatus for treating filamentary material, a substantially closed relatively long, straight pressure chamber provided at its ends with restricted openings for permitting entrance and exit respectively of filamentary material, means for supplying a treating fluid to the chamber under pressure, and an injector associated with the entrance opening having its discharge passage constructed and arranged with respect to the opening to conduct a sealing fluid at high velocity through the entire transverse area of said opening into the chamber with the material thereby preventing discharge of treating fluid from the chamber through the entrance opening.

16. In apparatus for treating filamentary material, a substantially closed, relatively long, narrow pressure chamber provided at its ends with openings for permitting entrance and exit respectively of filamentary material, means for supplying a treating fluid to the chamber and to direct it about the material in substantially the same direction of travel as that of the material, and an injector associated with the entrance opening having its discharge passage constructed and arranged with respect to the opening to conduct a sealing fluid at high velocity through the entire transverse area of said opening into the chamber with the material thereby preventing discharge of treatment fluid from the chamber through the entrance opening.

17. In apparatus for treating filamentary material, a substantially closed, relatively long, narrow pressure chamber provided at its ends with openings for permitting entrance and exit respectively of filamentary material, means for supplying a treating fluid to the chamber and to direct it about the material in substantially the same direction of travel as that of the material, and an injector associated with the entrance opening having its discharge passage constructed and arranged with respect to the opening to conduct a sealing fluid at high velocity through the

entire transverse area of said opening into the chamber with the material thereby preventing discharge of treatment fluid from the chamber through the entrance opening, said treating fluid supply means comprising a passage substantially concentrically arranged about the injector passage.

18. In apparatus for treating filamentary material, a substantially closed relatively long, straight pressure chamber provided at its ends with restricted openings for permitting entrance and exit respectively of filamentary material and an injector associated with the entrance opening having its discharge passage constructed and arranged with respect to the opening to conduct a sealing fluid at high velocity through the entire transverse area of said opening into the chamber with the material thereby preventing discharge of fluid from the chamber through the entrance opening, and a positively driven strand feeding device disposed outside the chamber adjacent each end thereof for stretching the strand as it passes through the chamber.

19. In apparatus for treating filamentary material, a substantially closed, relatively long, narrow pressure chamber provided at its ends with openings for permitting entrance and exit respectively of filamentary material, means for supplying a treating fluid to the chamber and to direct it about the material in substantially the same direction of travel as that of the material, and an injector associated with the entrance opening having its discharge passage constructed and arranged with respect to the opening to conduct a sealing fluid at high velocity through the entire transverse area of said opening into the chamber with the material thereby preventing discharge of treatment fluid from the chamber through the entrance opening, and a positively driven strand feeding device disposed outside the chamber adjacent each end thereof for stretching the strand as it passes through the chamber.

PAUL M. COLE.
ALVIN LODGE.