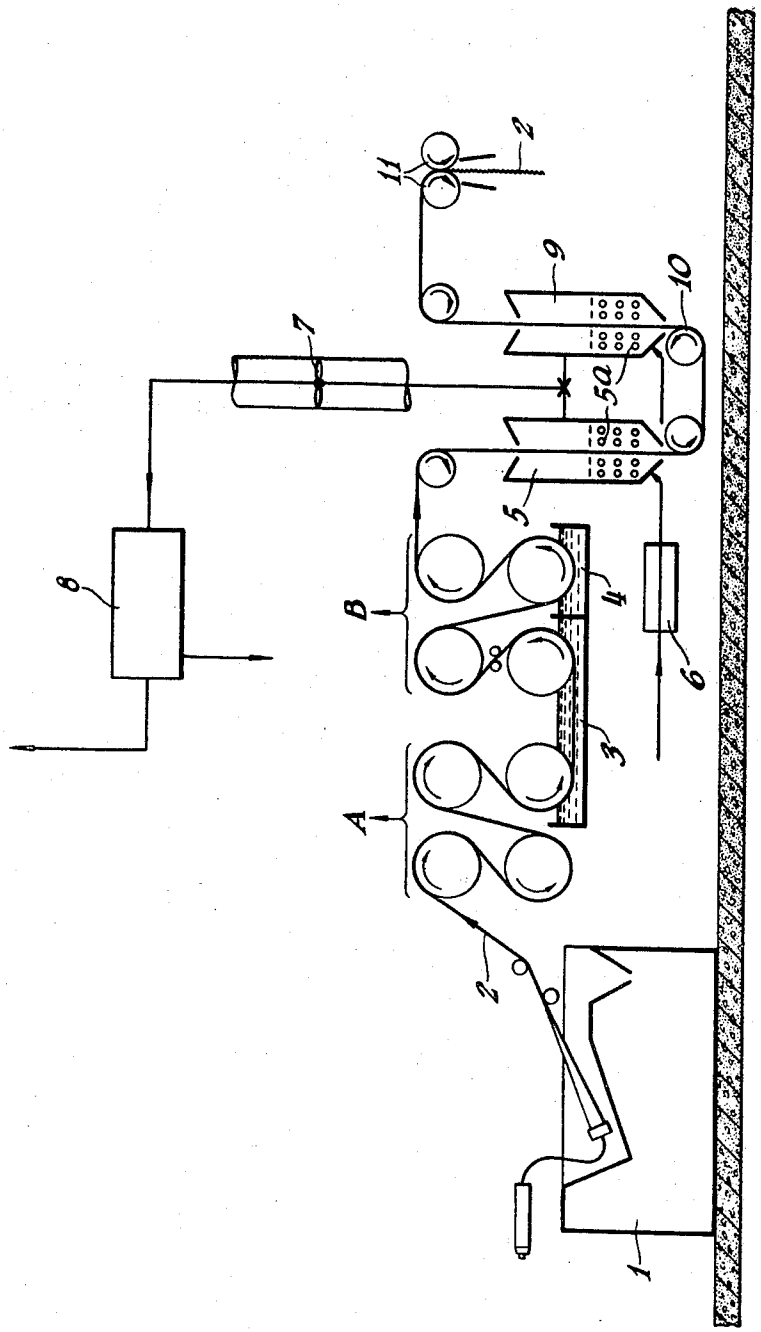
Sept. 17, 1968 C. H. GOODWIN 3,402,236

MANUFACTURE AND TREATMENT OF SYNTHETIC FIBRES AND FABRICS CONTAINING THE SAME

Filed Jan. 29, 1964



INVENTOR
CHESTER HOWARD GOODWIN
BY Thomas B. Leslie
ATTORNEY

United States Patent Office 3,402,236 Patented Sept. 17, 1968

3,402,236

MANUFACTURE AND TREATMENT OF SYNTHETIC FIBRES AND FABRICS CONTAINING THE SAME

Chester Howard Goodwin, Coleraine, County Londonderry, Northern Ireland, assignor to Chemstrand Limited, London, England

Filed Jan. 29, 1964, Ser. No. 340,932
3 Claims. (Cl. 264—210)

ABSTRACT OF THE DISCLOSURE

Filaments have been prepared from polymers in solution by wet or dry spinning techniques wherein the partially coagulated filamentary materials are given an orientation stretch in a hot water bath, passed through a finish bath and then continuously dried under tension in a hot fluidized drying zone. From the hot fluidized drying zone the dried filamentary tow is continuously relaxed in a second hot fluidized zone and thereafter passed to a texturizing operation.

This invention relates to the production of filamentary materials from thermoplastic polymers, copolymers, polyesters and polyamides.

In the manufacture of synthetic filaments from fibre-forming thermoplastic polymers and copolymers such as polyacrylonitrile, polyvinyl alcohol, polyvinyl chloride, polyesters, polyamides, polyurethane or polyolefin by conventional techniques, the polymer is dissolved in a solvent and then spun into a liquid coagulating bath or a dry chimney. The residual solvent must be removed from the spun filament after its passage through the coagulation zone and this is commonly effected by washing the filament in large volumes of water or other cleansing liquids or by bringing the filament into contact with large volumes of heated air or other gases. Both of these methods necessitate the use of extensive solvent recovery facilities to reclaim the solvent from the water or other cleansing liquid, the heated air or other gas and to restore the solvent to its original condition so as to permit its re-use.

Some synthetic filaments, notably acrylonitrile polymer filaments, are characterised by low molecular orientation and consequently have relatively low tensile strength. Tensioning or stretching the fibres under heat has the effect of increasing orientation and therefore improving tensile strength. Such stretching also introduces a relatively high residual shrinkage capacity, commonly known as dimensional instability. The susceptibility to shrinkage of the tensioned fibres can be reduced and for practical purposes substantially eliminated by relaxing the fibres by heating, e.g. by hot air or steam, while they are free to shrink and thus render the fibres dimensionally stable.

It is an object of the present invention to provide a process whereby synthetic fibres in fabric, tow, yarn, or continuous filament form can be treated in a continuous manner in order to remove therefrom residual solvent or water and to relax the fibres and thereby enhance the properties thereof.

According to the present invention, there is provided a process for the production of filamentary materials by extruding a solution of a polymer, dissolved in a solvent, into a coagulating zone, characterised by the steps of continuously withdrawing the filament from the coagulating zone, passing the filament successively through a hot stretch bath and a textile finish bath, conveying the filament through a first hot drying zone and an extractor zone to recover the solvent therefrom, conveying the filament through a second hot drying zone under relaxed conditions to render the filament dimensionally stable and thereafter subjecting the filament to a texturizing operation. The invention also comprises an apparatus for the production of filamentary materials by extruding a solution of a polymer, dissolved in a solvent, into a coagulating bath, comprising a first set of rollers driven at a first linear speed for withdrawing said filament from said coagulating bath, a hot stretch bath into which said withdrawn filament is passed, a second set of rollers driven at a second linear speed exceeding said first linear speed to impart an orientation stretch to said filament, a textile finish bath through which said stretched filament is passed by said second set of rollers to apply a textile finish to said filament, a first heated fluidized bed dryer containing a heat transfer medium through which said filament is withdrawn, means for admitting heated inert gas to said dryer to reduce the load thereon, means for extracting the solvent from said first dryer, a roller over which said filament is passed into a second heated fluidized bed dryer, said roller being driven at such a predetermined linear speed as to permit relaxation of said filament, means being provided for texturizing said filament.

In carrying the invention into effect by way of example, an acrylonitrile polymer is dissolved in a solvent as, for example, dimethyl-formamide using techniques well known to those skilled in the art to form a spinning solution or "dope." The accompanying drawing illustrates diagrammatically one form of apparatus suitable for carrying out the invention. The spinning solution or "dope" is extruded through a spinneret into a coagulating bath **1** containing a liquid coagulating medium whereby the "dope" is partially coagulated into filament form. The partially coagulated filament **2** is then withdrawn from the bath **1** by a first set of rolls designated A and the filament **2** is passed into a hot stretch bath **3** and withdrawn therefrom by a set of rolls designated B and driven at a greater peripheral speed than the set of rolls A whereby the filament has imparted thereto an orientation stretch. The filament is thereafter passed through a bath **4** by the second set of rollers B to apply a textile finish to the filament after treatment in the stretch bath **3**. The filament is then withdrawn through a heated fluidized bed dryer **5** employing small ceramic beads **5***a* as a heat transfer medium, the requisite heat being supplied mainly by electrical heaters (not shown) in direct contact with the ceramic beads **5***a*. In order to reduce the load on the fluidized bed dryer **5**, heated inert gas is admitted thereto, such gas being heated by an electrical heater **6**. Temperature is controlled by sensing the temperature of the filament upon exit from the fluidized bed dryer **5** and a second fluidized bed dryer hereinafter referred to. The solvent, carrying inert gas, is withdrawn from the dryer **5** by an extractor fan **7** and then blown onto a solvent extracting system designated generally by the reference numeral **8** whereby the solvent is condensed or scrubbed for recovery. The filament is then passed through a second fluidized bed dryer **9** similar to the dryer **5** and heated in the same manner, the roll **10**, over which the filament passes into the dryer **9**, being driven at such a peripheral speed as to permit 20–35 percent relaxation of the filament at a controlled level. Such relaxation imparts to the filament increased basic dyeability, better resistance to fibrillation, and improved elongation. After undergoing relaxation, the filament is passed through crimping rolls **11** whereby it is crimped.

It will readily be appreciated by those skilled in the art that the foregoing is given by way of example only and that modifications can be made to suit requirements. Thus, the invention can be employed subsequent to the wet spinning of polyamides where dimethyl sulphoxide is used as a solvent and modacrylics can be wet or dry spun using acetone as a solvent. Likewise, polyurethane-polyester filaments could be wet spun employing dimethylacetamide as a solvent. In general, any polymer that can be dissolved

in a solvent and spun into filaments by employing known coagulation steps can be subsequently treated in accordance with the invention with advantageous results.

After undergoing treatment by the fluidized bed dryers, the filament can be subjected to such other treatment as is appropriate to the form of the filament or the properties thereof that are desired. Thus, for example, the filament can be crimped or otherwise deformed by mechanical, thermal or chemical means or it can be texturized by any other known texturizing procedure. The filaments treated in accordance with the invention can be allowed to remain in continuous form or reduced to staple lengths.

The invention can be employed both for the removal of solvent or moisture from spun filaments and the continuous relaxation thereof in the manner hereinbefore described. Alternatively, either of these steps can be performed separately. Filaments produced and treated in accordance with the invention can be in continous single or multifilament form or in the form of tow for staple or tow processes. The invention is also applicable to the treatment of yarn or fabrics formed from synthetic fiilamentary materials.

The fluidized bed dryers employed in carrying out the invention can be of any shape to conveniently handle the filament in the form in which it is presented to the dryer. While the normal temperature of the dryers is 200–400° F., this will depend upon the composition of the filament and the contact time which normally would be from a few seconds to a few minutes.

The invention provides a process whereby fibre in tow, yarn, or continuous filament form can be dried and/or the solvent removed therefrom and/or the fibre relaxed to exhibit a more desirable appearance and physical structure and this is effected in a continuous operation which is not at present possible when dealing with some classes of fibre.

I claim:

1. In a process for the continuous production of dimensionally stable filaments formed by extruding a solution of a polymer into a coagulating zone to produce a partially coagulated filament, the steps comprising withdrawing the partially coagulated filaments from the coagulating zone at a first linear speed and passing the partially coagulated filaments into a hot water bath, continuously withdrawing said filaments from said hot water bath at a second linear speed greater than said first linear speed to impart an orientation stretch to said filaments, passing the stretched filaments through a heated fluidized zone to dry said stretched filaments and to extract water and solvent from said stretched filaments and thereafter passing the dried filaments through another heated fluidized zone and withdrawing said filaments from said other zone at a linear speed less than said second linear speed to effect relaxation of the dried filaments and thereafter texturizing said relaxed filaments.

2. The process of claim 1 wherein said filament is treated with a textile finish between the steps of stretching and drying.

3. The process of claim 2 wherein the extracted water and solvent are passed from said heated fluidized zone to a recovery zone.

References Cited

UNITED STATES PATENTS

3,088,793	5/1963	Knudsen et al.	264—210
3,113,827	12/1963	Moore.	
2,395,157	2/1946	Work et al.	
2,785,478	3/1957	Audas.	
2,901,312	8/1959	Audas.	
2,917,806	12/1959	Spence et al.	264—282 X
3,036,932	5/1962	Masarguppi et al.	
3,052,989	9/1962	Doleman.	
3,124,631	3/1964	Davis et al.	264—181
3,248,798	5/1966	Burgess.	
3,251,428	2/1966	Tabler.	

FOREIGN PATENTS

885,513	12/1961	Great Britain.
686,866	12/1953	Great Britain.

JAMES A. SEIDLECK, *Primary Examiner.*

J. H. WOO, *Assistant Examiner.*