April 14, 1959 W. N. SELLERS ET AL 2,881,474

SPINNING DEVICE

Filed Sept. 26, 1955 2 Sheets-Sheet 1

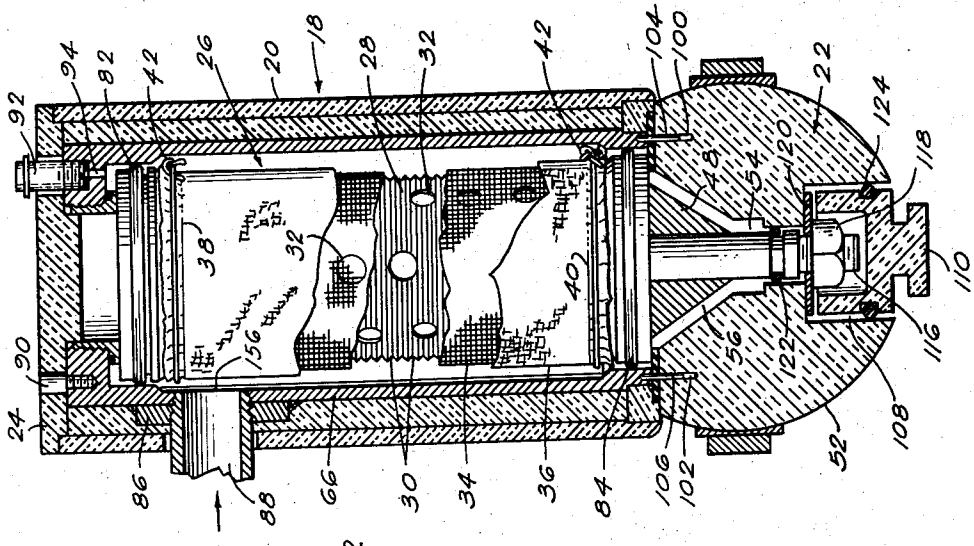


Fig. 2

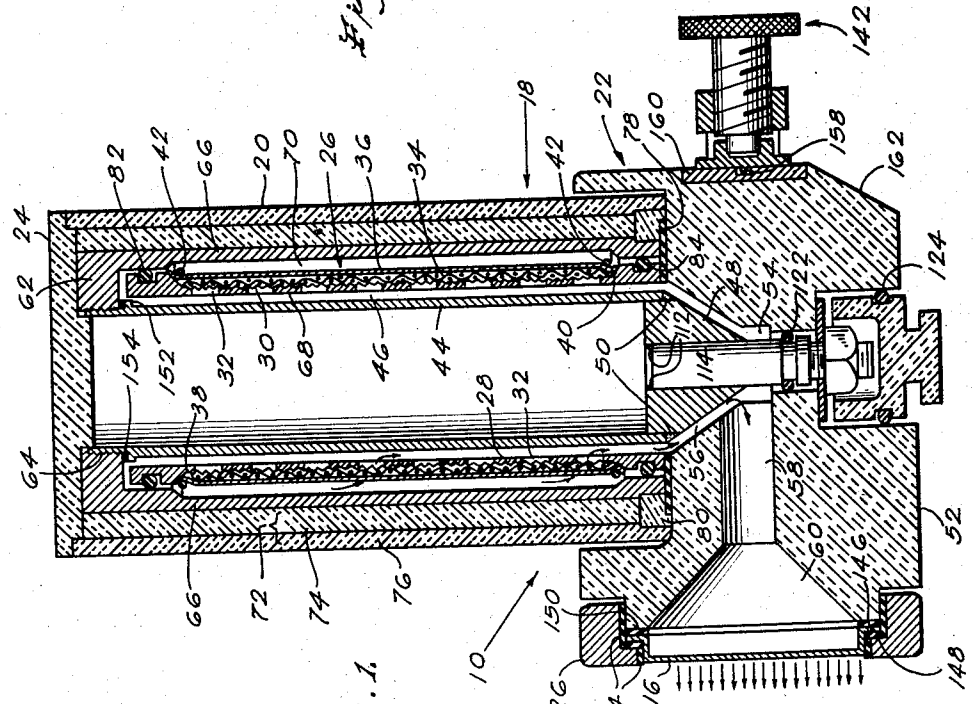


Fig. 1

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SPINNING DEVICE

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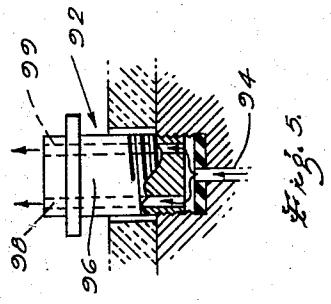


Fig. 5.

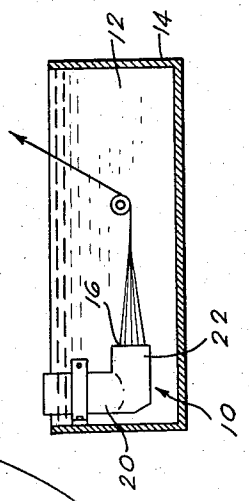


Fig. 6.

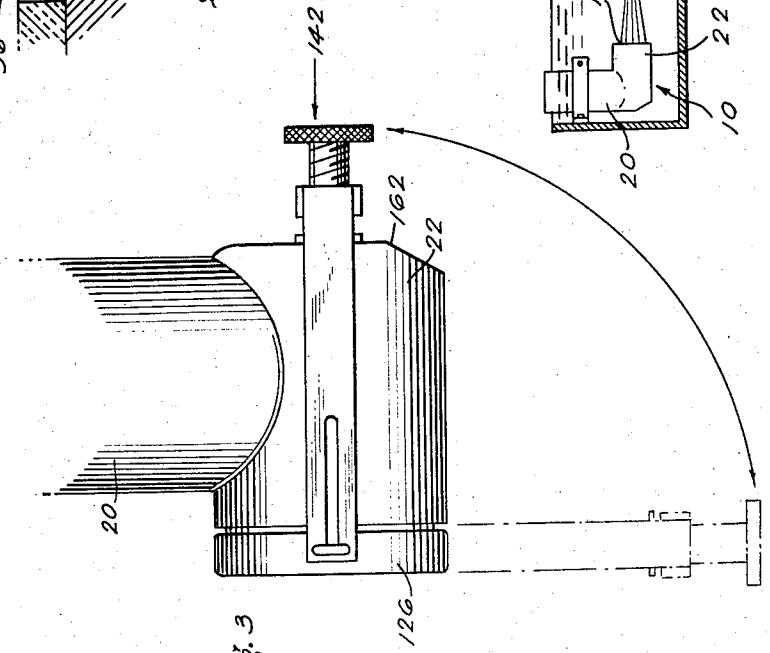


Fig. 4

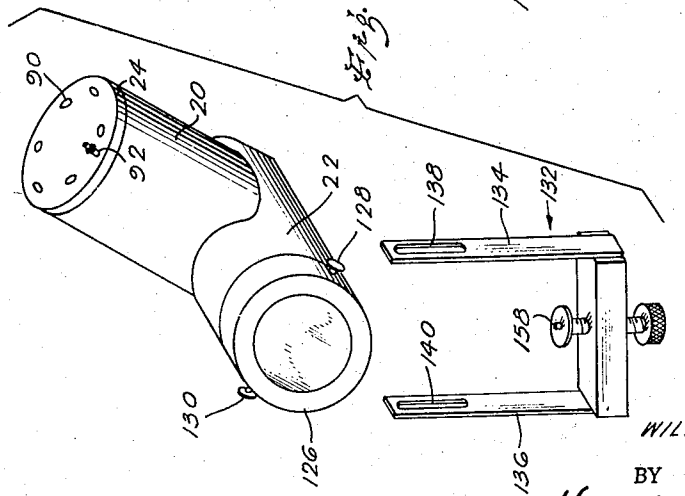


Fig. 3

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2,881,474

SPINNING DEVICE

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Application September 26, 1955, Serial No. 536,700

4 Claims. (Cl. 18—8)

This invention relates to a spinning device which is especially adapted for use in the production of artificial or synthetic filaments, and more particularly is concerned with a new and improved spinnerette head (and the combination thereof with a spinnerette) for use in the production of filaments from a viscous spinning solution, e.g., a viscous solution of an acrylonitrile polymerization product. Still more particularly, the invention is concerned with such a device which is adapted to be immersed in a liquid coagulating bath, for instance, a cold (e.g., −15° C. to +10° C.) aqueous coagulating bath such as is used in certain processes of producing filaments comprised of a polymer or copolymer of acrylonitrile.

In the production of artificial or synthetic filaments or fibers, a dope or solution of the coagulable material is extruded through a spinnerette containing a number of minute orifices into a coagulating chamber where the filamentary material is formed or coagulated either by evaporation of the volatile solvent in which the solid component has been dissolved (so-called "dry-spinning") or into a bath of liquid coagulant in the case of so-called "wet-spinning." The spinning solution is usually filtered prior to extrusion, and this is generally done by passing the solution through a separate filtering device, e.g., a candle filter, located either before or after the pump that pumps the solution to the extrusion or spinnerette head and from which the solution flows to the spinnerette.

In producing artificial filaments by the spinning of solutions of a fiber-forming material, it frequently happens that the solution at normal temperature, or when warmed only slightly, is so viscous that it cannot be extruded or spun satisfactorily because, for example, of low pullaway speed from the face of the spinnerette and resulting low production rate per spinning unit. To obviate this difficulty it was common practice prior to the present invention to use a spinnerette provided with means so arranged as to permit the circulation (either within or outside the spinnerette) of a liquid or gaseous fluid medium at a constant temperature, whereby both the spinnerette and the material being extruded therethrough also are at a constant temperature (see, for example, British Patent No. 293,416). Various types of spinnerettes and spinnerette assemblies that are adapted to be submerged in a liquid coagulating bath also were known prior to our invention. Illustrative of such types are those shown in U. S. Patent No. 2,370,765.

Additional problems arise in wet-spinning when the spinning solution itself is very viscous at normal temperature and hence has to be heated prior to extrusion, and when there is also employed a low-temperature coagulating bath which is maintained at a temperature considerably lower, e.g., 40° to 100° lower, than the temperature of the dope being extruded. Such a process is described in Cresswell U.S. Patent No. 2,558,730, dated July 3, 1951, and wherein solutions of homopolymeric acrylonitrile and of various copolymers of acrylonitrile are extruded at about 90° C. into an aqueous coagulating bath maintained at about 0° C.

The present invention is a different solution to the problems described briefly above, and provides other advantages that are not inherent in the prior art devices.

It is a primary object of the instant invention to provide a new and improved device for use in spinning viscous spinning solutions that is relatively simple and inexpensive to construct, that can be fabricated in part from materials having a relatively low thermal conductivity, that eliminates the need for a heated jacket or other heating means embodied in an extrusion head, and that requires less labor for cleaning and for changing the spinnerette and filter than prior devices of a similar nature.

It is a further object of the invention to provide a spinning device of the kind herein involved which will yield extruded filaments of improved uniformity and at a high production yield per spinnerette.

Another object of the invention is to provide a spinning device whereby spinnerettes can be rapidly changed merely by operation of one threaded member and which does not require the usual tools normally needed in order to change spinnerettes.

Still another object of the invention is to provide a spinning device which includes a built-in filter that has a high filtering capacity and which can be quickly and easily removed from the unit for inspection or replacement when necessary.

Another object of the invention is to provide a spinning device which operates efficiently in a cold aqueous coagulating bath; and by the use of which the spinning operation as a whole is improved and, in general, an overall improvement in the uniformity of multifilament yarns is obtained.

Other objects of the invention will be apparent to those skilled in the art from the accompanying drawing and the following description.

The foregoing objects and advantages are attained by constructing and using apparatus embodying our invention.

The novel features which are characteristic of our invention are set forth in the appended claims. The invention itself, however, will best be understood by reference to the following more detailed description when considered in connection with the accompanying drawing in which:

Fig. 1 is a side sectional view of apparatus embodying our invention and showing both the spinnerette and the spinnerette head;

Fig. 2 is a front view, partly in section, of the apparatus shown in Fig. 1 and with the filter unit partly broken away to show the various components thereof;

Fig. 3 is a perspective view of elements of the apparatus, showing the main body portion of the spinnerette head in a position preliminary to insertion in a clamping means used in assembling the apparatus prior to spinning;

Fig. 4 is another view of a portion of the apparatus shown in Fig. 3, and showing the clamping means in both operating (raised) and non-operating (lowered) positions;

Fig. 5 is a view, partly in section, of a portion of the apparatus shown in Fig. 4, and more particularly means for bleeding gas from the unit prior to spinning; and

Fig. 6 illustrates somewhat schematically the use of the apparatus in the wet-spinning of filamentary material.

Referring to the drawing, which is merely illustrative of a device embraced by our invention, it will be noted that the device there shown is a particular and a preferred form of a spinnerette assembly **10** which is especially adapted to be immersed in a liquid (more particularly cold liquid) coagulating bath **12** contained in the vessel **14** (Fig. 6). This assembly includes a spin-

nerette 16 and a spinnerette head 18 comprising an elongated body member 20 and a spinnerette holder 22. The body member 20 is provided at one end with a suitable cap 24, which is preferably a removable cap and which closes this end of the body member. At the other end of the elongated body member is the spinnerette holder 22, which is detachably mounted thereon and at an angle thereto, for instance, in the preferred embodiment, at an angle of 90° thereto as shown in the various figures.

A filter cartridge 26, which is preferably cylindrical in shape, is detachably mounted within the elongated body member 20. This filter cartridge advantageously may take the form shown in Fig. 2, although other types of filter cartridges or units obviously may be employed. The cartridge 26 is comprised of a filter core 28, the exterior surfaces of which are preferably provided with a series of annular or semi-annular recessions 30 extending along the main body of the core. These recessions may take the form of a plurality of annular or semi-annular grooves or of screw threads. The core 28 is further provided with a series of openings or vents 32 for the passage of spinning solution from the exterior to the interior of the core.

If desired, the recessions 30 may be depressed at spaced intervals to form at least one passageway and advantageously a plurality of passageways extending along the exterior surfaces of the main body of the core. Such passageways can be formed by notching the ribs of the recessions 30 at spaced intervals. In cases where the filter core is constructed with such passageways, the individual passageway should extend at one end at least to the point where an individual vent 32 appears. If desired, the number of such passageways may correspond to all or only some of the openings in the exterior surfaces of the core.

A screen 34 envelops the filtering area of the core 28 and forms a base or support for the porous filter medium 36, especially in the areas comprising the openings 32. This screen may be, for instance, 30 x 30 mesh wire cloth, and it may be held in place by any suitable means, e.g., by spot welding the seams to form a close-fitting sleeve about the core. During use of the device the screen 34 prevents portions of the filter medium 36 from being forced into the openings 32.

Any suitable filter medium may be employed, e.g., one formed of a wrap of cloth formed, for example, of nylon, followed by one or more wraps of more closely woven nylon or similar material, and finally by a sheath of a fabric such as Vinyon N which is shrunken over the other layers by immersion in hot water. The filter medium 36 is held in place upon the core 28 by any suitable means. For instance, the main body portion of the core may be provided with the upper annular groove 38 and the lower annular groove 40, and the filter medium then may be secured at each end around the said annular grooves by suitable tie means 42, e.g., a cord, string or the like.

A hollow insert 44 (Fig. 1), preferably cylindrical in shape and with a metal wall, fits within the cartridge 26, closely adjacent to (but spaced a short distance from) the inner surface of the core 28, thereby forming a narrow passageway 46 (Fig. 1) for conducting filtered spinning solution when the device is in use. More particularly, the passageway 46 provides for downward flow of the spinning solution which has passed through the filter medium 36 and thence through the openings 32.

The insert 44 fills the void within the filter cartridge 26 and reduces to a minimum the amount of hot, filtered spinning solution which otherwise would be held within the cartridge and subjected to heat loss prior to extrusion, especially when the assembly is immersed in a cold, aqueous coagulating bath.

The insert 44 is provided at its lower end with the extension 48. This extension, like the insert 44, is preferably formed of metal, e.g., stainless steel, and is in the shape of a truncated cone. The extension 48 is welded or otherwise fixedly united to the bottom of the insert 44 as shown at 50 (Fig. 1).

The main body portion 52 of the spinnerette holder 22 is provided with the recess 54 which slopes upwardly and outwardly as shown, so as to form a side wall that matches the contour of the extension 48. This extension fits into the recess 54 thereby to provide the passageway 56 as a continuation of the passageway 46. The passageway 56 joins with the conduit 58, which is drilled or otherwise formed in the main body portion 52 and which widens as shown at 60 until it has approximately the same diameter as the spinnerette 16 which is fitted therein.

The hollow insert 44 is externally threaded at its upper end where it is united to the internally threaded member 62 to form the union 64. To this insert a shoulder 152 is welded or otherwise attached, upon which is positioned a gasket 154 formed, for example, of neoprene, compressed asbestos, etc. If desired, a flanged joint or union may be formed between the insert 44 and the member 62.

The threaded member 62 has a side wall which extends downwardly to form the inner casing 66 and which, with the wall 68 (Fig. 1), forms the passageway 70 for conducting spinning solution to the filter cartridge 26. For purpose of simplicity in illustrating the device, the wall 68 is shown in Fig. 1 as a single layer or member although in actuality it comprises, when in use and as shown in Fig. 2, a filter core 28 having thereon a screen 34 and a porous filter medium 36.

The inner casing 66 is surrounded by an outer casing 72 formed of a material having a low heat-transfer coefficient, that is to say, a thermal insulating material. This outer casing advantageously may comprise an inner layer 74 of low-density insulating material, e.g., foamed polyester resin, phenol-formaldehyde, urea-formaldehyde resin or the like; and an outer layer 76 formed of relatively strong and rigid material having a low heat-transfer coefficient, for example, nylon, unplasticized polyvinyl chloride, laminates of fiber glass and a phenolic resin or a polyester resin, etc.

Elongated body member 20 is provided at its lower end with a gasket 78 formed, for example, of neoprene or other resilient material and with a ring 80 of suitable material having a low heat-transfer coefficient such as nylon. This ring adds strength to the structure where otherwise the weaker inner layer 74 of foamed insulation would be present.

The O-rings 82 and 84 at the upper and lower portions of the filter cartridge 26 aid in sealing the internal portions of the spinnerette assembly from the entrance of liquid coagulant when the assembly is immersed in a liquid coagulating bath during use, and also against leakage of the filtered and unfiltered solution (O-ring 82).

The internally threaded member 86 (Fig. 2) is welded or otherwise suitably attached to the inner casing 66, at the upper portion of the elongated body member, and into this internally threaded member is screwed the externally threaded conduit 88 through which the spinning solution is charged to the device through an opening 156 in the inner casing 66 from a supply source (not shown).

The cap 24 fits upon the elongated body member 20 as shown in Figs. 1, 2 and 3. This cap is preferably formed of a material having a low heat-transfer coefficient such as nylon or similar material of which the outer layer 76 is composed. Suitable holes may be drilled therein and in the member 62 and the cap attached to the elongated body member as shown at 90 in Figs. 2 and 3.

To facilitate the release of gas such as air from the assembly and/or the spinning solution prior to use of the apparatus, the device is advantageously provided with the member 92 (Figs. 2 and 5), which functions both as means for releasing gas when partly opened or as a drain plug that can be removed completely when the device is not in use so that liquid can be readily drained from

the device when desired or required. As shown more clearly in Fig. 5, any gas that may be present in the unit passes to the member **92** through the conduit **94**. The externally threaded cap or plug **96** has two small openings **98** and **99** therein and through which gas can escape to the exterior. The member **92** functions somewhat in the nature of a valve when it is used to bleed off gas.

The main body portion **52** of the spinnerette holder preferably is formed of a suitable strong, rigid material having a low heat-transfer coefficient, e. g., nylon. Recesses **100** and **102** are drilled therein where indicated, and into which fit the aligning pins **104** and **106**. These pins aid in rapidly aligning the elongated body member **20** with the main body portion **52** of the spinnerette holder when it is desired to unite the two parts to form the spinnerette assembly.

The body portion **52** is provided with the recess **108** and which is closed, when the device is to be used, by the plug **110**. This plug likewise is formed of a suitable strong, solid material having a low heat-transfer coefficient, e.g., nylon.

The hollow insert **44** (Fig. 1) has welded thereto, as shown at **112** (Fig. 1), an attachment **114** formed, e.g., of stainless steel or other suitable material and which terminates in the threaded portion **116**. The nut **118** fits on the threaded portion **116**. A washer **120** is interposed between the nut **118** and the bottom of the recess **108**. Upon tightening the nut **118** the elongated body member **20** and the spinnerette holder **22** are rigidly held together. Similarly, by merely removing the nut **118** the two parts can be readily disassembled.

The O-rings **122** and **124** aid in sealing the main body portion **52** of the spinnerette holder from the entrance of liquid coagulant when the device is immersed in a liquid coagulating bath during use and, also (O-ring **122**), against leakage of spinning solution.

The forward end of the main body portion **52** of the spinnerette holder is provided with the detachable annular ring **126** and to which are attached two bosses **128** and **130** on opposite sides thereof. A yoke **132** has arms **134** and **136**, each of which is slotted as shown at **138** and **140**. The bosses **128** and **130** can be fitted into the slots **138** and **140** as indicated in Fig. 3. The annular ring **126** is then held tightly in position by bringing the yoke **132** into its normal operating position and tightening the screw **142**, whereby a clamping action is effected. The screw **142** has a guide or aligning extension **158** that fits into a corresponding recess in the metal plate **160**, which is embedded in the rear end of the main body portion **52**. The latter is cut off as shown at **162** so that the yoke **132** can be readily swung downwardly from an operating to a non-operating position.

The detachable annular ring **126** is advantageously comprised of a suitable metal, e.g., stainless steel. Referring particularly to Fig. 1, which shows a spinnerette **16** in position in its holder **22**, it will be noted that the inner sides thereof are provided with a different material, advantageously a resilient material **144**, e.g., neoprene, which is suitably bonded to the stainless steel base. The lip **146** of the spinnerette is positioned between a ring **148**, which is formed of a suitable material such as nylon, and a gasket **150** formed, for instance, of neoprene.

The described means of holding the spinnerette in the spinnerette holder and clamping it in position has several important advantages over the prior art means. Specifically, it avoids a twisting action on the gaskets between which the spinerette lip is interposed and the imperfect seal that, as a consequence of such twisting, frequently results when screw means are involved in tightening the spinnerette in position in its holder. Other prior means of fastening a spinnerette in its holder required the tightening of several nuts on corresponding bolts which was time-consuming and did not always give a perfect seal. The foregoing disadvantages are avoided by the device of the present invention.

The device of the instant invention is especially suitable for use, although obviously not limited thereto, in combination with other elements of wet-spinning apparatus of the kind disclosed and claimed in Sonnino copending application Serial No. 536,479, now Patent No. 2,849,751, filed concurrently herewith. In Fig. 6 the device of this invention is shown for purpose of illustration as being clamped in position in a coagulating bath **12**. In a preferred use of the device, the conduit **88** is attached to a hollow trunnion (not shown). Then, when it is desired to move the device from a point within the bath to a point outside the bath or vice versa, this is done by merely swinging it about the axis of the trunnion. In this way the device can be readily drained of liquid through the passageway **58**, the widened portion thereof **60** and member **92**, or can be readily inspected or serviced. The device may be provided with additional drain plugs as desired or as may be required.

To remove the filter cartridge **26** from the device for inspection or replacement of the filter medium **36**, this can be done by separating the spinnerette holder **22** from the elongated body member **20** as previously described, and which involves the removal of only one nut, namely, nut **118**. The cartridge is then removed by use of a simple tool with hooks that engage, from the inside, openings **32** of the filter core **28** and pulling downwardly.

The device of the present invention fulfills the objects of the invention as set forth previously herein. It reduces operating and maintenance labor and provides greater uniformity in extrusion temperature and, consequently, better uniformity of product. It also provides greater resistance to corrosion than the prior art devices, which are generally comprised mainly of metal throughout; and reduces refrigerating and heating requirements, when the preferred embodiment is employed in the aforementioned Cresswell process, by reducing thermal leakage to a minimum.

We claim:

1. A spinnerette assembly comprising an elongated, cylindrical body member having an outer casing formed of a thermal insulating material; a removable cap closing one end of said body member; a cylindrical filter cartridge detachably mounted lengthwise within said elongated body member; walls defining an outer passageway adjacent to, and running lengthwise of, said cartridge and being so positioned that the passageway formed thereby can conduct unfiltered spinning solution to said cartridge; an inlet conduit leading to said passageway; a hollow, cylindrical, metallic insert fitting within said cartridge and spaced a short distance therefrom so as to form a narrow passageway therebetween, the walls defining said passageway being so positioned that the passageway can receive and carry away from the filter cartridge spinning solution that has been filtered during its passage from the outside to the inside of said cartridge; a spinnerette holder with a forward end and a main body portion, said holder being detachably mounted at the other end of said elongated body member, the forward end of said holder forming an angle of about 90° with the said body member, said holder including a detachable annular ring having two bosses on opposite sides thereof, and the main body portion of said holder being formed of a thermal insulating material; a spinnerette having a lip, said spinnerette being mounted in an operating position in said spinnerette holder and with the lip of the spinnerette interposed between the facing surfaces of the said ring and of the main body portion of the said holder; clamping means including a yoke having slotted arms into which said bosses can be fitted and whereby the said annular ring can be tightened so as to hold the said spinnerette in position; walls defining a passageway within said spinnerette holder for conducting filtered spinning solution to said spinnerette; and means for sealing the internal parts of said spinnerette assembly against the inflow of liquid coagulant when the said assembly is

immersed in a liquid coagulant during use in a wet-spinning process.

2. A spinnerette head comprising an elongated body member having an outer casing formed of a thermal insulating material; a cap closing one end of said body member; a filter cartridge detachably mounted lengthwise within said elongated body member; walls defining an outer passageway adjacent to, and running lengthwise of, said cartridge and being so positioned that the passageway formed thereby can conduct unfiltered spinning solution to said cartridge; an inlet conduit leading to said passageway; a hollow insert fitting within said cartridge and spaced a short distance therefrom so as to form a narrow passageway therebetween, the walls defining said passageway being so positioned that the passageway can receive and carry away from the filter cartridge spinning solution that has been filtered during its passage from the outside to the inside of said cartridge; a spinnerette holder with a forward end and a main body portion formed of a thermal insulating material, said holder being detachably mounted at the other end of said elongated body member, the forward end of said holder forming an angle of about 90° with the said body member, said holder including a detachable annular ring having two bosses on opposite sides thereof whereby a spinnerette having a lip can be mounted in an operating position in said spinnerette holder and with the lip of the spinnerette interposed between the facing surfaces of the said ring and of the main body portion of the said holder; clamping means including a yoke having slotted arms into which said bosses can be fitted and whereby the said annular ring can be tightened so as to hold the said spinnerette in position; and walls defining a passageway within said spinnerette holder for conducting filtered spinning solution to said spinnerette.

3. A spinnerette head as in claim 2 wherein the filter cartridge is cylindrical in shape.

4. A spinnerette head as in claim 2 wherein both the filter cartridge and the hollow insert are cylindrical in shape.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,881,474 April 14, 1959

William Noble Sellers et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 66, for "100°" read -- 100° C. --; column 2, line 56, for the syllable "ping" read -- ning --; column 4, line 25, beginning with "For" strike out all to and including "filter medium 36." in line 30, same column.

Signed and sealed this 28th day of July 1959.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents