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FLUID TREATING APPARATUS FOR STRANDS

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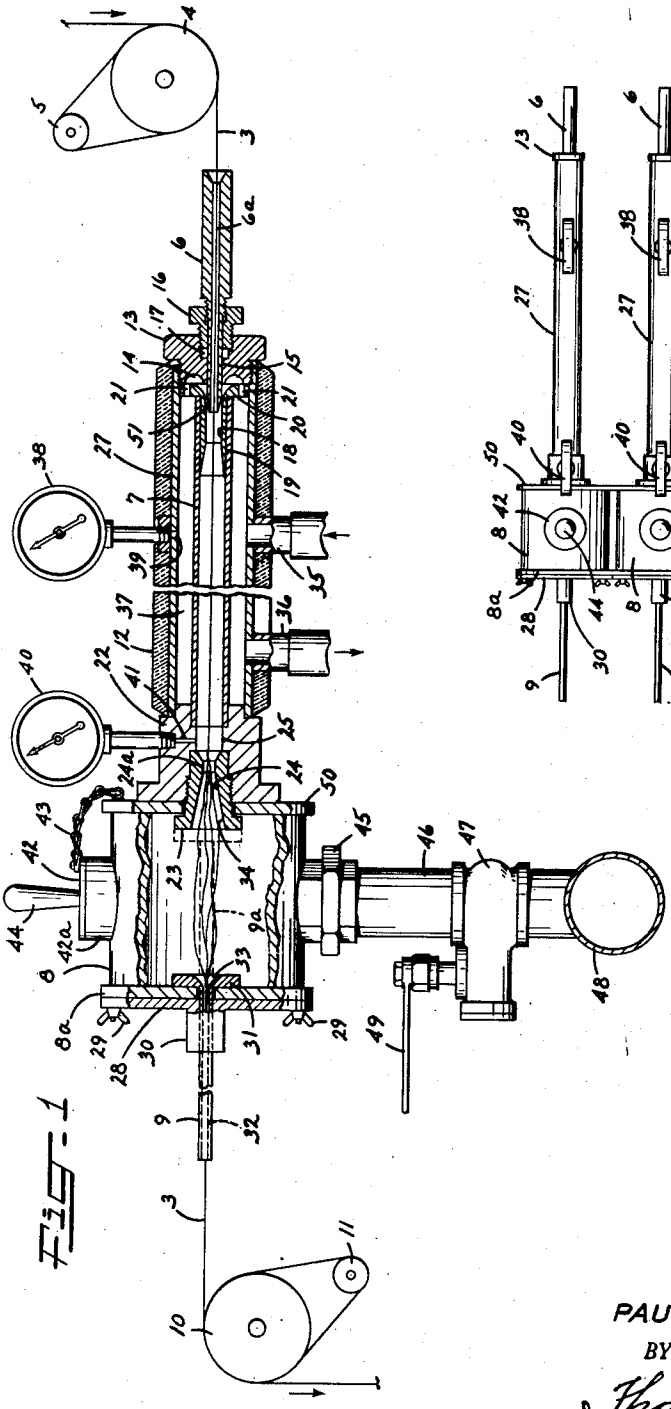

FIG - 1

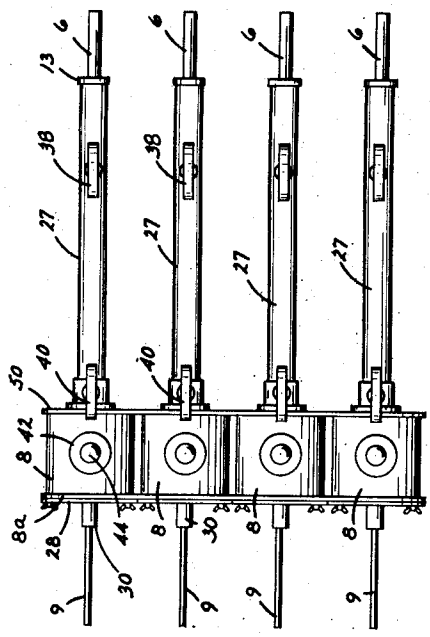

FIG - 2

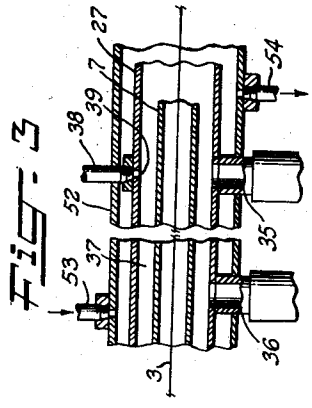

FIG - 3

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FLUID TREATING APPARATUS FOR STRANDS

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16 Claims. (Cl. 68—5)

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This invention relates to an improved apparatus for the treatment of strands and like materials. More particularly, the invention relates to a new and improved apparatus for treating natural, synthetic, or artificial yarns and monofilaments with fluid media in liquid or vapor condition in a substantially closed chamber during their travel from one point to another. Further, the invention is concerned with utilizing fluid media for applying heat to filamentary material, or for applying heat while simultaneously softening the textile material by virtue of a swelling or solvent action of the vapors thereupon. The invention is further adapted to plasticizing or softening textile materials, especially when in the form of yarn-like bundles, when it is desired to shrink or stretch, or otherwise treat, such materials in softened condition.

"Strand," as used throughout this specification and the appended claims, is intended to include all types of strands, threads, yarns, filaments, fibers, fibrous bundles, bundles of filaments or filamentary material, ribbons, bands, extruded wire, rods and the like, etc.

The present invention is applicable to the treatment of strands made from various types of materials, such as cotton, wool, flax, hemp, etc., regenerated cellulose, such as that produced from viscose, cuprammonium cellulose, and the like, cellulose ethers and esters, such as methyl cellulose, hydroxyethyl cellulose, ethyl cellulose, etc., cellulose nitrate, cellulose acetate, cellulose propionate, cellulose butyrate, mixed cellulose ethers and esters, vinyl resins, such as polyacrylonitrile, copolymers of acrylonitrile, polyethylene, polyvinyl chloride, copolymers of vinyl chloride with vinyl acetate or acrylonitrile, after chlorinated vinyl polymers and copolymers, vinylidene polymers, such as polyvinylidene chloride, etc., and condensation polymers, such as polyamides and polyesters, and the like, etc.

The known apparatus for the treatment of strands with fluids in liquid or vapor condition during their travel from one point to another comprise a substantially closed chamber, into which the strands pass through orifices which have dimensions only slightly greater than those of the cross-sections of the strands in order to reduce loss of treating fluid as far as possible. For example, it is customary to treat synthetic or artificial strands with steam for the purpose of altering their properties such as by stretching the strands in an atmosphere of steam under pressure or by permitting the strands to shrink during the steam treatment.

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Various and sundry types of apparatus have been devised for treating strands with a fluid medium, both in a liquid and vapor condition. Each of the apparatuses has been designed with a specific purpose in mind, however, and the ultimate overall apparatus, suitable for all kinds of operations, has not as yet been attained. In the construction of strand-treating apparatus there are various problems which must be solved and overcome. For example, the threading of such apparatus presents quite a problem because it is necessary, each time that a fresh batch of materials or strands is to be treated, to open up the apparatus sufficiently to make it possible to thread or lace the materials through the orifices therein by hand. This involves loss of treatment fluid and also loss of heat when the operation is conducted at a superatmospheric temperature, particularly if it is necessary to allow the apparatus to cool before it can be handled. Therefore, the apparatus must be so constructed that it can be easily and readily threaded when necessary.

The threading of the apparatus is made more difficult by the fact that it is necessary that the strand entrance and exit orifices must be as small as possible in order to prevent the escape of treating fluid, such as steam, and the like, from the treating chamber. The escape of treating fluid is undesirable in that it has an adverse effect on the strands being treated. That is, there is a pressure drop across the orifices or openings and treating fluid, such as steam, escaping therethrough exerts a frictional effect on the strands passing through the orifices which sets up an irregular and uncontrolled tension in the strands, in addition to the tension exerted by any mechanical stretching devices. Therefore, it is desirable that the size of the orifices be kept as small as possible while at the same time being so constructed that the apparatus may be readily and easily threaded.

Further, when treating a strand which comprises a plurality of filaments or fibers, such as a tow, and the like, in a heating fluid under tension, there is a tendency for the strands to adhere or stick to one another, particularly when the fibers and filaments are formed from materials such as copolymers of acrylonitrile and the like. In such cases the fibers and filaments must be separated or prevented from adhering to one another and this must be done in such a manner so as not to detrimentally affect the size of the entrance and exit orifices and also so as not to affect the threading of the apparatus.

It is a primary object of the present invention to provide a new and improved apparatus for the continuous treatment of strands with a fluid material, in either liquid or vapor condition, which overcomes the hereinbefore mentioned difficulties and disadvantages and is designed so as to incorporate all of the desired features hereinabove pointed out.

It is another object of the invention to provide a strand-treating apparatus which is easily threaded, and produces strands in loose and separated condition when a plurality thereof are being treated, and in addition, is readily adjustable as to pressure within the treating chamber.

Other objects and advantages of the present invention will be apparent from the discription thereof hereinafter.

In general, the objects of the present invention are accomplished by passing a strand to be treated continuously through a chamber while at the same time passing a fluid medium, such as steam or super-heated steam, through the chamber in the same direction as the travel of the strand. The strand enters the chamber through an adjustably mounted nozzle, the opening in which is only slightly larger than the strand passing therethrough. An opening which is one to three times the diameter of the strand passing therethrough in size is satisfactory. The strand after passing through the nozzle enters a larger chamber or tube while at the same time steam or other fluid is injected into the chamber at the point of entrance of the strand therein. Upon leaving the chamber, the strand passes through an expansion nozzle, which has a Venturi opening therein, and into an enlarged chamber or muffler and then into an elongated tube, the opening in which is only slightly largerly than the strand passing therethrough, for example, a capillary tube, which tube serves as the exit orifice and is slidably mounted in one face or wall of the muffler in perfect alignment with the over-expanded nozzle. Here again, an opening one to three times the diameter of the strand is satisfactory.

In the muffler or expansion chamber the steam or other fluid medium reaches a turbulent state by reason of passing through the funnel-shaped portion of the expansion nozzle at the entrance thereto. The steam and the like passes through the constricted portion of the Venturi opening in the expansion nozzle and enters the funnel shaped portion thereof with a rush causing the turbulence which in turn causes the adhering strands to separate prior to passing out of the apparatus through the exit orifice. It is to be understood, of course, that the size of the strand entrance nozzle and the slidably mounted tube in the wall of the muffler which acts as an exit orifice are dependent upon the size of the strand being treated.

Since the present invention is applicable to numerous and different types of strand-treating apparatus, for simplicity the invention will be described in detail as the same is employed in connection with a strand-stretching device or tube, it being understood that the preferred embodiment shown in the accompanying drawing is merely intended to be illustrative and the invention is not to be limited thereby, but only in accordance with the scope of the appended claims.

In the drawing,

Figure 1 is a side elevation view, partly in section of a single preferred strand-treating tube,

Figure 2 is a diagrammatic plan view of an arrangement of a plurality of the strand treating tubes, such as shown in Figure 1, and

Figure 3 is a sectional side elevation view of a portion of the preferred strand-treating tube showing another embodiment of the invention.

Referring to all figures of the drawing a strand 3 passes around a godet 4 and an associated lap-displacing guide 5, through a nozzle 6, a fluid treating chamber or tube 7, which is positioned in and extends through the fluid chamber or tube 27, through an expansion chamber or muffler 8, and through an elongated tube or capillary 9, and then about another godet or wheel 10 and its associated lap-displacing guide 11 and then to the point of ultimate use, etc. The tube 27 may be made of porcelain, iron, steel, copper, and the like, but is preferably made of a metal which is resistant to the particular fluid being employed therein. The tube or chamber 27 may be wrapped or lagged with a suitable insulating material 12, such as asbestos, rock wool, cork, or the like. If desired, the tube 27 may be jacketed and a heat-exchanging liquid or gas, such as hot or cold water, steam, etc., passed therethrough (see Figure 3). The godet 10 may travel at the same, slower, or faster speed than godet 4, depending on whether shrinkage, stretching, or neither is desired.

Referring to the embodiment shown in Figure 3, the tube 27 is enclosed by a jacket 52. Attached to the jacket 52 is an inlet conduit 53 and an outlet conduit 54 for passing the heat-exchanging liquid or gas through the jacket. If desired, the direction of flow of the heat-exchanging liquid or gas through the jacket may be reversed, in which case inlet conduit 53 will become an outlet conduit and outlet conduit 54 will become an inlet conduit.

Threaded on to the strand-entrance end of tube 27 is a cap or closure 13 which has an annular groove 14 on the inner face thereof and has an opening 15 through the center thereof. Threaded on to the cap 13 is a packing gland 16 which abuts against the packing 17 which is positioned about the opening 15. Threadedly mounted in the packing gland is the nozzle 6 which extends through the opening 15 of the cap 13 making a sliding fit therewith. The nozzle 6 extends into the Venturi opening 18 in the member 19, which is positioned in the tube 7 and abuts against the cap 13. The flanged portion 20 of the member 19 has a series of openings 21 therein arranged in a circle and communicating with the annular groove 14 in the cap 13.

On the other end of tube 27 there is a fitting 22 rigidly attached to the tube. Threadedly mounted in the fitting 22 is an expansion nozzle 23, the Venturi opening 24 in which communicates with the opening 25 in the fitting 22 which in turn communicates with the tube 7 mounted in fitting 22 and extending through the interior of tube 27 and being connected at its other end to the member 19. The expansion nozzle 23 extends into and communicates with the expansion chamber or muffler 8. Mounted on one wall of the muffler 8 and fastened thereto by means of wingnuts 29 is a plate 28, which has a bearing 30 extending outwardly from the center thereof. Slidably mounted in the bearing 30 is an elongated tube or capillary 9 on one end of which is an enlarged portion 31 which, when the tube is in normal operating position, abuts against the inner wall 8a of the muffler 8, as shown in Figure 1. The opening or capillary 32

in the tube 9 fans out into the funnel shaped entrance opening 33 in the enlarged portion or flange 31. This opening 33 is of the same size and in perfect alignment with the funnel-shaped portion 34 of Venturi opening 24. Thus at the start of operation, or at any other time thereafter when it is necessary to thread the apparatus, the tube 9 is moved to the right, as viewed in Figure 1, until the portion 31 abuts against the expansion nozzle 23. This is shown by the dotted line position 9a of the tube in Figure 1. There is thus presented one continuous passage throughout the apparatus, namely through the opening 6a in nozzle 6, through the member 19, tube 7, fitting 22, expansion nozzle 23, and tube 9. The apparatus is threaded by placing a vacuum line on the tube 9 when it is in the dotted-line position 9a and then drawing the strand through the apparatus.

Attached to the lower portion of the fluid chamber or tube 27 is a conduit 35 which acts as a fluid or steam inlet. A second conduit 36 also positioned at the bottom of tube 27 serves as a fluid or condensate outlet. Threadedly mounted in the top of tube 27 is a pressure gauge 38 which communicates by means of opening 39 with the outer fluid chamber 37. Threadedly mounted in the fitting 22 is a pressure gauge 40 which communicates by means of opening 41 with the opening 25 in the fitting or block 22. That is to say gauge 38 measures the fluid chamber pressure and gauge 40 measures strand-treating tube pressure.

Mounted in the top of the muffler 8 is a plug 42 which rests or is otherwise fastened in the upwardly extending conduit portion 42a of muffler 8 and which when removed, presents an opening by means of which the interior of muffler 8 may be cleaned when desired or necessary. A holding chain 43 is connected at one end to the muffler 8 and at the other end to the plug 42. For convenience of removal a handle 44 is fastened to the plug 42.

To the lower face of the muffler 8 there is connected, by means of a pipe coupling 45, a conduit 46 which has a quick-opening gate valve 47 positioned therein. The conduit 46 is connected at its other end to the pipe 48 which serves as an exhaust header. The purpose of conduit 46 is to carry the exhaust steam or other treating fluid from the muffler or expansion chamber 8 back to the source of supply, to waste, to the atmosphere, or to a recovery system, as desired. The valve 47 is actuated by means of the removably mounted wrench-like handle 49.

In the embodiment shown in Figure 2 a plurality of yarn or strand-treating tubes are arranged side by side and are fastened together by means of the plate 50 which acts as a wall for each of the mufflers 8. Each of the strand-treating tubes shown therein is identical in construction to the tube shown in Figure 1. It is to be understood of course, that only one steam exhaust header, such as that shown at 48 in Figure 1, need be employed in the embodiment in Figure 2.

Referring again to Figure 1, the steam or other fluid enters the fluid chamber 37 through conduit 35 and passes through the openings 21 into the annular groove 14 and then into the tube 7 through the Venturi opening 18. The leading tapered end 51 of nozzle 6 extends into the Venturi opening 18 and the steam entering the tube 7 passes over and in contact with the tapered portion 51. By screwing the nozzle 6 in-

wardly or outwardly in the packing gland 16 the size of the opening between the member 19 and the tapered portion 51 of nozzle 6 may be adjusted so as to allow more or less steam or other fluid to enter the interior of tube 7. The nozzle 6 will turn freely in the packing, and loosening of the packing gland 16 is not essential. The packing 17 exerts sufficient friction to hold nozzle 6 in the desired position. If desired, however, when adjusting nozzle 6, the packing gland 16 may be loosened prior to screwing or unscrewing nozzle 6 and then retightened. This is an important feature of the present invention since by means of the adjustable nozzle 6 the pressure in the tube 7 may be regulated. It is also significant to note that by arranging the openings 21 in a circle about the tube 7 the steam is directed into the tube 7 completely and uniformly surrounding the strand passing therethrough. Due to the construction of the orifice for the passage of steam into tube 7, the steam is prevented from passing out through the opening 6a in nozzle 6 thereby eliminating any danger of damage to the strand which would result therefrom.

The strand and the steam pass through the tube 7 and thence through the constricted portion 24a of the expansion nozzle 23 and then into the muffler or expansion chamber 8. As the steam passes into the muffler 8 it creates quite a turbulence therein and especially in opening 34, which causes the strands or filaments passing therethrough to separate. This is particularly advantageous when treating a strand such as a tow. The force of the steam entering the muffler 8 forces the enlarged portion 31 of tube 9 against the wall 8a of the muffler 8 thus holding it in operative position. The exhaust steam then passes out of the apparatus through the conduit 46.

By having the steam enter the tube 7 completely surrounding the strand there is a parallel flow of the steam and strand through the apparatus thus alleviating any danger of the strand rubbing the interior walls of the tube 7 and becoming damaged thereby. If desired, the tube 7 may have a capillary bore therein of equal diameter to the bore in the nozzle 6 and the slidable tube 9. This is possible since the apparatus is arranged to be easily and readily threaded irrespective of the size of the opening in the tube. By employing an expansion chamber or muffler adjacent the exit orifice of the apparatus the objectionable escape of steam or other fluid treating material through the exit orifice is alleviated.

While steam has been specifically referred to in describing the apparatus, it is to be understood that the invention contemplates the use of other vapors, for example, acetone or acetone-acid and acetone-steam mixtures, air, formaldehyde, chlorine, and other toxic, corrosive, or obnoxious gases, etc., and various liquids, such as water, alkalies, acids, organic or inorganic solvents, and solutions of solids and gases in liquids.

By means of the present invention, threading of the strand treating tubes or chambers is greatly facilitated without opening the chamber and without increasing the size of the strand inlet and exit orifices. In addition it is possible by means of the present apparatus to easily regulate the pressure of the steam and other fluid in the tube while the the same time reducing to a minimum the loss of steam or other fluid from the apparatus through the inlet and exit orifices. Further, strands which have a tendency to stick

together when stretched and heated leave the apparatus in separated condition and all danger of sticking together is alleviated by means of the present invention.

The present invention embodies a new and unique combination of beneficial and novel features not heretofore presented in the strand-treating apparatus art. The device is simple in construction and may be produced at a minimum of cost. The present apparatus closely approximates the ultimate desired in strand treating apparatus. Numerous other advantages of the present invention will be apparent to those skilled in the art.

It is to be understood that the drawing and description are merely intended to be illustrative and that changes and variations may be made therein without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. An apparatus for treating continuously moving strands with fluid comprising an elongated cylindrical straight tube, means for continuously passing a strand through the tube, a fluid chamber surrounding the tube, a cap mounted on one end of the tube and chamber, said cap having an annular groove on the inner face thereof, said tube opening into the annular groove, a nozzle threadedly mounted in the cap and extending into the tube opening, a strand entrance orifice in the nozzle, said nozzle being movable toward and away from the tube, a fluid-expansion chamber connected to the other end of the tube, a Venturi tube positioned in alignment with the tube and extending into the expansion chamber, said fluid expansion chamber having a member slidably mounted in an opening in the end-wall thereof, said member comprising a flange-like portion inside the expansion chamber abutting against the end-wall thereof in normal operating position and an elongated portion extending outwardly through the opening in the end-wall of the expansion chamber, said flange-like portion and elongated portion having openings therein for the passage of the strand therethrough, the opening in the flange-like portion flaring out in a direction toward the Venturi tube, said member being movable toward and away from the Venturi tube, conduit means connected to the expansion chamber for removing fluid therefrom, conduit means for supplying fluid to the fluid chamber, and means adjacent the strand-entrance orifice for directing the fluid from the fluid chamber to the elongated tube through the annular groove on the inner face of the cap.

2. An apparatus as defined in claim 1 wherein the opening in the elongated portion of the member is a capillary which is in alignment with the opening in the flange-like portion of the member.

3. An apparatus as defined in claim 2 wherein the axes of the strand entrance orifice, the opening in the elongated cylindrical straight tube, the opening in the Venturi tube, and the openings in the member are coincident.

4. An apparatus as defined in claim 15 wherein there are conduit means connected to the expansion chamber for removing fluid therefrom.

5. An apparatus as defined in claim 15 wherein the strand-treating chamber comprises an elongated cylindrical straight tube.

6. An apparatus as defined in claim 15 wherein the opening in the slidable member is in alignment with the opening in the strand-treating chamber, and wherein the strand-treating chamber comprises an elongated cylindrical straight tube, and wherein there are conduit means connected to the expansion chamber for removing fluid therefrom.

7. An apparatus as defined in claim 16 wherein there are conduit means connected to the expansion chamber for removing fluid therefrom.

8. An apparatus as defined in claim 16 wherein the strand-treating chamber comprises an elongated cylindrical straight tube.

9. An apparatus as defined in claim 16 wherein the axes of the strand-entrance orifice, the opening in the elongated treating chamber, the opening in the Venturi tube, and the opening in the slidable member are coincident.

10. An apparatus as defined in claim 16 wherein the slidable member comprises a flange-like portion inside the expansion chamber abutting against the end-wall thereof in normal operating position and an elongated portion extending outwardly through the opening in the end-wall of the expansion chamber, said capillary opening in the slidable member flaring out in a direction toward the Venturi tube.

11. An apparatus as defined in claim 10 wherein the strand-treating chamber comprises an elongated cylindrical straight tube and wherein there are conduit means connected to the expansion chamber for removing fluid therefrom.

12. An apparatus as defined in claim 11 wherein the axes of the strand-entrance orifice, the opening in the treating tube, the opening in the Venturi tube, and the opening in the slidable member are coincident.

13. An apparatus as defined in claim 16 wherein the entrance to the strand-treating chamber comprises a Venturi throat.

14. An apparatus for treating continuously moving strands with fluids comprising, an elongated strand-treating chamber, a fluid chamber surrounding the treating chamber, a closure mounted on one end of the fluid chamber, said closure having an annular groove on the inner face thereof, a flange on the entrance end of the treating chamber abutting against the inner face of the closure, a plurality of openings in the flange connecting the fluid chamber and annular groove, said treating chamber opening into the annular groove, an adjustably mounted member in the closure extending into the entrance end of the treating chamber and movable toward and away from the entrance end of said treating chamber, said groove, being concentric with the member and said groove and member forming an annular passage whereby the fluid can flow from the fluid chamber into the treating chamber, a strand-entrance orifice in the member, a second closure on the other end of the chambers, an expansion nozzle mounted in the second closure and communicating with the treating chamber, said expansion nozzle having an opening therein with walls diverging in a direction away from the treating chamber to allow the fluid from the treating chamber to expand as it passes through the expansion nozzle, and means for supplying fluid to the fluid chamber.

15. An apparatus for treating continuously moving strands with fluids comprising, an elongated strand-treating chamber, a fluid chamber surrounding the treating chamber, a closure mounted on one end of the fluid chamber, said closure having an annular groove on the inner face thereof, a flange on the entrance end of the treating chamber abutting against the inner face

of the closure, a plurality of openings in the flange connecting the fluid chamber and annular groove, said treating chamber opening into the annular groove, an adjustably mounted member in the closure extending into the entrance end of the treating chamber and movable toward and away from the entrance end of said treating chamber, said groove being concentric with the member, and said groove and member forming an annular passage whereby the fluid can flow from the fluid chamber into the treating chamber, a strand-entrance orifice in the member, a second closure on the other end of the chambers, a fluid-expansion chamber connected to the second closure, an expansion nozzle mounted in the second closure and communicating with the treating chamber and expansion chamber, said expansion nozzle having an opening therein with walls diverging in a direction toward the expansion chamber to allow the fluid from the treating chamber to expand as it passes through the expansion nozzle, said expansion chamber having a member slidably mounted in an opening in the end-wall thereof, said slidably mounted member being movable toward and away from the strand-treating chamber, an opening in said slidable member for the passage of a strand therethrough, and means for supplying fluid to the fluid chamber.

16. An apparatus for treating continuously moving strands with fluids comprising, an elongated strand-treating chamber, means for continuously passing a strand through the treating chamber, a fluid chamber surrounding the treating chamber, a closure mounted on one end of the fluid chamber, said closure having an annular groove on the inner face thereof, a flange on the

entrance end of the treating chamber abutting against the inner face of the closure, a plurality of openings in the flange connecting the fluid chamber and annular groove, said treating chamber opening into the annular groove, a nozzle threadedly mounted in the closure extending into the entrance end of the treating chamber and movable toward and away from the entrance end of said chamber, said groove being concentric with the nozzle and said groove end nozzle forming an annular passage whereby the fluid can flow from the fluid chamber into the treating chamber, a strand entrance orifice in the nozzle, a second closure on the other end of the chambers, a fluid-expansion chamber connected to the second closure, a Venturi tube mounted in the second closure and communicating with the treating chamber and expansion chamber, a slidable member mounted in an opening in the end-wall of the expansion chamber, said slidable member being movable toward and away from the Venturi tube, a capillary opening in said slidable member for the passage of a strand therethrough, and means for supplying fluid to the fluid chamber.

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