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Bous et al.

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[54] **SYSTEM FOR BULKING YARN**

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.** **D06c 7/02,** F26b 13/12, F26b 13/30

[58] **Field of Search** ..... 8/149.2, 149.3; 68/5 D, 5 E; 28/62, 72 HR; 57/34 HS, 157 TS; 34/52, 56, 157

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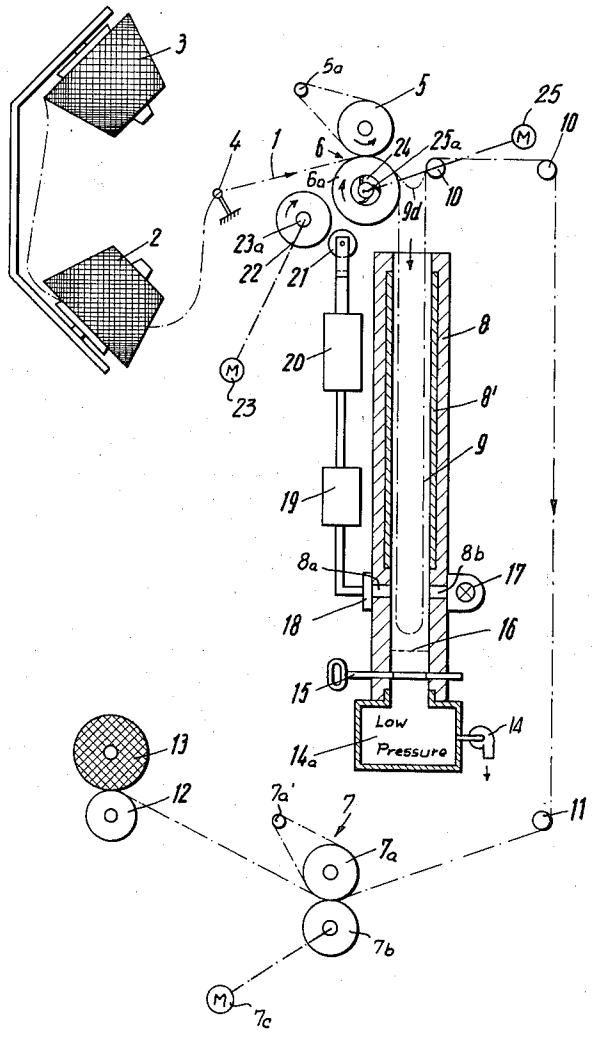
[57] **ABSTRACT**

A system for heat-treating a filament, especially for the bulking of yarn in which a loop of the filament is suspended in a hanging condition between a feed point and a take-up point by advancing the filament at said feed point at a rate greater than that at which the filament is withdrawn at said take-up point. The loop is enclosed in a vertical tube substantially out of contact with the vertical walls thereof and the supply of filament within said tube is held substantially constant by controlling the relative speed at which the filament is fed and withdrawn at said points.

13 Claims, 7 Drawing Figures



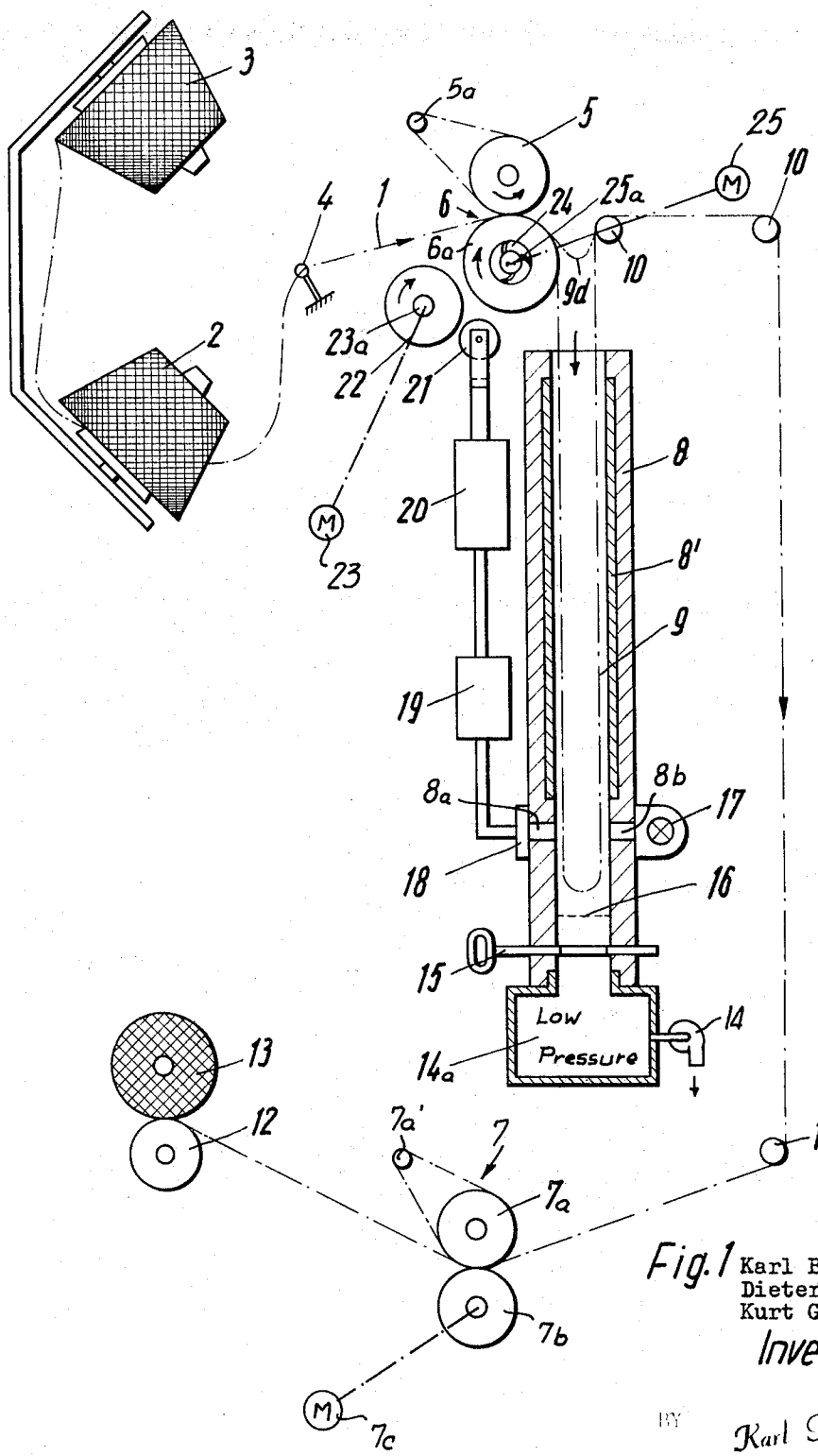


Fig. 1

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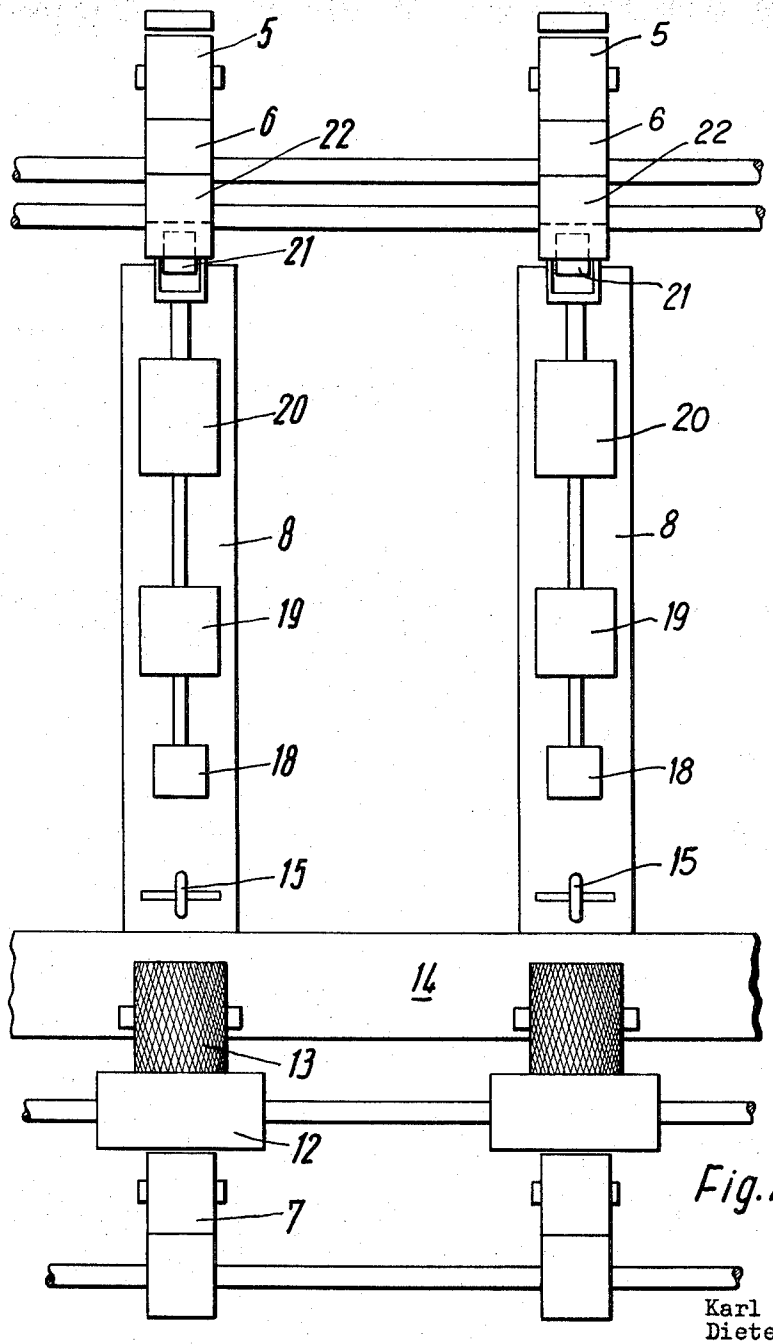

Fig. 2

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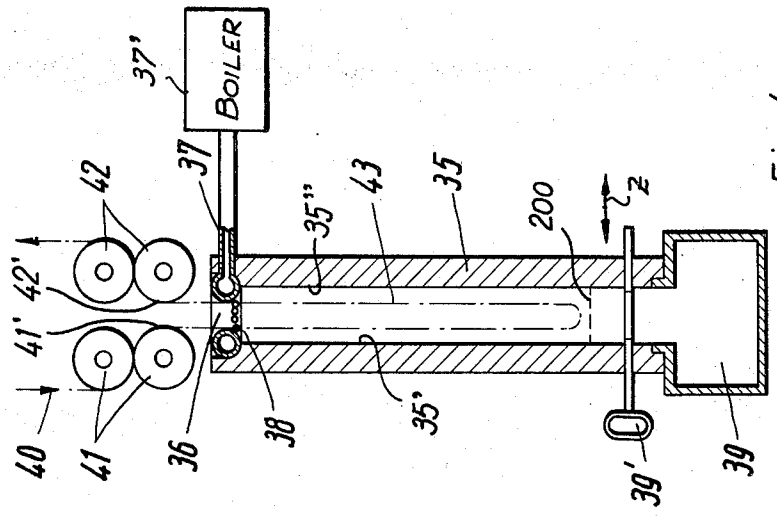

Fig. 4

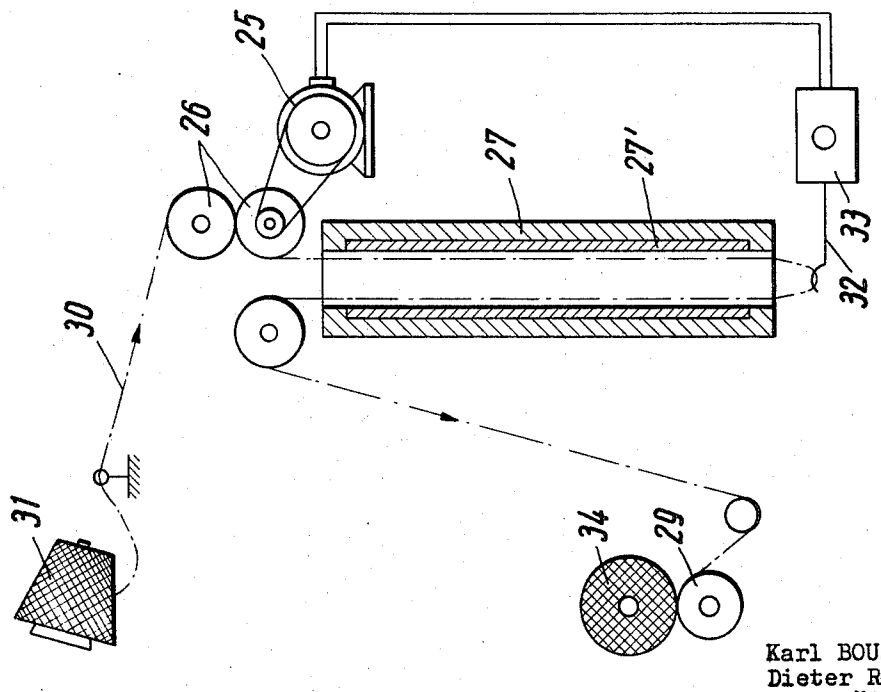

Fig. 3

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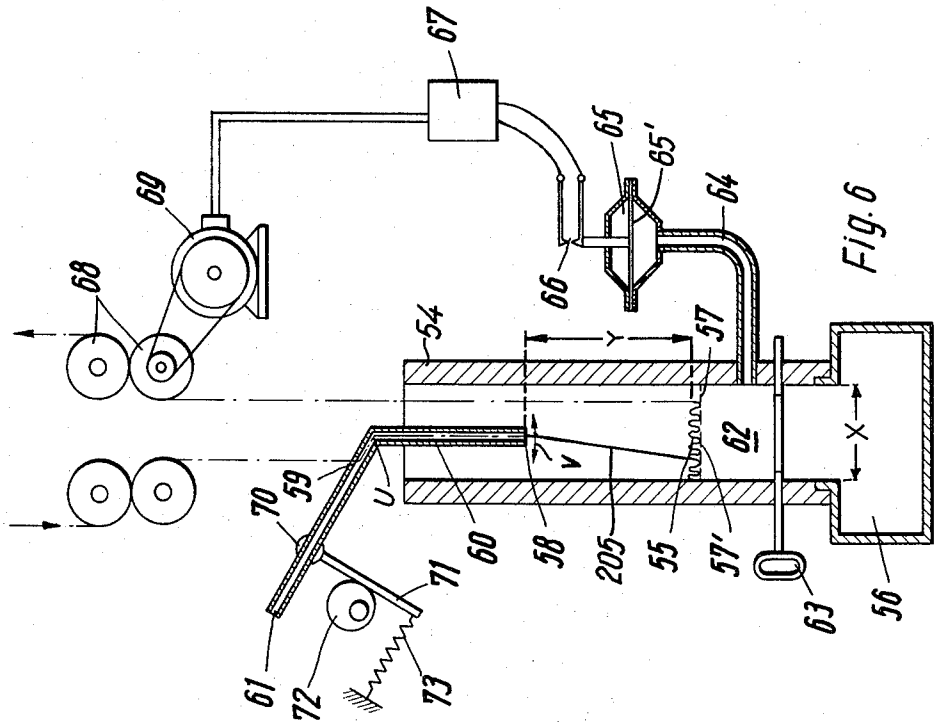

Fig. 6

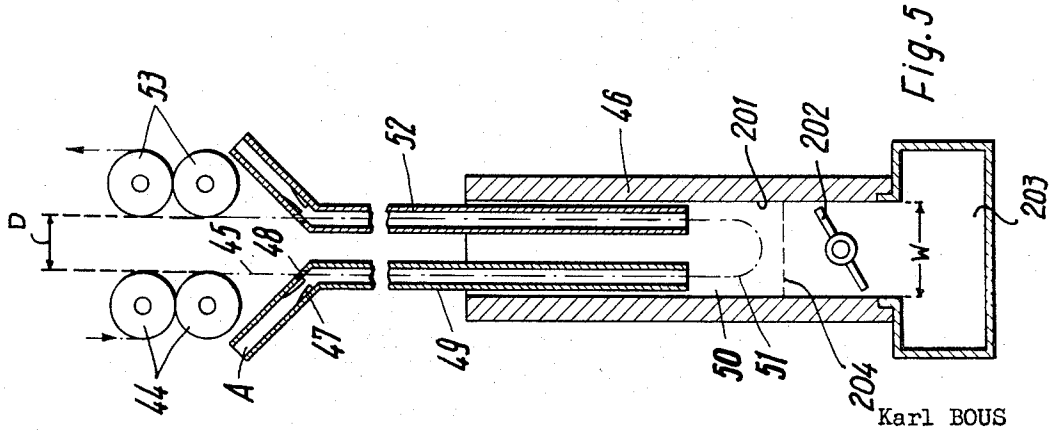

Fig. 5

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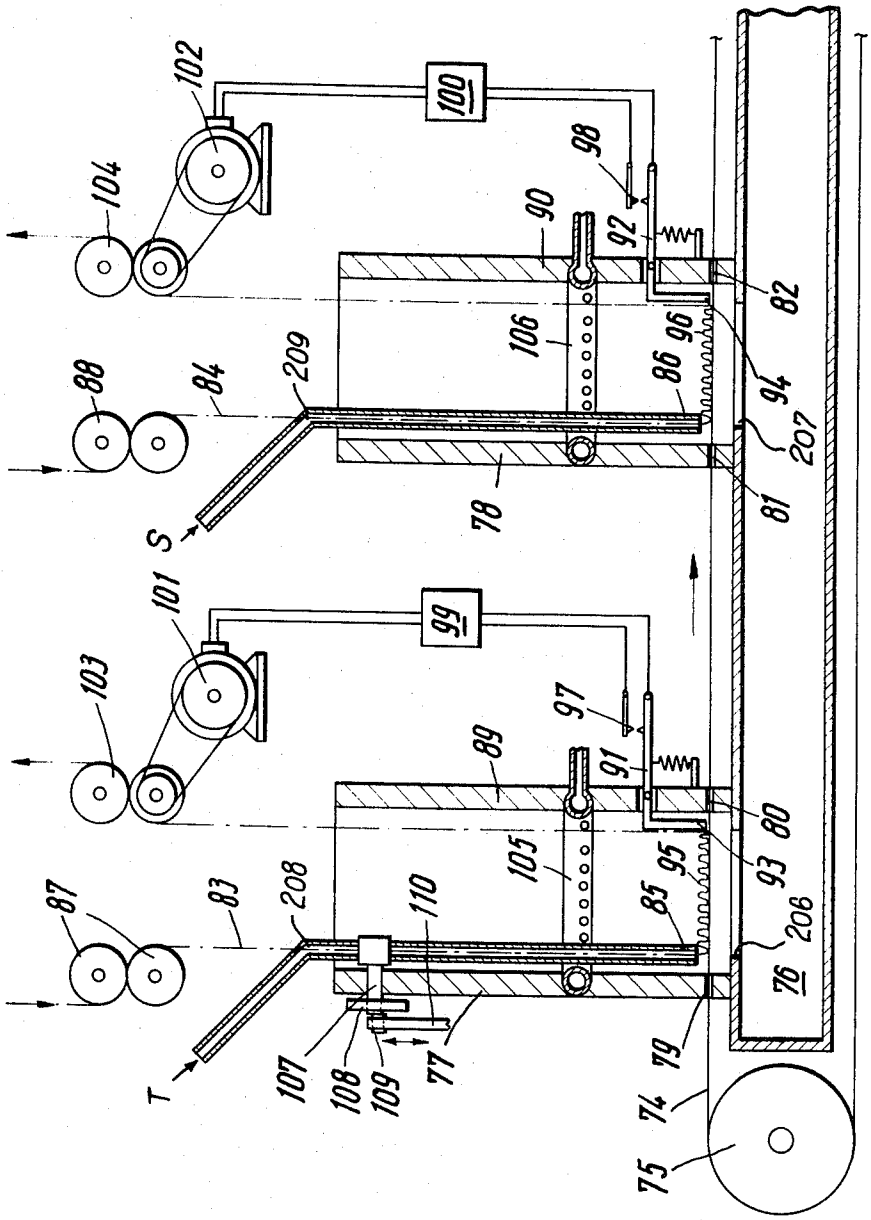

Fig. 7

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SYSTEM FOR BULKING YARN

FIELD OF THE INVENTION

The present invention relates to an apparatus for treating a filament. More particularly this invention concerns an apparatus for heat treating a yarn to impart a crimp to it. In general terms, therefore, the invention relates to the bulking of heat-shrinkable synthetic-resin filaments and filaments, threads, yarns, etc. which can be bulked by heat and/or chemical treatments.

BACKGROUND OF THE INVENTION

In the course of production of yarn or thread several processes such as dying or bleaching, twisting, spinning, and crimping must be carried out in quick succession to obtain a product at a commercially acceptable price.

Several of these processes are often carried out with the aid of heat; bulking or crimping in particular relies on the different shrinkage rates of the several different kinds of filaments in a combination yarn. For the purposes of the present invention, the term bulking will be defined as any chemically and/or heat induced deformation of a yarn or filament to increase its apparent volume. In general, the heating of the yarn imparts a crimp or curl to it by plastic-memory or simple length shrinkage so that the yarn occupies a greater volume and has a wool-like texture.

The simplest and most common method of treatment involves the dyeing and sizing of the yarn right on the spool. In another method a so-called bulking or shrinking chamber is used in which the yarn is subjected to steam or hot air. Such a chamber has small holes in both sides, with the yarn being pulled continuously through. Such a system has one big problem, however: plugs of lint form at the entrance and exit holes so that treatment must be stopped periodically for elimination of these plugs and prior to removal these plugs hinder the normal shrinking of the yarn. It has been suggested to eliminate the holes by passing the yarn straight between a pair of guides with a heating tube arranged between these guides. In this system it is unfortunately necessary to advance the yarn at a very low speed in order to insure sufficient dwell time adjacent the heat. In addition the drive which pulls the yarn through must run slower than that drive that feeds the yarn in order to allow for shrinkage. When, as often happens, the characteristics of the yarn change throughout its length and, for example, a section of great shrinkage potential comes between the drives, the difference in speeds does not suffice and the yarn is broken.

In another arrangement the yarn is fed over a hot metal plate and caused to shrink by direct contact with the metal. Yarn so treated develops a very harsh hand and is often too stiff for many uses.

It is necessary with acrylic high-bulk yarns to treat them for a short period of between 0.5 and 2.0 seconds with heat at a temperature between 90° centigrade and 120° centigrade. In the above processes, temperatures in excess of 200° centigrade are usually employed in order to sufficiently shrink the yarn in a short time. Such high temperatures often alter the overall characteristics of the filaments treated, and completely melt them if, for example, the yarn advance must be stopped momentarily. In general, contact of the yarn with a hot surface, i.e. a heater, is undesirable and the maintenance of a relaxed condition of the yarn during treatment is essential.

OBJECTS OF THE INVENTION

It is therefore an object of the present invention to provide an improved system for treating a textile filament.

Another object is the provision of an improved apparatus for shrinking a yarn which overcomes the disadvantage of the above-described apparatuses.

It is also an object of the invention to provide an apparatus for the high-speed continuous bulking of heat-shrinkable synthetic-resin yarn which can be controlled with ease, provides no danger to the goods, can be used with yarns of different types, occupies little space, affords sufficient treatment time, and is economical to operate.

A further object is to provide an apparatus which can process textile filaments faster than the above-described devices with the resultant product having a better quality than heretofore possible.

SUMMARY OF THE INVENTION

The present invention attains the above objects by passing the yarn or filament through the treatment chamber in the form of at least one loop hanging down from between a pair of guiding and driving devices. The distance between the two sets of rollers serving to feed and withdraw the yarn on opposite sides of the treatment chamber is a fraction of the vertical height of the loop hanging down between them. Means is provided to direct a current of a hot fluid down in the chamber, and means also is provided to detect the length of the loop and correspondingly adjust the speed of one or both pairs of rollers to maintain this length constant.

Radiant heat, saturated steam at 100° to 250° centigrade, similarly heated air, superheated steam, water heated to 60° to 100° centigrade, or mixtures thereof can be used as the hot treatment fluid.

The loop can be, according to a feature of the present invention, a single free-hanging loop. The time the loop spends in the treatment fluid can be increased by allowing a length of the filament to build up in the base of the chamber while the danger that the mass will compact is completely obviated. In both cases there is no mechanical restraint to shrinking, so that the finished product will be fully treated.

In accordance with another feature of the invention the treatment chamber is an upright elongated sleeve whose upper end is arranged adjacent the feed and withdrawal rollers and adjacent a source of hot treatment fluid, and whose lower end is provided with the means for sensing the length of the loop and is connected to a source of reduced pressure to draw the heated fluid down.

It is, therefore, an important feature of the invention to provide the treatment means in the form of an elongated upright tube provided with a heating means, e.g. a radiant-heating surface or means for admitting a heating fluid to the interior of the tube preferably at an intermediate location along its length, communicating with a filament-feed device and a filament-takeup device at its upper end. Advantageously the lower end of the tube communicates with a suction source. While in some instances it is preferred to permit the loop to hang downward freely (out of contact with the walls of the tube and any other element therewithin), it has been

found to be desirable to provide, in other instances, a loop-engaging sensor finger or lever to control the suction means and/or one or both of the aforementioned devices to regulate and maintain the loop. Alternatively, the sensor may be of the optical (photocell) type or of the pressure type and has the same function.

According to yet another feature of the invention the loop is supported, at its lower end or bight, by a perforated surface through which suction is applied to regulate, in part, the rate at which the accumulated portion of the yarn loop traverses this surface. The surface may be formed by a moving perforated band whose speed defines the rate at which the accumulated yarn transversely crosses the interior of the tube. The band may form the perforated support surface for a plurality of such tubes, through which the yarn passes in succession. Control means for the filament feed and/or the band to control the loops may be provided for each such tube.

It has been found to be desirable, in combination with the above features or independently thereof, to provide at the upper end of the treatment tube an inlet and outlet duct leading downwardly on opposite sides of the tube. The filament can be fed in through one of these ducts and is led out through the other, one of the ducts being connected with the source of beating fluid. The other duct may serve as the return for this fluid. At least one of the ducts may be periodically swingable about a horizontal axis perpendicular to the axis of the tube to control the accumulation on the perforated surface.

DESCRIPTION OF THE DRAWING

The above and other objects, features, and advantages will become apparent from the following description, reference being made to the accompanying drawing in which:

FIG. **1** is a vertical section through an apparatus representing a first embodiment of the present invention and adapted to carry out the method thereof;

FIG. **2** is a side view of the first embodiment; and

FIGS. **3–7** are vertical sections through five other embodiments of the present invention.

SPECIFIC DESCRIPTION AND EXAMPLES

In FIGS. **1** and **2** there is shown an apparatus wherein a filament **1** is drawn from one or both of a pair of spools **2** and **3** through an eye **4** by a combined feed-guide apparatus (feed device) **6.** The filament **1** is taken up by a withdrawal mechanism (take-up device) **7** and wound on a spool **13.**

The feed mechanism **6** consists of a pair of rollers **5** and **6***a*. The filament passes several times around the roller **5** and a small roller **5***a* adjacent it. A motor **25** is connected to a shaft **25***a* which in turn is connected in its clockwise rotational sense to the roller **6***a* via a one-way override clutch arrangement **24.**

The filament **1** forms a loop **9** in an upright chamber **8** provided with heat-radiating elements **8'** along its interior. A plurality of small guides **10** and **11** lead the filament to the takeup device **7** which consists of a pair of rollers **7***a* and **7***b*, around the former of which the filament is wound several times with interposition of a small wheel **7***a'* as in the drive arrangement **6.** A motor **7***c* drives the roller **7***b* and a motor **12** drives the spool **13.**

A pair of in-line apertures **8***a* and **8***b* are formed across the base of the vessel **8.** A photoelectric eye **18** is placed adjacent the aperture **8***a* and a light source **17** adjacent the aperture **8***b*. The cell **18** is connected via an amplifier **19** to a solenoid **20** carrying a roller **21** engageable between a wheel **22** carried on a shaft **23***a* driven by a motor **23** and the roller **6***a*.

Below the loop **9** there is arranged a screen **16** to prevent the filament **1** from being drawn past a damper **15** into a low pressure chamber **14***a* connected to the input of a blower **14,** or for accommodating an accumulation of the filament as described below.

The feed device **6** is driven at a rate that advances the filament into the chamber **8** at a velocity between 0.2 percent and 2.0 percent slower than the velocity at which the device **7** draws the filament **1** out of the vessel **8** plus a percentage of this latter velocity equal to the average amount of shrinkage (say, 10 to 30 percent). The motor **23** when connected to the roller **6***a* is adapted to override the clutch **24** and drive the filament **1** between 2 percent and 5 percent faster than the roller **6***a* does when only driven through its clutch **24** by the motor **25.**

By way of Example, an acrylic-fiber filament **1** is used having a shrinkage of between 18 percent and 22 percent the motor **7***c* is set to pull the filament out of the vessel **8** wherein it forms a loop **9** substantially 15 centimeters high at a velocity of 20 centimeters per second. The motor **25** is adapted to advance the filament into the vessel **8** at a velocity of 23.75 centimeters per second while the motor **23** can advance the filament at a rate of 25 centimeters per second. The elements **8'** are heated to 200° C so that as the air passes down in the column **8** at 30 centimeters per second it beats to about 150° C.

As the apparatus is started a small loop **9***d* is formed. The light source **17** directs its beam at full strength on the photocell **18** and actuates the solenoid to urge the roller **21** between the rollrs **22** and **6***a* so that this latter is driven at its faster speed, 25 cm/sec. Once a loop is formed between the light source **17** and eye **18** the solenoid **20** is deactivated and the roller **6***a* is driven at its slower speed, 23.75 cm/sec. As the lower end of the loop **9** tends to move up or down the solenoid **20** is actuated to keep the loop length substantially constant.

In FIG. **3** an apparatus is shown wherein a filament **30** is pulled off a spool **31** by a pair of rollers **26** driven by a motor **25.** The filament **30** forms a loop in a chamber **27** formed as a sleeve and provided at its interior with radiant heating means **27'**. A spool **34** is driven by a roller **29** to take up the filament **30.** A sensing finger **32** engaged through the loop is connected via a circuit **33** to the motor **25** so that when the loop shortens the motor **25** is speeded up to lengthen it, the finger **32** mechanically engaging the loop and actuating a microswitch. No means for producing a current stream is provided in this embodiment, although such means can be employed. Of course the circuit **33** can be coupled to the motor driving the takeup spool **34** and the motor **25** can run at a constant speed if desired. In this case the peripheral velocity of the spool **34** would be decreased in order to lengthen the loop.

FIG. **4** shows schematically a vertical treatment chamber **35** in which the yarn **43** is heated by saturated steam or with steam superheated to 180° C at 0.1 to 1 atm gauge. At the upper end of the treatment chamber, there is provided a perforated annular nozzle **36** with

apertures 38 trained upon the path of the yarn at the mouth of tube 35. The nozzle is connected by a duct 37 to a source of heated fluid as represented by the boiler 37'. The apertures 38 of the annular nozzles 36 are so arranged that the entire treatment tube 35 is filled with steam, the steam being drawn downwardly to the suction box 39 at the bottom of the tube. The volume of steam which is drawn off by suction and the velocity of the steam in the tube 35 can be controlled by a valve means represented by the 39' which is shifted in the direction of arrow Z. As already described, the yarn 40 is fed between a pair of nip rolls 41, constituting the feed device and disposed so that the point 41' at which the loop 43 of yarn drops from the feed device, lies inwardly of the wall 35' of the tube. Similarly, the point 42' at which the pickup device 42, formed by a pair of nip rolls 42, lies inwardly of the wall portion 35'' opposite wall 35'. Thus the loop 43 is constrained to pass through the treatment tube out of contact with the walls of the latter. The peripheral speed of the takeup rolls 42 is, of course, 18–25 percent less than the supply speed of the feed rolls 41, the peripheral speed differential being maintained by control devices as described in any of the preceding or suceeding embodiments. A perforated plate 200 can be provided in the vertical tube 35 to form a support for an accumulated portion of the yarn, if desired, and to prevent the loop from passing into the suction box 39 on the aperture in slide 39.

A more intensive treatment of the yarn over a greater treatment time can be obtained with the system illustrated in FIG. 5. In this embodiment, the vertical treatment tube 46 defines a treatment chamber 201 above a butterfly flap 202 controlling the suction produced by a vacuum box 203 at the lower end of this tube. A perforated plate 204 is provided above the flap 202 for the reasons already described with respect to the perforated plate 200. In this embodiment, the supply means or feed device is formed by a pair of nip rolls disposed at a distance D from the takeup rolls 53 which is less than the width or diameter W of the chamber of tube 46. The filament 45 extending downwardly without contact with any surface to form the loop 51, passes through a duct 49 reaching downwardly into the otherwise open end of the treatment tube 46. The duct 49 extends over a length of 0.5 to 2 m while surrounding the yarn, only a portion of this length being within the treatment tube 46. The inlet A of duct 49 is connected to a source of treatment fluid, preferably saturated steam, supersaturated steam, heated air or water with a temperature of 60° to 100° C. A constriction 47 is provided upstream of the yarn to accelerate the flow of steam as it reaches the yarn and an aperture 48 is provided through which the yarn is supplied. Upon formation of the loop below the duct 49, the yarn passes through an analogous tube 52 which can be longer or shorter than tube 49 and can be used to conduct the treatment fluid from the system. Thus treatment fluid can be introduced through both tubes 49 and 52 and evacuated only by the suction box, or introduced by the tube 49 and removed by the suction box 203 together with the duct 52.

The present invention also contemplates more prolonged treatment of the yarn, e.g. by the system which has been illustrated in FIG. 6. In this embodiment, the upright treatment chamber is a tube 54 in which the loop 205 is gathered at its bottom end and is supported on a perforated plate or sieve 57 to form a layer 55 of the yarn. At the lower end of the tube 54 is provided a suction box 56 adapted to apply a subatmospheric pressure in the space 62 between the perforated plate 57 and the suction box. This suction which is controlled by a flap valve as shown at 202, or by the sliding plate 63 of FIG. 6, serves to retain the yarn layer 55 against the plate with a friction force determined by the suction level. Depending upon the type of yarn, the gauge and the treatment speed, the yarn layer may include 10–200 m of yarn.

Into the open upper end of the treatment tube 54, there extends a duct 60 which, like the duct 49, is provided with a window 59 through which the yarn extends. At the mouth of the tube 58, the yarn emerges to form the loop 205. The duct 60 is also provided with an inlet 61 for saturated steam, steam superheated to 105° to 250° C, heated air or hot water with a pressure of 0.1 to 1 atmosphere gauge. The distance Y between the mouth of tube 58 and the perforated support surface 57 ranges between 2X and 4X where X is the length of the perforated surface.

In the embodiment illustrated, the loop-forming means is controlled in response to pressure. Thus, a membrane capsule 55 is connected by a line 64 with the space 62 below the perforated surface 57. The membrane 65' of the capsule is arranged to operate a switch 66 which, via an amplifier 67, controls an electric motor 69 coupled to the rolls 68 of the takeup device.

As soon as a portion of the perforated plate 57, for example the region 57' is covered by yarn, the fluid entering the chamber 62 is confined only to the balance of the perforated plate. The flow through the latter is thereby reduced. With increasing thickness of the yarn layer upon the perforated surface 57, the suction in the space 62 increases or the absolute pressure drops. Via the pressure controller 65, 66, 67, etc., the increased suction force triggers the motor 69 to accelerate the latter and drawing off the yarn at a faster rate, thereby reducing the thickness of the yarn layer. Should the loop fail to materialize at all or gradually be decreased, a similar pressure sensor is provided to slow down the motor 69. Using a conventional control point and pressure controls, correcting the system at 2 to 15 operations per minute, it has been possible to compensate adequately the treatment time for varying shrinkage conditions and yarn characteristics. A constant control can, of course, also be provided when the contact 66 is replaced by a potentiometer (not shown) in a stepless speed control circuit for the motor 69.

For a uniform distribution of the yarn on the perforated plate 67, the tube 60 is oscillated in the direction of arrow V about the pivot axis U via an arm 71 bearing against an eccentric or cam 72 and held thereagainst by a spring 73. The fulcrum can, if desired, be formed by a bearing 70 at the junction of arm 71 with duct 60.

A somewhat more complicated system generally similar to that of FIG. 6, has been illustrated in FIG. 7, in which a number of yarns are passed through respective treatment tubes and/or a single yarn is passed through a number of treatment tubes. In this embodiment, the perforated surface, upon which the yarn loops are supported, includes an endless band 74 displaced upon conveyer rolls 75 (only one shown) driven with a peripheral speed of 0.3 to 6 mm/minute. The vertical treatment tubes 89, 90, etc., each mounted above an

opening **206, 207** of the suction box, are provided with aligned slits **79, 80, 81** and **82** traversed by the perforated band **74** whereby the band extends through the bottoms of the tubes **79, 80** above the respective opening into the suction box. It is important to concepts relevant to this embodiment that the yarn **83** and **84** are deposited upon the band **74** close to the inlet slot **79** and **81.** For this purpose, tubes **85** and **86,** which extend downwardly into the treatment tubes **89** and **90** are provided and have inlets **208, 209** through which the yarn enters these tubes from the feed rolls **87, 88.** The treatment fluid may be introduced at T and S, respectively.

The yarn **83** and **84** is led from each treatment tube **89** or **90** via a respective takeup device **103, 104.** In this embodiment, the takeup devices are controlled by respective levers **91** and **92** whose arms **93** and **94** are pivotally mounted on the treatment tubes **89** and **90** and bear respectively upon the layers of yarn **95** and **96** carried by the band **74.** The layers **95** and **96** are thus retained by suction against the band until the yarn contacts the sensor **91, 93** or the sensor **92, 94,** each of which is provided with a switch **97** or **98** controlling an amplifier **99** and **100** to operate the variable speed electric motors **101** or **102.** The latter drive the takeup rolls **103** and **104.** When excessive yarn accumulates upon the perforated band **74,** the pressure upon the sensor **93, 94** is greater, whereby the latter adjust the motor to take up the yarn more rapidly and vice versa. Should the perforated band **94** slow down, more yarn will accumulate until the sensor is operated to maintain the yarn treatment time substantially constant. Each of the treatment tubes **89, 90** is provided with a nozzle ring **105** or **106** through which the treatment fluid can be introduced. An oscillation or swinging arrangement of the arm **85, 86** is also possible to spread the yarn over the band. In the embodiment illustrated, the arm **85** is mounted for rotation on a shaft **107** parallel to the band **74** so that the plane of swing is transverse. A drive rod **110** can be coupled to a crank pin **109** of the disk **108** on shaft **107.** As the bar **110** is vertically reciprocated, the duct **95** swings in a direction transverse to the plane of the paper.

The invention as described above has been shown by way of example as applicable to the shrinking of yarn and the bulking thereof. The yarn may be available from any source, may be passed entirely through the system, may be used for other heat treatments, etc. Thus the system may be used for the stabilization of carpet yarns, for the fixing of latent textures in yarns and may be employed together with a twisting or twining step. These and other modifications, readily apparent to those skilled in the art, are intended to be included in the spirit and scope of the present claims.

We claim:

1. An apparatus for the continuous heat treatment of a textile filament, especially for the bulking of yarn, comprising:

a feed device for advancing a filament and take-up device for withdrawing of filament spaced apart to form a downwardly hanging free loop;

a vertically extending tubular treatment chamber surrounding said loop individually and receiving only a single filament loop;

means for heating the single loop within said tubular chamber;

means for controlling the speed of at least one of said devices for regulating the length of the single loop in said chamber; and

suction means communicating with said tubular chamber at a lower end thereof for drawing fluid through said tubular chamber.

2. The apparatus defined in claim **1** wherein the last-mentioned means is a suction box common to a plurality of such chambers each receiving a single such filament loop.

3. The apparatus defined in claim **1,** further comprising a perforated support surface below said loop and traversed by said fluid whereby said fluid temporarily retains filament of said loop on said support surface.

4. The apparatus defined in claim **3** wherein said support surface is a moving perforated band.

5. The apparatus defined in claim **1** wherein the means for controlling the speed includes a sensor responsive to the bight of said loop for controlling said one of said devices.

6. The apparatus defined in claim **5** wherein said sensor is a finger engaging said loop.

7. The apparatus defined in claim **5** wherein said sensor is a photoelectric means across said chamber and generating a beam intercepted by said loop.

8. The apparatus defined in claim **5** wherein said chamber is provided with a perforated support surface collecting a portion of said loop and said sensor is responsive to suction pressure below said perforated support surface.

9. The apparatus defined in claim **5** wherein said chamber is provided with a perforated support surface collecting a portion of the filament of said loop and said sensor is a finger responsive to the accumulation of said portion of said filament.

10. The apparatus defined in claim **1,** further comprising a duct extending downwardly into said tube, said filament being guided through said duct.

11. The apparatus defined in claim **10,** further comprising means for introducing a heating fluid into said tube through said duct.

12. The apparatus defined in claim **10** wherein said chamber is provided with a perforated supporting surface accumulating a portion of said loop, further comprising means for oscillating said duct across said supporting surface.

13. The apparatus defined in claim **10,** further comprising another duct leading from said chamber and guiding said filament from said loop.

* * * * *