Feb. 2, 1971 R. K. STANLEY 3,559,254

APPARATUS FOR STUFFER CRIMPING TEXTILE STRANDS

Original Filed July 3, 1967 2 Sheets-Sheet 1

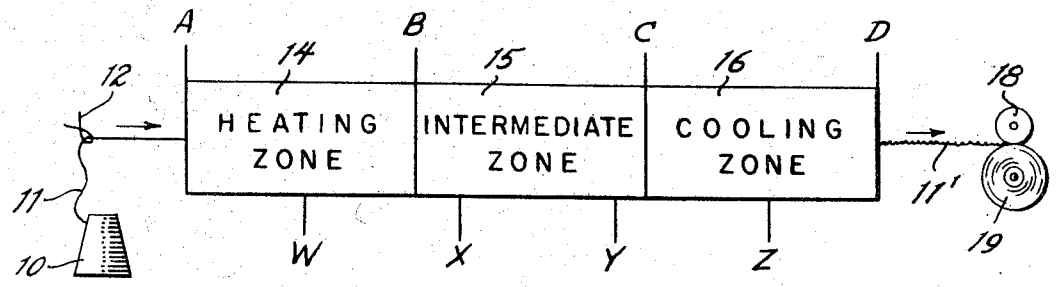


Fig. 1.

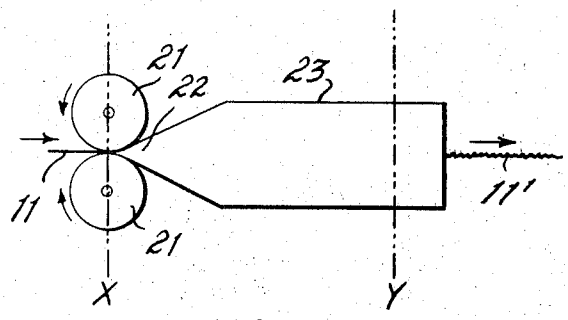


Fig. 2.

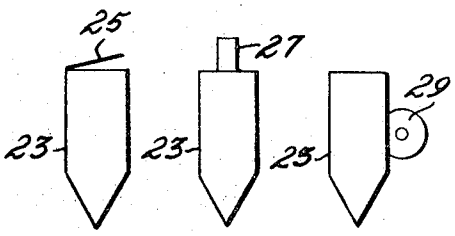


Fig. 3a. Fig. 3b. Fig. 3c.

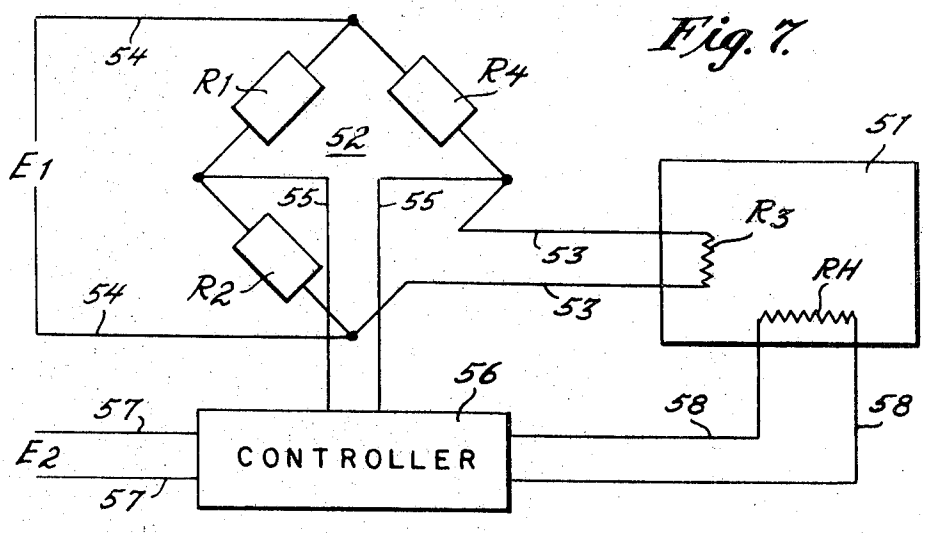


Fig. 7.

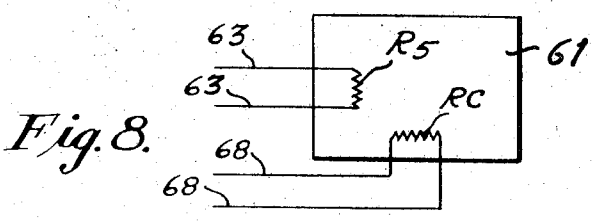


Fig. 8.

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APPARATUS FOR STUFFER CRIMPING TEXTILE STRANDS

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Fig. 4

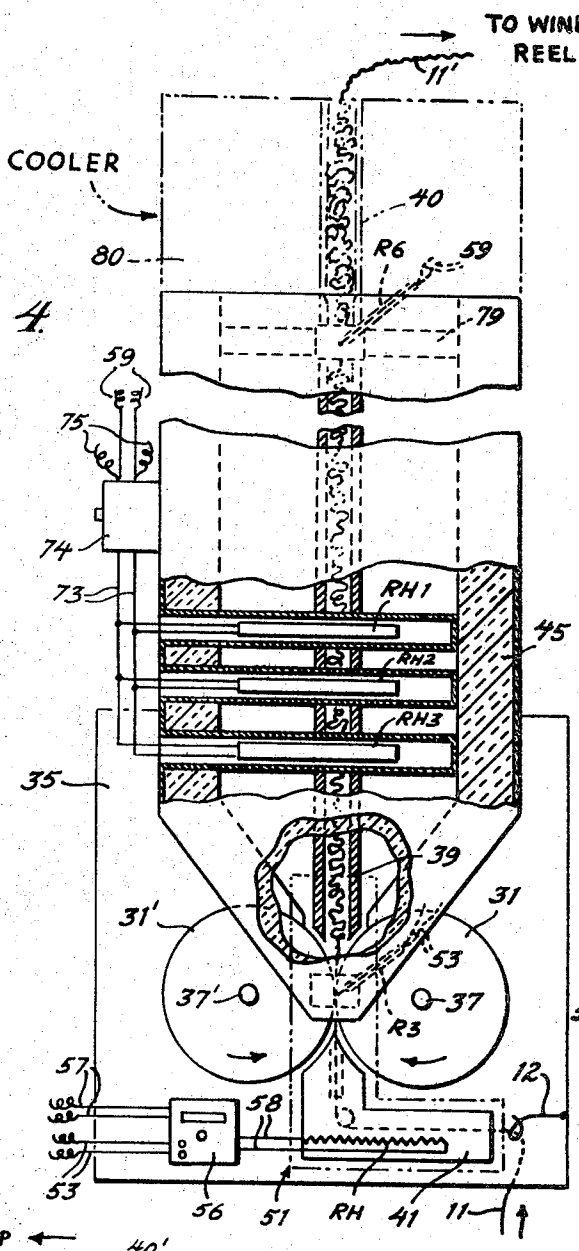
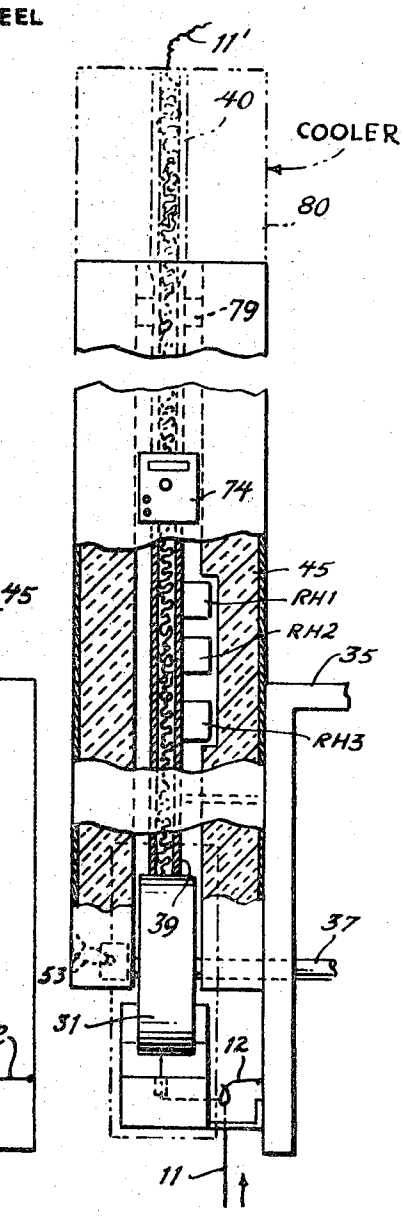


Fig. 5



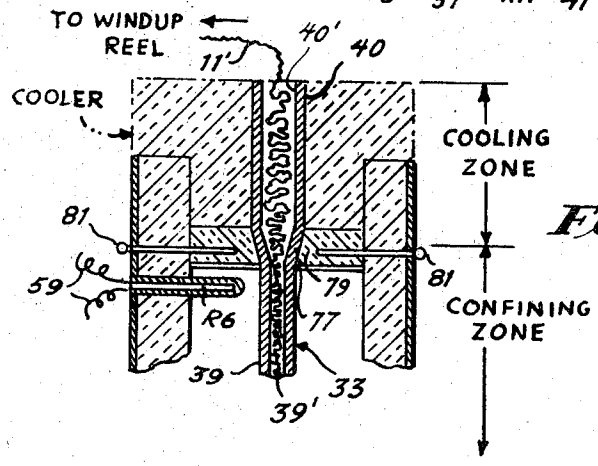


Fig. 6.

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3,559,254

APPARATUS FOR STUFFER CRIMPING TEXTILE STRANDS

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Continuation of application Ser. No. 650,762, July 3, 1967, which is a continuation-in-part of application Ser. No. 349,338, Mar. 4, 1964, now Patent No. 3,348,283, dated Oct. 24, 1967. This application June 9, 1969, Ser. No. 835,883
The portion of the term of the patent subsequent to Oct. 24, 1984, has been disclaimed
Int. Cl. D02g 1/12
U.S. Cl. 28—1.6 4 Claims

ABSTRACT OF THE DISCLOSURE

A stuffer-crimper for textile strands is provided with means for preheating such a strand to crimping temperature, means for maintaining the strand at substantially such crimping temperature while it is being crimped and subsequently being stress-relieved therein, and means for cooling the crimped, stress-relieved strand.

This application is a continuation of my copending patent application Ser. No. 650,762, filed July 3, 1967, now abandoned, which was a continuation-in-part of my prior application Ser. No. 349,338, filed Mar. 4, 1964, and now U.S. Pat. 3,348,283.

This invention relates to apparatus for strand treatment, particularly for compressively crimping a textile strand under controlled temperature conditions.

There are a number of well known methods, primarily mechanical, of crimping textile strands that contain one or more synthetic filaments made of somewhat thermoplastic composition and characterized by undue surface regularity and configurational rectilinearity. Of those methods a very prominent one is compressive crimping, as in a stuffer-crimper in which such a textile strand is forced, as by and between a pair of counter-rotating nip rolls, into a confining region from which its escape is impeded temporarily, as by suitable impeding means, sufficiently to cause the strand entering the region to bend back and forth upon coming into forcible contact with the accumulation of strand already present therein.

Heating of the strand preparatory to or during crimping is known, as is subsequent cooling thereof. However, such heating and cooling may be imperfectly accomplished or controlled, so as to have undesirable consequences, at least on certain types of strand or on strands having certain chemical composition. If imperfectly crimped, and if thereafter not adequately stress-relieved, the strand may have undesirable non-uniform or unstable crimp configuration.

A primary object of the present invention is improvement in the configuration or stability (or both) of crimp in textile strands.

Another object is improved temperature control in crimping and stress-relieving of textile strands.

A further object is improvement in design of apparatus for more effective stuffer-crimping of textile strands.

Other objects of this invention, together with means and methods for attaining the various objects, will be apparent from the following description and the accompanying diagrams.

Certain apparatus for the stuffer-crimping of thermoplastic strands is disclosed in my U.S. Pat. 3,111,740, which is incorporated herein by reference insofar as pertinent. That apparatus includes means providing a heating zone and a subsequent cooling zone, with a stuffing chamber located entirely in the cooling zone, immediately adjacent to the nip rolls for feeding the strand into the stuffing chamber. The strand entering the chamber is buckled thereupon into crimped configuration and is immediately cooled to fix or set the crimp. No intermediate zone, such as that taught in the present invention, is provided for stress-relieving the crimped strand meanwhile. In U.S. Pat. 2,949,659, J. W. I. Heijnis et al., earlier disclosed stuffer-crimper apparatus wherein a preheated strand is stuffed by nip rolls into a chamber provided with cooling fins along part of its length. Interconnected to the stuffing chamber is an air conduit for heating the crimped strand further by injecting hot air into a portion of the chamber adjacent the nip rolls or for assisting the cooling of the crimped strand in the further portion of the chamber by withdrawing air from the chamber and thereby producing countercurrent flow of cool air thereinto from the strand exit at the far end of the chamber. Additionally, that apparatus makes use of balls in the chamber to provide crimping back-pressure and to prevent entanglement of the strand.

Apparatus of this invention is illustrated in the drawing, in which:

FIG. 1 is a schematic representation, largely in block form, of strand treatment according to the present invention;

FIG. 2 is a schematic representation of stuffer-crimping apparatus including the intermediate, or confining, zone of FIG. 1;

FIGS. 3*a*, 3*b*, and 3*c* are schematic representations of items of stuffer-crimping apparatus useful according to FIG. 2;

FIG. 4 is a fragmentary front elevation of an embodiment of a stuffer-crimper for carrying out the strand treatment represented in FIG. 1;

FIG. 5 is a side elevation of the apparatus of FIG. 4;

FIG. 6 is a sectional fragmentary side elevation of the apparatus shown in FIGS. 4 and 5 in the vicinity of an end-wall that marks the division between the confining and cooling zones;

FIG. 7 is a schematic representation of electrical circuitry and related components useful in apparatus according to FIG. 4; and

FIG. 8 is a schematic representation of other electrical circuitry and related components useful in apparatus according to FIG. 4.

In general, the objects of the present invention are accomplished, in apparatus for compressively crimping textile strand, by means for preheating the strand to a temperature at which it is readily crimpable, before applying crimping stress, and means for maintaining the strand under essentially constant-temperature conditions throughout substantially the entire period of application of crimping stress and thereby stress-relieving it in the crimped configuration, and preferably means for positively cooling the strand subsequently.

A stuffer-crimper embodiment of such apparatus provides an intermediate, confining zone into which a preheated textile strand enters immediately upon entering the stuffiing chamber of the apparatus. The confining zone is provided by an insulated chamber preferably having auxiliary heating and/or cooling means for maintaining the interior of the chamber, and more particularly the textile strand stuffed into the chamber, under a substantially constant temperature throughout the portion of the chamber in which the strand is under crimping stress, for stress-relieving the crimped strand. The chamber is provided with internal temperature-sensing means, in the wall as at both ends of the chamber, and with preferably external comparator means therefor connected to control means effective to actuate and regulate the heating and/or cooling means.

The present apparatus provides crimped textile strand with improved bulk and crimp stability and is particularly useful, therefore, in the manufacture of carpeting, upholstery, and certain apparel fabrics.

FIG. 1 shows, schematically, strand **11** leaving wound package **10** and passing through pigtail guide **12** and into the first of three blocks (**14**, **15**, **16**) from the last of which crimped, stress-relieved **11'** passes to windup on package **19** driven by rotating roll **18** in surface contact therewith. Block **14** denotes a Heating Zone, which has initial and final boundaries A and B; block **15**, an Intermediate Zone (hereinafter sometimes referred to as a confining zone), with corresponding boundaries B and C; block **16**, a Cooling Zone, with boundaries C and D. Location W in the Heating Zone, locations X and Y in the Intermediate Zone, and location Z in the Cooling Zone are identified further below.

FIG. 2 shows, also schematically, strand **11** entering the nip of pair of rolls **21**, and crimped strand **11'** leaving stuffer-crimping chamber **23**, which is tapered at its opposite end or entrance **22** extending into the bight of the rolls. Location X is denoted as coincident with the roll axes, and location Y as at or near the end of the chamber, where the strand is released and substantially freed from the compressive crimping stress previously applied to it at or just inside the entrance. Location Y coincides substantially, therefore, with the effective location or termination of whatever temporarily impedes the strand from passing through and out of the chamber.

FIGS. 3*a*, 3*b*, and 3*c* show, also schematically, three conventional types of stuffer-crimping chambers, with particular reference to impeding elements for the strand in the chamber, shown in the order of their development: pivoted gate **25**, reciprocating plunger **27**, and unidirectionally moving or movable wheel **29** (which also comprehends belts, etc.) as the impeding elements in chamber **23**. Each of these types of impeding means applies back-pressure to the strand seeking to escape from the chamber (or from that part thereof in which it is under crimping stress) as the rolls forcibly stuff more strand into the chamber through the entrance. Examples of the the respective types of stuffer-crimping elements may be found in U.S. Pats. 2,686,339, 2,734,229, and 3,027,619; hence, the omission herein of most details of their construction. My U.S. Pat. 3,279,025 shows a stuffer-crimper utilizing back-pressure applied by lateral confinement only, without added impeding elements, and the present invention is also applicable thereto so long as the herein prescribed adiabatic or constant-temperature conditions are attained throughout substantially the entire part of the confining zone in which the strand is under crimping compression.

FIGS. 4, 5, and 6 show, in sectional front elevation, side elevation, and fragmentary sectional side elevation, respectively, stuffer-crimper **23** readily adaptable for use with the mentioned representative types of impeding element. Preheater **41** provides a path (shown in broken lines) for strand to the nip of a pair of feed rolls **31**, **31'** which are juxtaposed to one end of stuffing chamber **33**, the front and back sidewalls of which overlap the rolls to the nip in order to ensure entrance of the strand into the chamber. The chamber is supported by inverted U-frame **35**, in which axles **37**, **37'** for rolls **31**, **31'** are journaled. Gears (not shown) at or near the opposite ends of the axles are in mesh with one another, and axle **37** carries also motor driven drive means (not shown) by which the axles are turned in a known manner. Suitable drive means are taught in U.S. Pats 3,027,619 and 3,279,025, for example.

A suitable impeding element, such as **27** shown schematically in FIG. 3*b*, may be used in the exit end of stuffer-crimper chamber **33** of the apparatus of FIGS. 4 and 5. Thus, plunger **27** may be inserted in the top end of the chamber **33**, either fitting loosely therein to permit crimped strand to be withdrawn between the outside

thereof and the inside wall of the chamber or with a central longitudinal bore to permit the strand to be withdrawn axially through the plunger. Any other suitable impeding element may be provided in the illustrated stuffer-crimper, or equivalent crimping means may be substituted. Preferably, as taught in my U.S. Pat. 3,279,025, mentioned above, no added obstruction is placed in the chamber **33**, in that portion **39'** of the bore of crimping chamber **39** that constitutes the confining zone or crimping chamber proper, in which the strand is under crimping compression. Crimping chamber **39**, therefore, preferably is in the form of an upright cylindrical chamber having a vertical bore therethrough open at both ends, although closed off by feed rolls at the entrance end. As a matter of operating practice the crimping operation is started by inserting a rod temporarily into at least aligned enlarged upper portion **40'** of the stuffing chamber bore to assist in formation of an accumulation or wad of crimped strand in crimping chamber **39'** therebelow.

In passing through the apparatus, a textile strand is heated to crimping temperature by the preheating means. The strand then passes through nip rolls and is forced thereby into the immediately adjacent stuffing chamber. The strand is immediately crimped as it is stuffed into the chamber by the nip rolls into compressive contact with an accumulation of crimped strand already present in the chamber and thereby undergoes compressive crimping stress. The heated, stressed strand then remains in the crimped form while it begins its passage upwardly in the confining zone under substantially adiabatic conditions, i.e., with the strand temperature remaining substantially at the level at which the strand was heated, crimped, and stressed on entering the confining zone. The length of the portion of the chamber providing the confining zone is made sufficient to retain the crimped strand in the zone long enough to be relieved gradually of the stress of the crimping step as it passes upwardly and before leaving the zone. The still hot, stress-relieved crimped textile strand passes therefrom directly into the cooling zone where the crimp is permanently set by the cooling effect. While means may be introduced to convey the strand through the chamber, it is sufficient to force it therethrough by the continuous introduction of uncrimped strand by the feed rolls at the chamber entrance.

As suggested by a comparison of the apparatus of FIGS. 4 and 5 with that of FIGS. 1 and 2, each of which contains the reference characters X and Y, all of that part of the stuffing chamber **39** in which the strand is subject to crimping stress should be located in the Intermediate Zone **15**. As shown in FIGS. 1 and 2, heat is supplied in Heating Zone **14** and is provided to raise the temperature of the strand before imposition of crimping stress, and heat is removed in Cooling Zone **16** after removal of crimping stress to lower the strand temperature. These operations are controlled in appropriate manner, as indicated below. Intermediate Zone **15** is insulated and thereby maintained under essentially adiabatic conditions, with the object of maintaining the temperature of the strand therein, and particularly during its passage through the crimping and stress-relieving phases, essentially constant. The size of the Intermediate Zone, as measured by the time the strand is therein, should be great enough to permit or effect dimensional equilibrium in the strand, e.g., maximum shrinkage, and is discussed further below.

Referring now in more detail to FIGS. 4, 5, 6, 7, and 8, thermoplastic textile strand **11**, e.g., 6-nylon, enters preheater **41** in region **51**, in which is located an electrical heating element RH. The strand is heated to a suitable crimping temperature in the range of 150°–350° F., as it is drawn into the preheater **41** by nip rolls **31** and **31'**. The actual heater temperature will depend upon the degree of lubrication (if any) and rate of travel of the strand (1000–2000 yards per minute is preferred) as well as upon the strand composition and denier, the chamber composition, and the method of heating. In this embodi-

ment the heating is by radiation from an electrical resistance element RH, but it also may be by conduction, convection, etc.

As strand **11** passes between the bight of nip rolls **31** and **31'**, its temperature is continuously sensed by a sensing means, e.g., thermistor R3, having a pair of leads **53** leading to a thermostat **56** connected also to wires **58** from the heating element RH and wires **57** leading to a source of electrical potenital.

FIG. 7 shows, schematically, electrical circuitry for a thermostat and its related components useful in region **51**, which may be (or be part of) Heating Zone **14**. Electrical potential E1 provides, via a pair of leads **54**, the input to electrical bridge **52**, which may be a simple, Wheatstone bridge (or a more complex type) provided with resistors (or other suitable impedance elements) R1, R2, R3, and R4 in its various arms: resistor R3 being a thermistor having the pair of leads **53** and being located in region **51** to sense the temperature thereof, and the other resistors being less susceptible to, or compensated for, resistance change with variation in temperature (or being maintained at constant temperature). The bridge output is transmitted via a pair of leads **55** to Controller **56**, which is supplied with electrical potentia E2 via a pair of leads **57** and which controls the temperature of region **51**, in response to the bridge output, by means of heating element RH located in that region and connected to the Controller via leads **58**.

Instead of a heating resistor, as a minor variation the heating element may be suitable radiant (or other) heating means and the leads thereto may be suitable piping, the Controller of the thermostat controlling the flow of heating fluid through the piping in conventional manner as it otherwise can control the flow of heating electrical current. Further details of the Controller and its connection into the circuit are omitted for simplicity, being obvious to persons having an understanding of the pertinent art.

After passing between rolls **31**, **31'**, strand **11** thereupon enters bore **39'** of crimping chamber **39**, where it is immediately crimped upon impact with the accumulated wad of crimped strand immediately ahead of it in the bore. The crimped strand is now ready for stress-relieving. The stress-relieving, as discussed above, is carried out by passing the crimped strand in its stressed, crimped form through bore **39'** of crimping chamber **39** while keeping the temperature of the strand substantially constant. To achieve the latter objective, the crimping chamber is surrounded by a wall of insulating material **45**, which may be asbestos, glass wool or fibers, plastic foam or other known insulating materials. Glass wool is preferably used. The insulation **45** preferably extends downward to the bight of rolls **31**, **31'** as well as upward to the upper, or exit end **77** of the crimping chamber **39**. An air space is preferably provided around crimping chamber **39** for better equalization of the temperature of the crimping chamber and the strand therein. A temperature-sensing element, or thermistor, R6, is provided in an aperture in chamber **33** in the air space adjacent crimping chamber **39**, preferably near its upper end, for sensing of the temperature at this point. Lead wires **59** conduct the temperature signal from thermistor R6 to thermostat **74**, which is similar to the thermostat, indicating controller **56** described in connection with FIG. 7. Stuffing chamber **33** is also provided, preferably in the air space **76** and adjacent to crimping chamber **39**, which at least one heating element, three of which RH1, RH2, and RH3 are shown in suitable sockets therefor in FIGS. 4 and 5 therefor. The heating elements are connected by wires **73** to the thermostat **74**. A pair of lead wires **75** lead from the thermostat to a source of electricity.

While one particular form of thermostat has been shown, it will be clear to one skilled in the art of temperature control that other devices may be used for the purpose of regulating, automatically, the temperature of the respective zones **14**, **15**, and **16**, and specifically the temperatures of the region **51** and the interior of stuffer chamber **33**, and specifically crimping chamber **39** and the crimped strand **11** therein. The intended purpose and resulting effect together are to maintain the temperature of region **51** at a predetermined level and simultaneously to maintain the temperature of the interior and the crimped strand **11** therein at substantially the same temperature as that of region **51**, thereby maintaining the strand in the confining zone at substantially adiabatic temperature.

The length of the stuffing chamber **33** is determined by the length of the Intermediate Zone required to stress-relieve a particular textile strand, and both lengths may and often will vary accordingly. The minimum length of the Intermediate Zone can readily be determined experimentally. It is the length necessary under given conditions for crimping and stress-relief of the crimped strand **11** in the area above the bight of nip rolls **31**, **31'**. A length of about a yard (having a bore or inner width about ¼ inch for use with strands of about10–100 denier) has proved adequate for nylon and other textile strand materials. The length of the Intermediate Zone for each denier is decreasingly less with increase in fineness of the stand and vice versa, i.e., a heavier strand will require a longer Intermediate Zone for stress-relieving than will a lighter strand. Conveniently a series of apertures are provided along the length of stuffing chamber **33** for insertion of a temperature sensing element R6 at an experimentally predetermined location at the distance from the bight of rolls **31**, **31'** at which the desired amount of stress-relieving of the stress of the crimped strand **11** has been achieved. Thus, for a 100 denier 6-nylon strand, sensing element R6 is positioned at a distance of about two feet from the bight of the rolls **31**, **31'** when stress-relieving such crimped strand maintained at a temperature of 200° F. and passed through the chamber at about 1500 yards per minute. The sensed temperature is controlled continually at 200° F. by means of thermostats **56** and **74** at appropriate settings thereof.

The stress-relieved crimped strand emerges from bore **39'** of the crimping chamber **39** portion of stuffing chamber **33** into aligned enlarged bore **40'** of succeeding portion **40** of the stuffing chamber at a temperature substantially the same as that of the Intermediate or confining zone, as defined above. When the denier of the strand is low, less time is required to stress-relieve the strand, and, correspondingly, a shorter confining zone is advantageously used. When a strand of heavy denier is being crimped and stress-relieved, a longer time will be required and a correspondingly longer confining zone is used. When the shorter confining zone is adequate, succeeding portion **40** of the stuffing chamber **33** above the end of the confining zone can be used advantageously to provide all or part of Cooling Zone **16**. Tapered portion **77** of the stuffer chamber constitutes a brief transition from the exit end of crimping chamber **39** to the entrance end of succeeding chamber portion **40**, at the level of the insulated upper endwall **79** of the stuffing chamber **33**. Endwall **79** is positioned at an advantageous location on the outside of the crimping chamber **39** substantially corresponding to the location of the level of desired, or optimum, stress-relief for the particular crimped strand being stress-relieved and is held in place by supporting pins **81**. The chamber bore preferably is enlarged substantially at that location to assure release of the crimped strand from compressive crimping stress at and above that level, and transition portion **77** effects an appropriate increase in size from the crimping chamber bore **39'** to bore **40'** of the cooling chamber, thereby releasing residual compressive stress. If added back-pressure or strand-impeding means should be used, as described above, such means would be situated at this transition level.

In the apparatus of FIGS. 4, 5, and 6, cooling means **80** of any suitable conventional type is preferably provided in the event that ambient air cooling is not adequate for

cooling the stress-relieved crimped strand after it leaves the Intermediate Zone **15** at the appropriate level. A jacketed cooling chamber utilizing a cooling fluid, such as the cooler taught in my U.S. Pat. 3,111,740, is suitable and is preferred when positive cooling is desired. In the event that such a cooler is used, it can ge provided with appropriate temperature-sensing means and positive cooling means. As shown in FIG. 8, cooling means **80** is provided with temperature-sensitive resistor or thermistor R5 located therein and having pair of leads **63** to a thermostat (not shown) having similar elements of the immediately preceding view. Cooling element RC therein has pair of leads **68** to the thermostat, the further analogy with the apparatus of FIG. 7 being apparent. The cooling element may be either a thermo-electric element or a refrigerating coil (in which instance leads **68** would be piping), for example.

The stuffing chamber **33** and apparatus elements may be made of steel or other durable material. If desired, as a minor variation the inside wall of bore **39'** of the crimping chamber **39** may be coated with a synthetic resin (e.g. with polytetrafluoroethylene or polyvinylidene fluoride), to reduce the coefficient of friction, in which event the chamber should be lengthened accordingly.

Suitable insulation of the Heating, Intermediate, and Cooling Zones permits accurate control of the temperature thereof. The respective zones should be sufficiently large, as compared with the rate of travel of the strand therethrough, to hold the strand for a long enough time to have the desired effect upon it. Temperature-sensing means may be provided at locations W, X, Y, Z, as suggested above, or at other convenient locations to ensure accurate determination of temperature, together with temperature-controlling means as may be required for the desired temperature control. Insulation of the Intermediate Zone, which contains the crimping means, from the other two zones may suffice to ensure adiabatic conditions therein. However, if that does not suffice to maintain the strand at essentially constant temperature therein, and especially while it is under crimping stress, one or more controllers (with heating or cooling elements, or both) may be employed as in the other two zones, as discussed above.

A strand being at least partially thermoplastic, as by having a thermoplastic component, when passed through the Heating Zone, should be heated to a temperature at which it readily accepts a crimp, usually at or in the vicinity of the softening temperature thereof. This varies, of course, for various strands and strand compositions but will be known to persons skilled in the art. Then the strand is crimped and stress-relieved in the Intermediate Zone without significant change in temperature, and finally has its temperature lowered in the Cooling Zone, whereupon the crimp is thereafter less readily reduced or removed. Because of localized heating of the strand by reason of external friction and/or internal friction at the chamber entrance where the strand assumes crimped configuration it may prove desirable to extract heat (i.e., cool) a first part of the crimping chamber to maintain (i.e., not exceed) the preheating temperature. Thereafter, in a succeeding portion of the crimping chamber, it may (or may not) be necessary to add heat to maintain that temperature until completion of stress-relief. A suitable number of temperature-sensing and controlling devices will be employed at suitable locations to assure attainment of temperature conditions as desired.

Strands treated according to this invention are noted for improved crimp stability. Excellent results have been obtained upon strands composed wholly or in substantial part of 6-nylon, and other thermoplastic strand compositions are also suitable. The illustrations and descriptions of apparatus herein are by way of examples; modifications may be made therein while retaining all or some of the advantages and benefits of this invention, which itself is defined as follows.

The claimed invention:

1. In apparatus for treating textile strands, compressive crimping means into which a textile strand is fed at a given speed, through which the strand passes and is crimped and stress-relieved in crimped configuration, and out of which the strand is withdrawn at a lower speed, means for preheating the strand to increased temperature before its entrance into the compressive crimping means, means for maintaining the strand in its heated condition at substantially the same temperature while under crimping compression in the compressive crimping means and thereby stress-relieving the strand in the crimpled configuration, and means for cooling the strand upon its release from the crimping compression, wherein the compressive crimping means includes a first fixed chamber provided with the temperature-maintaining means and in which the strand is subjected to crimping compression and a second fixed chamber provided with the cooling means and in which the strand is relatively free of crimping compression, and wherein the second chamber is aligned with the first chamber, and the respective chambers have individual temperature-control elements.

2. In a stuffer-crimper having a chamber with an entrance into which textile material is fed at a given speed to be compressed and an exit from which the textile material is withdrawn at a lower speed after being crimped and stress-relieved therein, and having means for heating the textile material to increased temperature adjacent but outside the chamber entrance, the improvement comprising means for sensing the temperature in the chamber, means for comparing the sensed temperature with a given temperature, heat-exchange means for altering the temperature in the chamber, and controller means for actuating the heat-exchange means to maintain the temperature in the chamber at the given temperature and thereby maintain the temperature of the strand in the chamber at the given temperature.

3. The stuffer-crimper of claim **2**, wherein the heat-exchange means comprises an electrical heater adjacent the chamber wall.

4. The stuffer-crimper of claim **2**, wherein the heat-exchange means comprises an electrical cooler adjacent the chamber wall.

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