Nov. 13, 1962 W. HILLEARY ET AL 3,063,124

TEXTILE HEATING APPARATUS

Original Filed Jan. 5, 1959 4 Sheets-Sheet 1

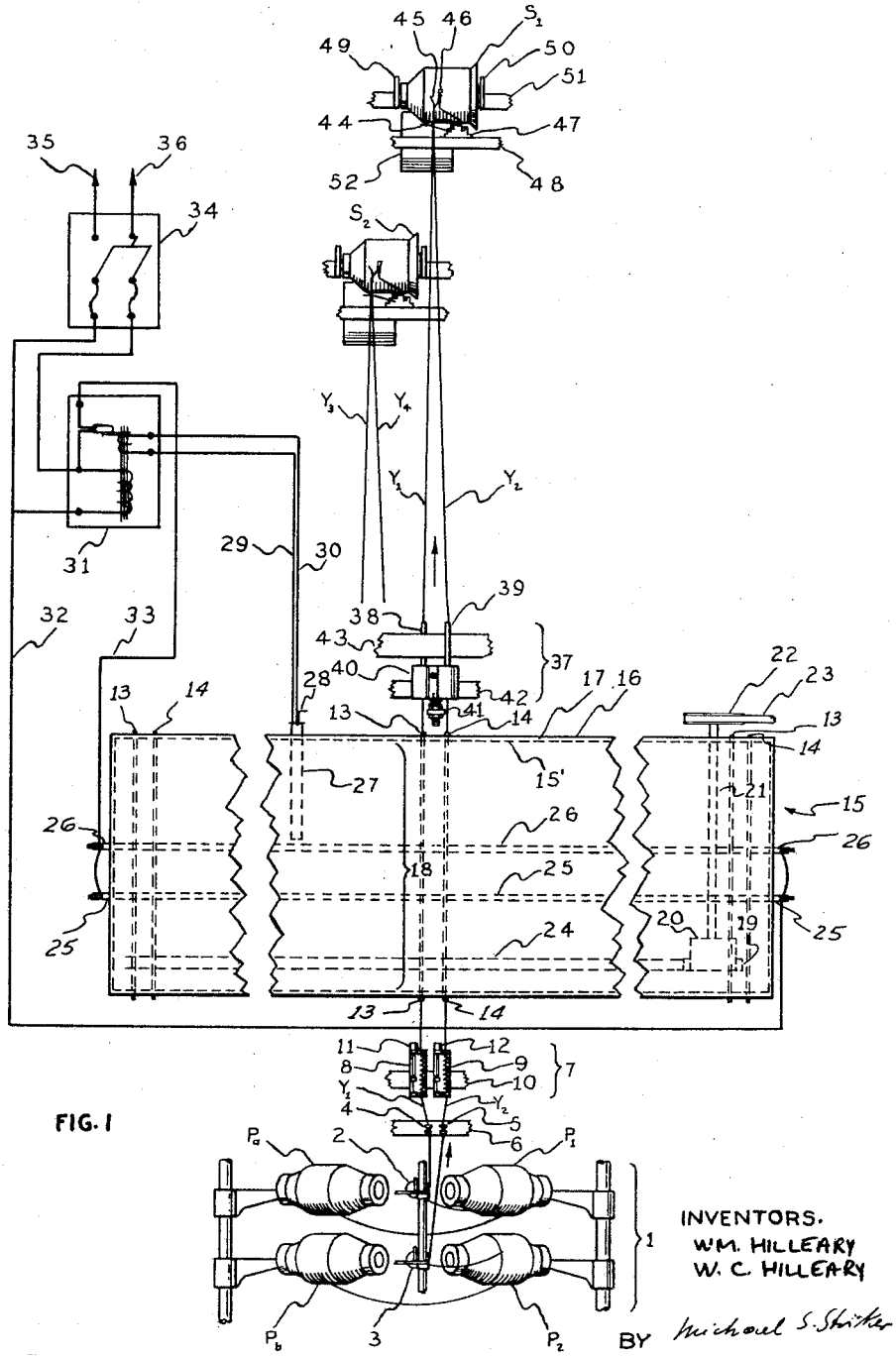


FIG. 1

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TEXTILE HEATING APPARATUS

Original Filed Jan. 5, 1959 4 Sheets-Sheet 2

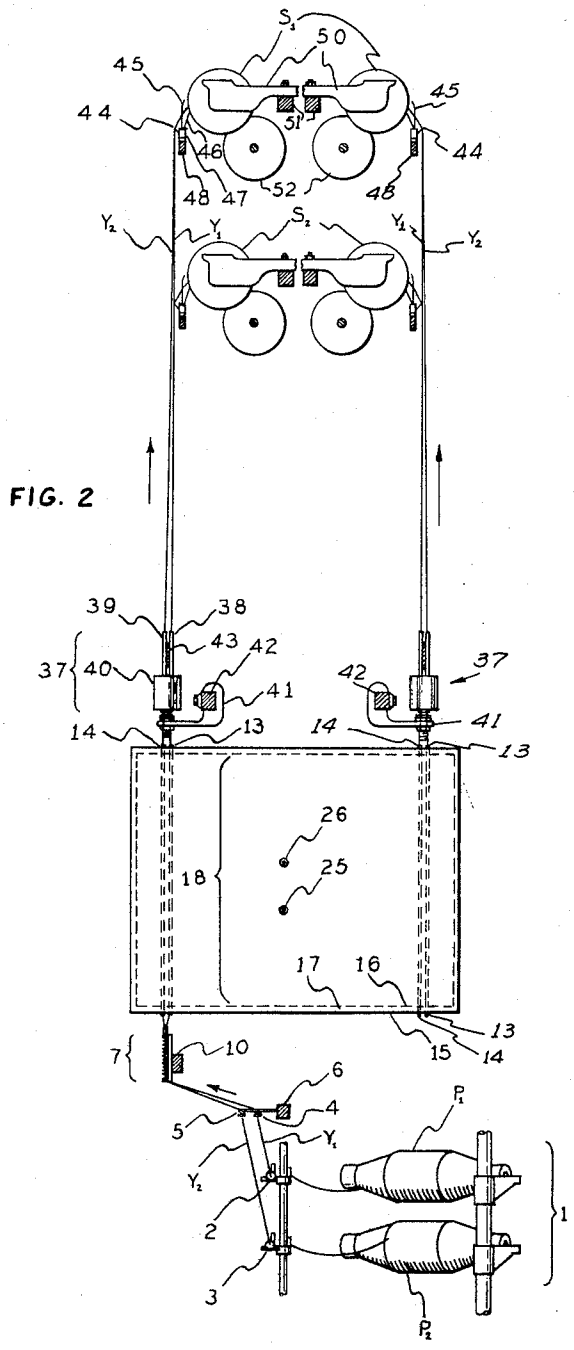


FIG. 2

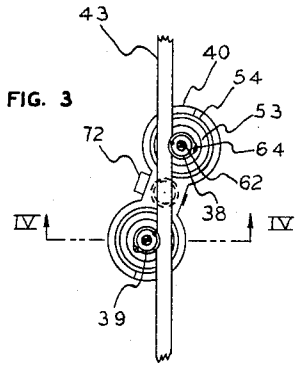


FIG. 3

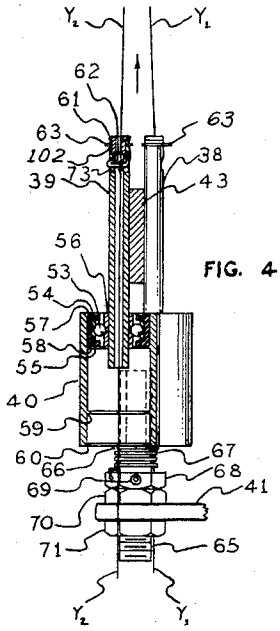


FIG. 4

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TEXTILE HEATING APPARATUS

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FIG. 5

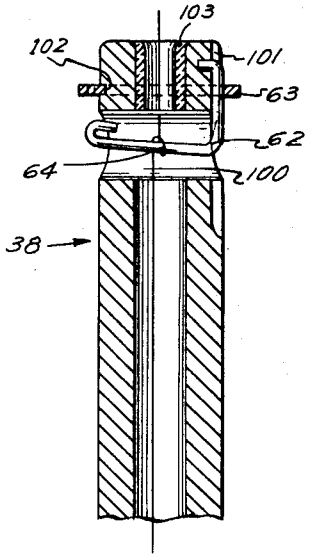
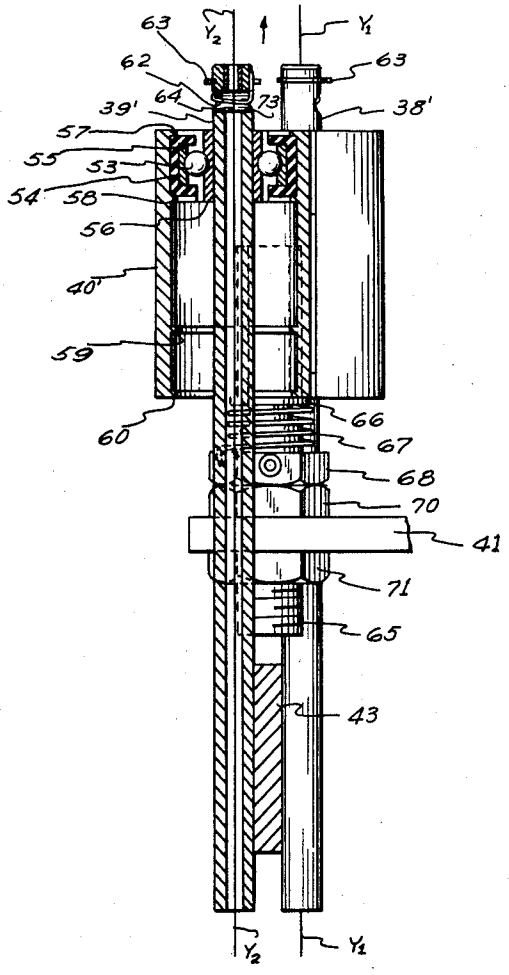


FIG. 8



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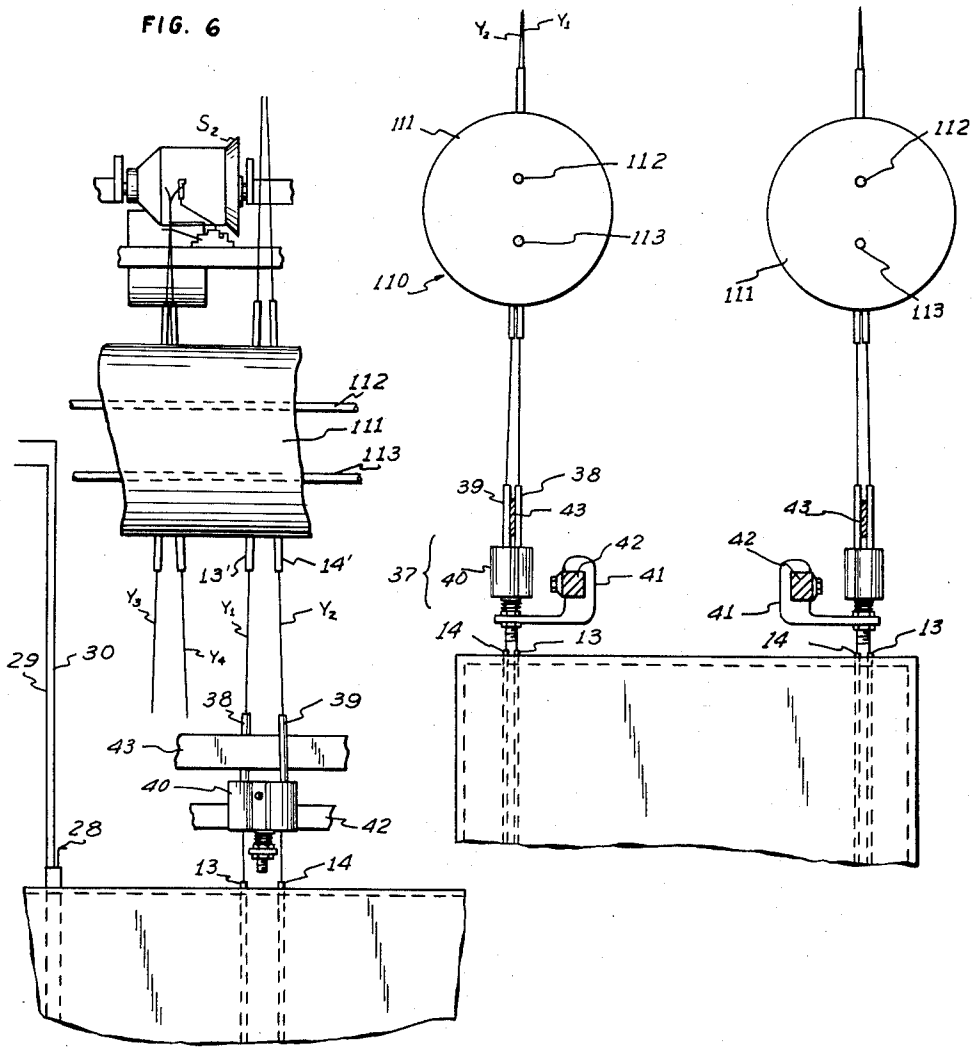
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FIG. 7

FIG. 6



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United States Patent Office 3,063,124 Patented Nov. 13, 1962

3,063,124

TEXTILE HEATING APPARATUS

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Original application Jan. 5, 1959, Ser. No. 785,060. Divided and this application May 17, 1960, Ser. No. 29,651

5 Claims. (Cl. 28—62)

The present invention relates to the treatment of thermoplastic yarn and apparatus for such treatment.

This application is a division of copending application Serial No. 785,060, filed January 5, 1959, and entitled "Process and Apparatus for Treating Thermoplastic Yarn."

More particularly, the present invention relates to the treatment of thermoplastic yarns, such as yarns of nylon, Dacron, tri-acetate, or other thermoplastic yarns of any denier, in such a way that the yarns have permanent kinks or curls in the individual filaments so as to greatly increase the elastic stretchability of the yarns.

Although there are at the present time certain known processes and apparatus for producing thermoplastic yarn of this type, the known processes and apparatus suffer from several defects. The machines used to treat the yarn are relatively large and require a considerable amount of space and separate machines are required for producing some of these changes in the yarn. Moreover, where it is required to raise the temperature of the yarn during the treatment thereof, the known heating apparatus is controlled with difficulty since it has a separate unit and control for each end of yarn and it is difficult, if not impossible, to provide absolute uniformity in the heating of different units or ends of yarn as each passes through its separately controlled heating unit. Another disadvantage of known heating apparatus for this purpose is its inefficient use of electric energy.

In particular, a number of operations and separate machines are required at the present time to produce combined or doubled yarn where the yarn is composed of a pair of oppositely false-twisted yarns which have been brought together. Also, when it is desired to eliminate some of the curl, kinkiness or stretchiness from a thermoplastic stretch yarn so as to produce a bulked yarn suitable for use in sweaters or the like, relatively large separate machines are required for this purpose.

One of the objects of the present invention is to provide a process and apparatus capable not only of quickly and efficiently producing permanently curled or kinked thermoplastic yarns which have considerable stretchability but also capable of quickly and efficiently combining together a pair of yarns which were oppositely twisted during their treatment so as to produce a doubled yarn composed of a pair of oppositely curled or kinked yarns which have been brought together.

Another object of the present invention is to provide a process and apparatus capable of quickly and efficiently producing a thermoplastic bulked yarn with a minimum number of steps and apparatus required for this purpose.

It is also an object of the present invention to provide a process and apparatus for uniformly heating thermoplastic yarns with the apparatus used for this purpose being extremely simple and effective in evenly heating the separate units or ends of yarn simultaneously with the twisting operation while at the same time being exceedingly compact and reliable in operation, and extremely efficient in its use of electricity.

The objects of the present invention also include the arrangement of different units used one after the other in treating the yarn, this arrangement being such that the several units are located in a minimum space and at the same time permit the yarn to move from unit to unit in the best possible manner.

With the above objects in view the present invention includes in a process for treating thermoplastic yarn the steps of passing thermoplastic yarn through a tube and circulating around and against the exterior of the tube a liquid which is maintained at a temperature sufficient to place the yarn in the tube in a plastic condition while at a temperature below its melting point, twisting this yarn while it is in plastic condition, cooling it to set curls or kinks in the individual filaments which adds the quality of stretchiness in the yarn, and then eliminating the twisting of the yarn. When producing bulked yarn the process of the invention includes the step of heating yarn, which has just been treated as above described, to a temperature somewhat less than that used during the twisting thereof so that some of the kinkiness or stretchability is taken out of the yarn, this heating taking place immediately after the cooling and untwisting of the yarn. In connection with the production of a doubled yarn, the process of the invention includes the steps of simultaneously twisting a pair of thermoplastic yarns in opposite directions, respectively, and then bringing the pair of yarns together just before they are wound onto a take-up spool. The latter operations preferably take place during movement of the yarns through an up-twister, and the yarn which has been doubled in this way is thereafter given an additional twist by a down-twister to guarantee that the oppositely curled yarns which form the doubled yarn will not come apart.

Also, with the above objects in view the present invention includes in an apparatus for treating thermoplastic yarns a container for liquid such as heat transfer oil and a plurality of tubes carried by and passing through the container with only the exterior surfaces of the tubes exposed to the interior of the container to be engaged by the liquid therein. A means is provided for continuously circulating the liquid in the container to improve uniformity of temperature inside the tubes, and a means is provided for automatically maintaining the liquid at a predetermined temperature which will give a desired temperature to yarns which pass through the tubes. Tensioning devices place the yarns under tension while they pass through these tubes, and the tensioning devices also stop the twist from running back to the yarn supply packages. Over the container are located a plurality of false twist spindles having a special structure according to the present invention, these false twist spindles twisting the yarns while they pass through the tubes and are in a plastic condition. In accordance with the present invention a pair of false twist spindles are simultaneously rotated in opposite directions by a single belt passing between and directly engaging the pair of spindles. The pair of oppositely twisted yarns are untwisted after cooling and are brought together just before winding thereof onto a take-up spool so as to form a doubled yarn. To produce a bulked yarn the pair of oppositely twisted and untwisted yarns are passed through a second heater located between the false twist spindles and the take-up spool so as to have part of their kinkiness or stretchability removed.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is partly fragmentary and partly schematic elevation of a structure according to the present invention for producing stretchy or kinky thermoplastic yarns;

FIG. 2 is an end view of the structure of FIG. 1;

FIG. 3 is a fragmentary top plan view of a pair of false twist spindles and the structure which supports and drives the same;

FIG. 4 is a sectional elevational view taken along line IV—IV of FIG. 3 in the direction of the arrows;

FIG. 5 is a fragmentary axial sectional elevational view of that part of a false twist spindle of the present invention which includes structure around which the yarn is turned while passing through the spindle;

FIG. 6 is a fragmentary elevation showing that part of the structure of FIG. 1 to which additional structure has been added to produce bulk yarn;

FIG. 7 is an end view of the structure of FIG. 6; and

FIG. 8 is a partly sectional elevational view showing a different embodiment of a false twist spindle assembly of the invention.

The apparatus shown in FIGS. 1 and 2 is conventionally referred to in the textile art as an "up-twister." This structure includes conventional up-twister apparatus such as the frame, motor, belt, builder motion apparatus, and take-up mechanism with yarn guides and guide rails.

The up-twister of the invention includes a special magazine creel **1** located at the lowest part of the entire organization and supporting the packages P of thermoplastic yarn Y to be treated according to the present invention. A special heating means **15** according to the present invention is located over the creel and between the latter and the heating means are located a plurality of tensioning means **7** of conventional construction. A plurality of false twist twin spindle assemblies **37**, only one of which is shown in the drawings for the sake of convenience and clarity, having a special construction according to the present invention are located over the heating means **15** and the take-up spools are arranged at an elevation higher than the spindle assemblies, as shown in FIGS. 1 and 2. Thus, the tensioning means **7**, the heating means **15**, and the twisting means **37** are arranged substantially vertically in that order one above the other between the creel **1** and the take-up spools S.

The creel **1** is of a standard construction but is arranged in such a way that the pairs of packages which are at the same elevation have the running out yarn end of one package connected with the starting end of the yarn of the other package so that there will be no interruption in the feeding of the yarn when a yarn package is emptied. Thus, referring to FIG. 1, it will be seen that yarn from the package P_1 passes through a stationary guide eye **2** upwardly through the stationary pigtail guide **4** carried by the statioanry bar **6**. This yarn is designated Y_1. The end of the yarn of package P_1 is connected with the yarn of package P_a so that when the package P_1 is emptied the yarn Y_1 will continue to be fed without interruption, being supplied at this time from the package P_a. During drawing off of the supply of the yarn from the latter package a fresh package is placed at the position of package P_1 and has its yarn connected with the end of the yarn on the package P_a, and this alternate replacing of the emptied packages and connection of the yarn of one package to another is carried out so as to provide continuous uninterrupted operation.

Of course, this supply of yarn takes place simultaneously from a large number of packages, and the drawing shows the packages P_2 and P_b from which the yarn Y_2 is derived, this yarn passing upwardly through the pigtail guide **5** carried by the bar **6** after first passing through the guide eye **3**, as indicated in FIGS. 1 and 2. A large number of creels each of which includes any desired number of pairs of packages arranged one above the other are located in a horizontal row beside each other beneath the heating means **15**.

Immediately above the guides **4** and **5** are located plurality of tensioning means **7** for the plurality of yarns, respectively. The tensioning means are of a conventional construction and each tensioning means includes

a stationary plate carrying a stationary coil spring and having a pair of ears which turnably support a pin which carries a second coil spring the convolutions of which extend between the convolutions of the stationary coil spring. The angular position of this pin is regulated by the operator so as to control the extent to which the convolutions of the springs intermesh, and the yarn passes upwardly between the meshing convolutions of the springs so as to have its upward movement retarded to an adjusted degree by these springs and thus the tension of the yarn is regulated in this way. This tensioning means also serves to stop the backing up of the twist in the yarn beyond the tensioning means to the creel and thus provides a means for holding a constant twist in yarn between the twisting means **37** and the tensioning means **7**. By preventing the twist from backing up to yarn packages, interference in an even flow of yarn from the packages is avoided. FIG. 1 shows the stationary plate **8** carried by the bar **10** and turnably supporting the pin **11** which carries the turnable coil spring whose convolutions mesh to an extent determined by the angular position of the pin **11** with the stationary coil spring directly carried by the plate adjacent to the right edge thereof, as viewed in FIG. 1 so that the yarn Y_1 is tensioned to a predetermined extent by this tensioning means. FIG. 1 also shows the stationary plate **9** and turnable pin **12** of the tensioning means which tensions the yarn Y_2, this pin **12** being connected with the turnable coil spring to adjust the extent to which its convolutions mesh with those of the spring carried by the plate **9**. Of course, the take-up spools S are driven in a conventional manner and the movement of the yarns from the packages and through the tensioning means, heating means, and false twist spindles is derived from the driven take-up spools.

The heating means **15** of the present invention, which heats the yarns during their passage from the tensioning means **7** to the twisting means **37**, includes a closed tank **15'** made of ferrous metal, for example. This tank **15'** is covered at its exterior by an insulating blanket **17** of fiber glass or the like, and this blanket is itself encased with a shell **16** made of plywood or other suitable material. Of course, the insulating blanket and shell are cut away at a small portion thereof at the upper part of the tank **15'** to give access to a plug carried by the top wall of the tank for closing the filling opening thereof, and a similar arrangement may be provided at a suitable lower part of the heating means for emptying the tank.

A plurality of tubes pass vertically through and are carried by the tank **15'**, these tubes also passing through the insulating blanket **17** and shell **16**. A pair of these tubes **13** and **14** are shown with yarns Y_1 and Y_2 passing respectively therethrough, and it is to be understood that a large number of such tubes are provided distributed along the entire heating means and the several yarns pass respectively upwardly through these tubes. Each of the tubes passes through a pair of vertically aligned openings respectively formed in the upper and lower walls of the tank **15'** and through similar aligned openings of the insulating blanket and shell, and each tube is directly welded to the tank **15'** at the openings in the top and bottom walls thereof with weldments extending all around each tube to completely seal the interior of the tank from the outer atmosphere at the places where the tubes are joined to the tank.

Heat is transferred through the tubes to the yarn passing through the same, and this heat is derived from a suitable liquid in the tank **15'** circulating around and against the exterior surfaces of the tubes **13**, **14**. The liquid in the tank is preferably heat transfer oil which fills the tank, this oil being indicated at **18** in FIG. 1. A gear pump **20** is driven by the shaft **21** which extends upwardly through the top of the heating means where the shaft **21** carries a pulley **22** driven by a belt **23** which is in turn driven from any suitable motor and pulley (not

shown). The continuously driven pump 20 causes the liquid in the tank to be continuously circulated, and FIG. 1 shows the inlet 19 of the pump located on the right side thereof, as viewed in FIG. 1, the outlet tube 24 being located on the left side of the pump and extending almost up to the left end of the tank, as viewed in FIG. 1. In this way the temperature of the liquid is maintained constant throughout all parts of the tank and an exceedingly uniform treatment of the yarn is obtained.

The liquid is heated by specifically constructed elongated heating elements 25 and 26 carried by the tank and passing horizontally therethrough. Each heating element is composed of an elongated electrically conductive resistor which converts electrical energy into heat energy, and this resistor is suitably encased within, and insulated from, a steel tube, for example, which is directly welded to the end walls of the tank. The heating elements 25 and 26 are electrically connected with conductors 32 and 33 in the manner indicated in FIG. 1, and these conductors are in turn connected electrically with a conventional inductance relay 31 of the mercury type. The temperature of the oil 18 in the tank is sensed by a thermostat or temperature sensitive switch 27 of conventional construction capable of being regulated by control 28 as diagrammatically shown in FIG. 1 for causing the switch 27 to close automatically when the temperature of the oil falls below a selected value and to open automatically when the temperature of the oil rises above a selected value. This switch 27 is connected electrically with relay 31 by the conductors 29 and 30. When the switch 27 closes, low voltage induced in the conductors 29 and 30 activates a 220 volt circuit in the inductance relay 31 causing electricity to flow through the heating elements 25 and 26 so as to heat the oil in the tank 15'. A manually operable safety fused circuit breaker 34 is included in the circuit between the lines 35 and 36 and the relay 31. The circuit breaker 34, inductance relay 31, and temperature sensitive switch 27 are all conventional commercially available units electrically connected in the above-described manner for maintaining within close limits the temperature of the liquid in the tank at a value selected by setting the switch 27.

The above-described heating means, in addition to providing absolute uniformity of temperature between and among the several ends of yarn passing through said heating means, provides extreme efficiency in the use of electrical energy.

The several yarns after passing through the several vertical tubes carried by the tank 15' respectively pass through a plurality of false twist spindles. These spindles are arranged in pairs so as to form twin false twist spindle assemblies 37, and, as is shown in the drawings, each assembly 37 includes a pair of false twist spindles 38 and 39. This construction is shown in greater detail in FIGS. 3–5. Each of the spindles 38 and 39 is in the form of an elongated tube open at its opposite ends and through which the yarns pass upwardly as indicated in FIGS. 1, 3 and 5.

A support means is provided to support the pair of substantially parallel spindles 38 and 39 of the assembly 37 for respective rotation about their axes. This support means includes for each spindle an inner bearing race 56 fixed to and surrounding the spindle and forming part of a high speed anti-friction ball bearing 53 carried by a cushioning annulus 54 made of neoprene rubber, for example, and embracing the outer race 55 of the bearing (FIG. 4). The support means further includes a housing 40 made up of a pair of die cast metal halves held together by a cap screw 72 (FIG. 3). The two halves of the housing 40 when thus connected together form a pair of interconnected tubular portions the inner surfaces of which tightly press against the exterior surfaces of the rubber cushioning annuli 54 so as to securely hold the latter and thus provide a secure support for the spindles which are still capable of tilting to a limited degree, if necessary, due to yieldability of the annuli 54. Each annulus 54 is located between a pair of inner flanges 57 and 58, additional flanges 59 and 60 being provided for an additional bearing assembly for each spindle, if desired.

The wall portions of the halves of housing 40 located between the tubular portions thereof cooperate to define a tubular recess located between and being parallel to the tubular portions which carry the annuli 54 and carrying in its interior a nylon bushing 66 in which a pin 65 is received with a free sliding fit (FIG. 4). The pin 65 extends downwardly through an opening or notch of a bracket 41 to which the pin 65 is removably fixed by the nuts 70 and 71 which are tightly clamped against the upper and lower faces, respectively, of the bracket 41. Above the lower threaded portion of pin 65 which carries the nuts 70 and 71, the pin 65 has a smooth exterior surface portion carrying a collar 68 of a hexagonal outer periphery to facilitate turning of the collar, and the angular position of the collar on the pin 65 is fixed by a set screw 69. The housing 40 is directly carried by a coil spring 67 coiled around the pin 65 between the collar 68 and the housing 40, the top convolution of the coil spring 67 directly engaging the bottom end face of the nylon bushing 66 while the bottom convolution of the coil spring directly engages the top face of the collar 68. The top end of the coil spring is fixed with the housing 40 by entering into an opening thereof, and the bottom end of the coil spring is fixed with the collar 68 as by extending into an opening thereof. The drive belt 43 for driving the spindles extends between the pair of spindles over the housing 40 in the example illustrated in FIGS. 3 and 4 and the angular position of the collar 68 is set so that the spring 67 will urge the spindles 38 and 39 with the necessary pressure respectively against the opposite faces of the drive belt which will thus simultaneously rotate the pair of spindles of the assembly 37 in opposite directions, respectively. Thus, the spring 67 supports the housing 40 for yieldable springy vertical movement and at the same time presses the spindles against the drive belt. A large number of assemblies 37 are arranged in a pair of straight parallel rows over the heating means longitudinally thereof, one of these rows of assemblies 37 being respectively carried by brackets 41 which are carried by the left stationary bar 42 of FIG. 2. As may be seen in FIG. 2, a second bar 42 is located at the elevation of the left bar 42 and carries a plurality of brackets 41 which extend toward the right edge of the tank 15', as viewed in FIG. 2, and carry the second row assemblies 37 which are arranged along the opposite side of the tank over the latter.

As is apparent from FIG. 4, the upper portion of the pin 65 which extends into the bushing 66 is of a reduced diameter and just above the collar 68 the pin 65 has an upwardly directed shoulder which limits the downward movement of the housing 40.

The belt 43 which drives all of the spindles has one run extending between the pairs of spindles of the left row of assemblies 37 of FIG. 2 and the other run of this belt extends between and engages the spindles of the right row of assemblies 37 of FIG. 2, this belt being driven by any suitable pulley and motor and being guided by at least one additional pulley (not shown).

As is shown most clearly in FIG. 5, each spindle 38, 39 etc. is provided adjacent to its top end with a transverse bore 100 and it is formed at its exterior surface with an axial groove 101 extending upwardly from the bore 100 and with an annular groove 102 extending around the exterior of the spindle between the bore 100 and the top end of the spindle. A ceramic liner 103 is carried by the spindle over the bore 100, if desired.

A springy wire 62 has a vertical leg located in the axial groove 101 and a right angle bend on its upper end extending into a small hole drilled into spindle in bottom of groove 101 which stabilizes the wire, and a snap ring 63

is located in the groove 102 and holds the wire 62 clamped tightly to the spindle. The springy wire 62 has a horizontal leg 64 extending transversely of the spindle through the bore 100 thereof and the free end of the horizontal leg 64 is bent back upon itself as shown in FIG. 5. It will be noted that the horizontal leg 64 is located substantially along the axis of the bore 100 and is actually inclined with respect to this axis in the manner shown in FIG. 5. When not in use the springy wire 62 will have the position illustrated in FIG. 5. This wire forms a reverse false twist element and the yarn is wound through at least one turn on the horizontal leg of the wire before passing upwardly through the portion of the spindle above the bore 11 thereon. During operation the upward pull of the yarn will deflect the horizontal leg 64 upwardly through a slight distance until the left free end of leg 64, as viewed in FIG. 5, engages the spindle at the left upper portion of the bore 100, as viewed in FIG. 5, and the wire 62 will remain in this position during the operation, the yarn slipping around the wire while moving upwardly through the spindle so that it acts as a false twister.

The embodiment of the spindle assembly shown in FIG. 8 is identical with that of FIG. 4 except that the housing 40' is shorter and the spindles 38' and 39' extend to a relatively short distance above the housing and have elongated portions extending downwardly beyond the housing and the belt 43 in this case passes beneath the housing 40 to engage the spindle portions located below the housing 40. In addition to the material saving in the housing 40' as compared with the housing 40, the embodiment of FIG. 8 makes it possible when removing a twin spindle assembly from its bracket to simply raise the assembly upwardly from the belt 43, while with the embodiment of FIG. 4 it is necessary to lower the spindle assembly away from the belt in order to remove the spindle assembly.

The yarns after passing through the false twist spindles continue to the take-up spools. As may be seen from FIGS. 1 and 2, the take-up spool S_1 has the pair of oppositely curled yarns Y_1 and Y_2 delivered thereto by a yarn guide means of conventional construction carried by the rail 48. This yarn guide includes the base member 47 fixed to the rail 48 and carrying the substantially horizontal guide arm 44 over which the pair of yarns Y_1 and Y_2 pass to a second guide arm 45 carried by the base member 47. The angular position of the guide arms 44 and 45 can be adjusted. The pair of yarns which are combined together pass around the vertical leg of arm 45 to a ceramic yarn guiding element 46 on a third arm which is pivotally supported on the base member 47 and turned back and forth so as to build up the spool S_1 in the manner shown in FIG. 1. The element 46 has a groove through which the pair of combined, oppositely curled yarns pass, and thus a doubled yarn composed of a pair of oppositely curled yarns is wound on the take-up spool. The spool is driven in a conventional way by the driving roll 52 and is supported by a pair of arms 49 and 50 carried by the bar 51. All of the take-up spools are arranged and driven in the same way with the doubled yarn delivered thereto in the same way, and, as is apparent from FIGS. 1 and 2, there are two decks of take-up spools arranged over each row of twin spindle assemblies 37.

With the above-described structure a curl or kink is permanently set into the thermoplastic yarn below the wire 62 where the yarn is twisted, and then the yarn is untwisted above wire 62 leaving curls or kinks in the individual filaments so that the yarn is elastic or stretchy. When it is desired to remove some of this stretchiness or kinkiness so as to produce a bulked yarn, a second heating means 110, shown in FIGS. 6 and 7, is arranged over each row of spindle assemblies 37. The heating means 110 takes the form of a cylindrical tank having tubes passing therethrough so that the several yarns pass respectively through these tubes before reaching the take-up spool. Thus, FIGS. 6 and 7 show the cylindrical tank 111 which may be supported by any suitable structure (not shown) and through which heating elements 112 and 113 longitudinally extend. The tank 111 is insulated in the same way as the tank 15' and is filled with a liquid such as oil, and this liquid is automatically maintained at a desired temperature and circulated through the tank with structure the same as that described above in connection with the heating means 15. Tubes 13 and 14 are shown in FIG. 1. Passing through the heating means 110 are similar tubes 13', 14', and these tubes are welded to the tank 111 in the same way that tubes 13 and 14 are welded to tank 15', to provide a fluid-tight secure connection therewith.

FIG. 1 shows additional yarns Y_3 and Y_4 combined together and taken up on spool S_2 of the lower deck, and FIG. 6 shows these yarns passing respectively through a pair of additional tubes of the second heating means before reaching the take-up spool S_2. The yarns Y_1 and Y_2 are shown passing through the tubes 13' and 14'.

Returning to FIG. 5, it will be seen that each spindle carries at its top end the ceramic guide eye 103. Each spindle has an outside diameter, in an actual construction which has been used, of approximately 5/16" and the bore thereof is 1/8". The heating elements 25 and 26, as well as 112 and 113 are approximately 26.5 feet long and the tanks 15' and 111 have a corresponding length.

The heater tubes 13, 14 are 17.35 inches long and 12 inches of their length are surrounded by the heated oil. The distance from the top of the tubes 13, 14 etc. to the lower deck of take-up spools is approximately 30 inches long while the distance from these tubes to the upper deck has a length of approximately 40 inches. The tubes of the upper heater are approximately 12 inches long. The bottom ends of these tubes are spaced above the top ends of the spindles by approximately 5.75 inches. The top ends of the tubes of the upper heater are approximately 2.75 inches below the lower deck of take-up spools and 12.75 inches below the upper deck of take-up spools.

Of course, these dimensions of a specific embodiment of the invention which has been constructed are not essential to the invention and are only presented to give a rough idea of the size of the elements. The length of the heater tubes is one of the factors which determine the exposure time of the yarn to the heat. The heater tubes are longer than conventional heating devices so as to provide a relatively long period of exposure of the yarn to heat and thus enable the use of a lower controlled temperature than in conventional apparatus.

Any thermoplastic yarns may be treated with the process and apparatus of the invention. As a specific example, a 34 filament 70 denier nylon yarn was treated in the matter now to be described to produce a yarn of strong elastic quality intended primarily for use in men's hosiery, although it may be used for other textile purposes, and other mutlifilament nylon, Dacron, tri-acetate or other thermoplastic yarn of any denier could be treated. The oil, in the specific case of 34 filament 70 denier nylon yarn, was maintained in the heating means 15 at a temperature of approximately 440° F. while the yarn traveled through the tubes of the heater at a linear speed of approximately 1 foot per second of unprocessed yarn. In this case the spindles were rotated at a speed of 36,000 r.p.m. Under other conditions as when working with other materials or when producing yarns for different purposes, it is possible to increase the spindle speed up to approximately 72,000 r.p.m. and an oil temperature of approximately 460° F. could be used with a yarn speed of approximately 2 feet per second of the unprocessed yarn. Any desired combination of spindle speeds and temperatures can be used. The yarn, in the specific example of 34 filament 70 denier nylon with a spindle speed of 36,000 r.p.m. and an oil temperature of 440° F., was turned once around the reverse twist wire

of the spindle, this turn of the yarn being clockwise for the Z twist yarn and counterclockwise for the S twist yarn. Of course, the speed of movement of the unprocessed yarn, 1 foot per second in this specific example, is obtained by the speed of rotation of the take-up spool.

With 34 filament 70 denier nylon yarn treated in this way, 12 inches of the unprocessed yarn was shortened to 2½ inches of finished yarn in the relaxed condition thereof. 12 inches of relaxed yarn processed in this way may be stretched to an average of 54.5 inches before breaking while 12 inches of the unprocessed yarn can be stretched to only 13.25 inches before breaking.

The yarn on the take-up spools may be moved from the latter through a down twister to have twist placed in the doubled yarn so as to prevent the oppositely twisted pair of yarns from coming apart. In the above example an additional twist of 2½ turns per inch is applied to the doubled yarn for this purpose.

Where the second heating means **110** is used for producing bulked yarn the temperature of the oil of the second heating means is maintained approximately 40° F. below the temperature of the oil in the heating means **15**, although the temperature of the oil in the secondary heater can be regulated to remove any desired amount of stretch, the higher the temperature of the oil in the second heater the greater the amount of stretch removed. The linear speed of the yarn through the secondary heater is of course the same as that of the processed yarn, approximately 1 foot per second in the above example.

Irrespective of the particular yarn treated, the temperature of the liquid in the heating means **15** is sufficiently high to place the yarn in a plastic condition but at a temperature below its melting point as it passes through a tube of the heating means. The twisting means over the heating means twists the yarn in the tube while this yarn is in a plastic condition, and when the yarn passes upwardly beyond the tube the outer atmosphere suddenly cools the yarn so as to set the twist therein.

With the present invention a machine normally carrying approximately 200 (two hundred) spindles can carry or operate 400 (four hundred) spindles thereby doubling the productive capacity of a given machine without increasing the floor space occupied by it.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of yarn treating process and apparatus differing from the types described above.

While the invention has been illustrated and described as embodied in thermoplastic yarn treating process and apparatus, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In an apparatus for treating thermoplastic yarns, in combination, a container adapted to contain a liquid such as oil; a plurality of yarn-guiding tubes carried by and passing through the container so that the liquid therein will engage the exterior surfaces of the tube but not the interior surfaces thereof, said exterior tube surfaces being engaged in the interior of the container only by the liquid therein; means located in said container for circulating the liquid in the same so that the liquid circulates around and against the exterior surfaces of the tubes; and means cooperating with the container for maintaining the liquid therein automatically at a desired temperature.

2. In an apparatus for treating thermoplastic yarns, in combination, a closed container adapted to contain a liquid such as oil, said container having top and bottom walls; a plurality of yarn-guiding tubes carried by said container and passing substantially vertically therethrough, said tubes extending fluid-tightly through said top and bottom walls of said container so that the liquid therein will engage the exterior surfaces of the tubes, the portion of each tube which extends between said top and bottom walls being completely exposed to the liquid in said container and all of said tubes being located in a common space in said container; means located in said container for circulating the liquid in said common space so that the liquid circulates around and against the exterior surfaces of the tubes; and means cooperating with the container for maintaining the liquid therein automatically at a desired temperature.

3. In an apparatus for treating thermoplastic yarns, in combination, an elongated container adapted to contain a liquid such as oil, said container having a pair of opposed end walls; a plurality of yarn-guiding tubes carried by and passing through the container so that the liquid therein will engage the exterior surfaces of the tubes, said tubes being located in a common space in the interior of said container and the entire exterior surfaces of said tubes in said common space being completely exposed to the liquid in said space; means located in said container for circulating the liquid in said common space, so that the liquid circulates around and against the exterior surfaces of the tubes; elongated heating means extending through the interior of the container through the common space therein between said end walls thereof for heating the liquid therein; and means cooperating with said heating means and with the liquid in the container for actuating said heating means to maintain the liquid in the container substantially at a constant, preselected temperature.

4. In an apparatus for treating thermoplastic yarns, in combination, an elongated container adapted to contain a liquid such as oil, said container having a pair of opposed end walls as well as top and bottom walls and said container being entirely closed; a plurality of substantially vertical yarn-guiding tubes carried by and extending through the top and bottom walls of the container as well as through the interior thereof, said tubes respectively having fluid-tight connections with said top and bottom walls of the container so that the liquid in the latter will engage the exterior surfaces of the tubes, all of said tubes being located in a common space in the interior of said container and the entire exterior surfaces of said tubes between said top and bottom walls of said container being exposed to said liquid in said common space; means located within said container for circulating the liquid in said common space so that the liquid circulates around and against the exterior surfaces of the tubes; elongated heating means extending longitudinally through the interior of said container in said common space thereof between said end walls thereof; and means cooperating with said heating means and the liquid in the container for actuating the heating means to maintain the liquid at a pre-selected range of temperatures.

5. In an apparatus for treating thermoplastic yarns, in combination, an elongated container adapted to contain a liquid such as oil, said container being entirely closed an having top and bottom walls as well as a pair of opposed end walls; a plurality of substantially vertical yarn-guiding tubes extending through the interior of the container and through said top and bottom walls thereof in a fluid-tight manner, so that the liquid in the container engages the exterior surfaces of the

tubes, all of said tubes being located within a common space in the interior of said contained and the entire exterior surface of each tube between said top and bottom walls of said container being exposed to liquid in said common space; elongated heating means extending longitudinally through the interior of said container in said common space thereof between said end walls thereof; pump means located in said container at a lower portion thereof and adjacent one of said end walls thereof, said pump means including an elongated conduit which extends from said pump means along substantially the entire length of the container to the other end thereof through said common space so that when said pump means is operated the liquid in the container will be circulated therethrough; and means cooperating with said heating means and the liquid in the container

for actuating the heating means to maintain the liquid in the container substantially at a preselected temperature.

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