METHOD AND APPARATUS FOR TEXTURING YARN

Filed April 21, 1967

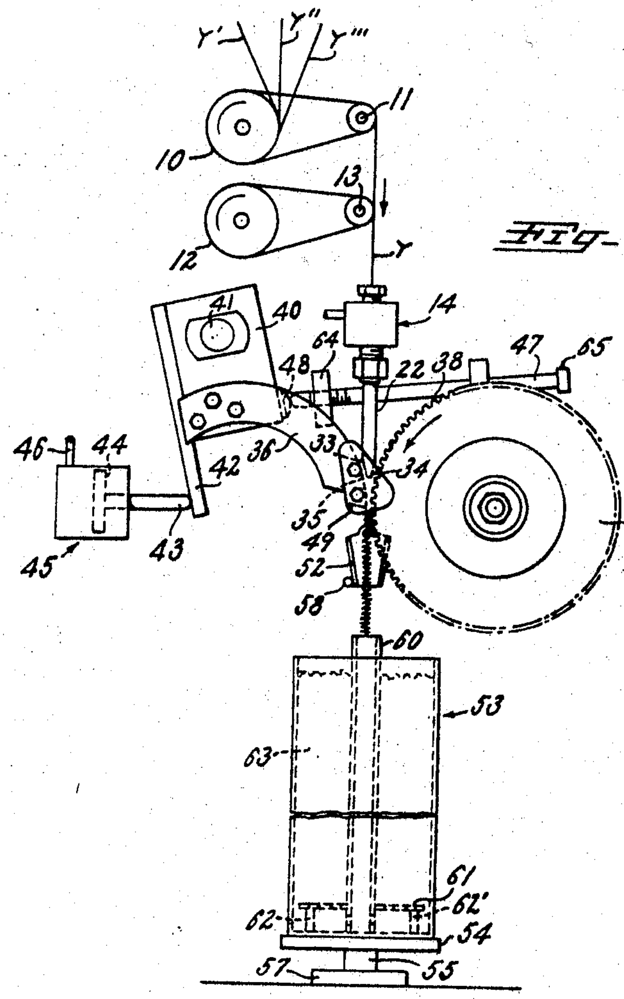

FIG. 1

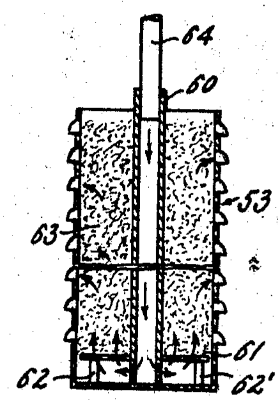

FIG. 4

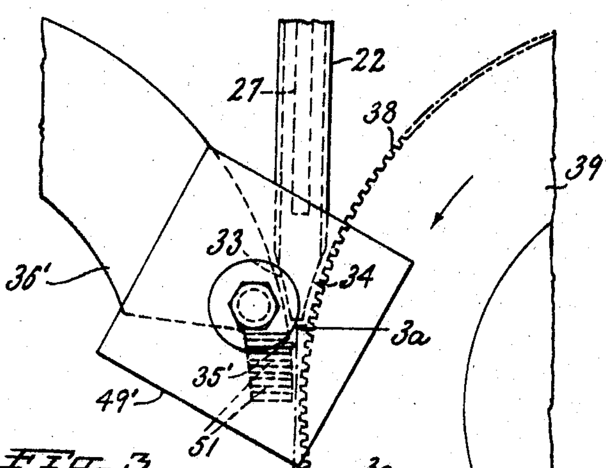

FIG. 3

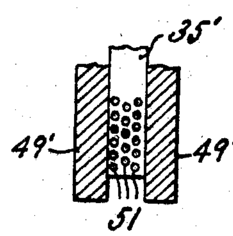

FIG. 3a

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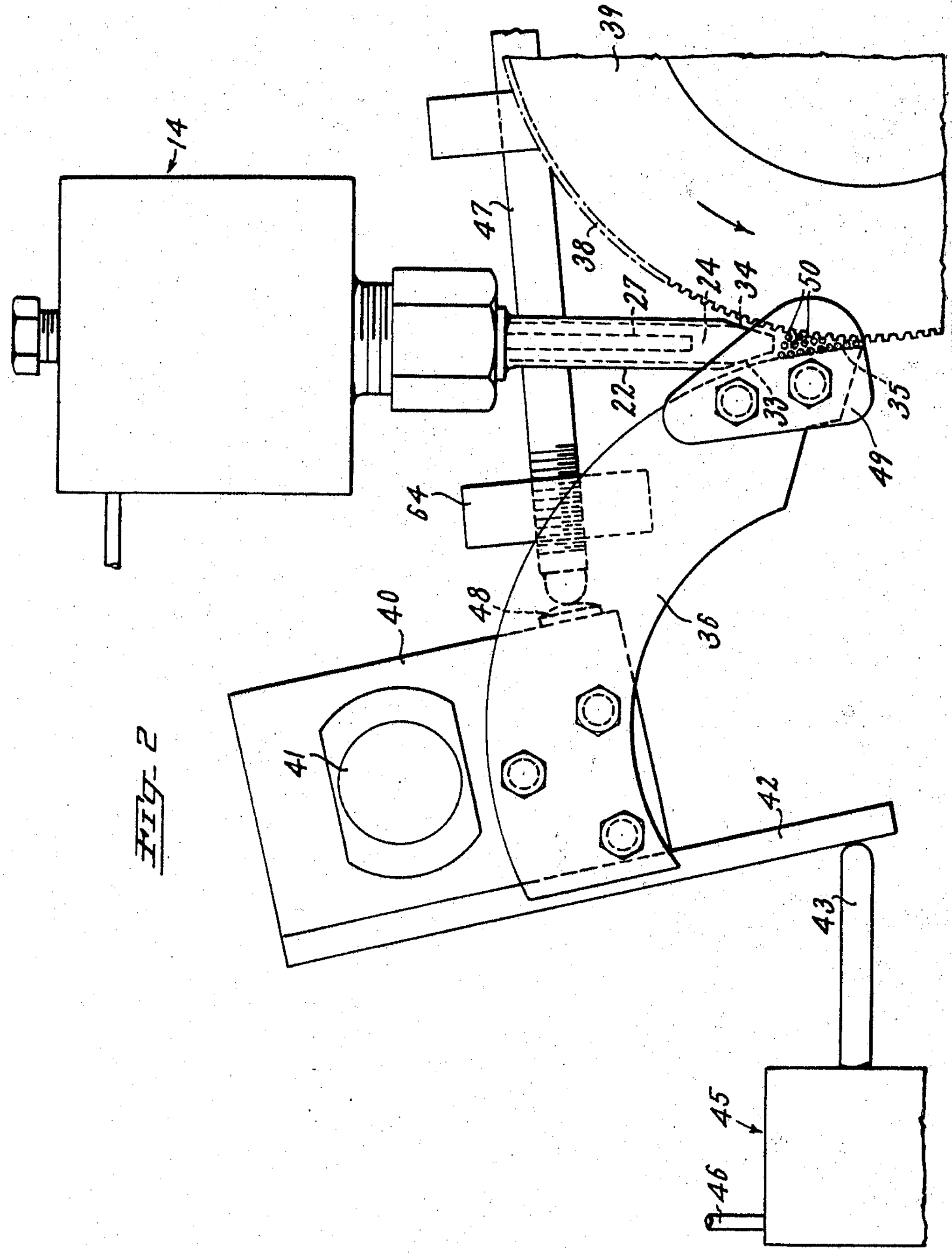

FIG. 2

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METHOD AND APPARATUS FOR TEXTURING YARN

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U.S. Cl. 28—1 15 Claims

ABSTRACT OF THE DISCLOSURE

Thermoplastic yarns are textured by a method and apparatus in which the yarn is jetted into a nip of two arcuate surfaces to longitudinally compress the same and pack it in the nip, it is passed through the nip in its packed condition and drops under substantially no tension other than its own weight, and still in its crimped condition, into a container or conveyor and set. The setting may take the form of reheating and subsequently cooling the yarn before subjecting it to longitudinal tension.

This invention relates to a method and apparatus for texturing thermoplastic yarn.

In United States patent application of Shichman et al. Ser. No. 373,686, filed June 9, 1964, now U.S. Patent No. 3,363,041, granted Jan. 9, 1968, of common ownership, there is disclosed a method and apparatus for crimping textile yarns in which the yarn is jetted toward the nip formed by a pair of arcuate surfaces.

This invention relates to an improved method and apparatus for texturing yarn by jetting the yarn toward a nip. In accordance with one embodiment of this invention a nip is formed between a pair of arcuate surfaces at least one of which is movable and has a rugose yarn contacting surface to which the yarn does not strongly adhere, i.e. one which will allow the yarn to fall therefrom under substantially its own weight, but which is adapted to advance crimped yarn through the nip as the rugose surface advances. At the nip, these surfaces are spaced from each other a finite distance sufficiently small to provide a resistance to the longitudinal advance of the yarn and not large enough to lose the compressive force on the yarn as it is hurled by the hot gas jet toward this nip, yet a distance sufficiently great that the yarn driving force generated by the gas acting on the yarn is not lost. Yarn to be textured is introduced into a moving stream of heated gas which is directed toward the nip, and the gas hurls the yarn longitudinally of itself toward the nip to pack the yarn into a chamber partially blocked by the arcuate surfaces, and the gas is vented through vents in a surface past which the yarn advances. The movable surface is advanced toward the nip to carry the yarn through the nip, after which the yarn falls from the nip still in a crimped condition. The yarn is cooled in this crimped condition or, if desired, further heat set, and subsequently wound up.

The invention will be further described with reference to the accompanying drawings forming a part hereof, wherein:

FIG. 1 is a schematic elevational view of an apparatus according to the invention suitable for carrying out the method of the invention;

FIG. 2 is an enlarged view showing the arcuate surfaces and the delivery tube used in the apparatus of FIG. 1;

FIG. 3 is a fragmentary view similar to FIG. 2 showing a modified form of apparatus;

FIG. 3*a* is a fragmentary view along the line 3*a*—3*a* of FIG. 3, and

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FIG. 4 is a view illustrating the reheating of the crimped yarn.

A first embodiment of texturing apparatus according to this invention is illustrated in FIGS. 1 and 2. A second embodiment of texturing apparatus according to this invention is illustrated in FIGS. 3 and 3*a*. FIG. 4 illustrates a heat setting step which may be used to treat yarn crimped on either of these two texturing apparatus. The method will be described with reference to these embodiments of apparatus.

Referring first to the embodiment disclosed in FIGS. 1 and 2 texturing apparatus in accordance with this invention is shown in conjunction with draw rolls which are adapted to draw an undrawn thermoplastic yarn Y, for example, a polypropylene multifilament continuous filament yarn. In the embodiment shown, three yarns Y′, Y″ and Y‴ are doubled to make the single larger yarn Y. This yarn Y is delivered to a first pair of godet rolls **10, 11** and thence to a second pair of godet rolls **12, 13.** As is customary, each pair of godet rolls consists of a relatively large roll **10** or **12** and a relatively small roll **11** or **13** with the two rolls in a pair arranged at an axis angle to each other so as to advance yarn in a series of spaced loops about the pair. Yarn Y is wrapped 6 to 8 times about each pair of driven godet rolls, and is advanced from the last pair **12, 13** to a texturing apparatus in accordance with this invention.

In the apparatus shown in these figures, the undrawn yarn Y is drawn between the two pair of godet rolls. In one example where 14,800 denier undrawn multifilament polypropylene yarn made up of 3 doubled strands, each having 156 filaments, is processed, roll **10** is heated to 200–270° F. and is rotated at a surface speed of 300 feet per minute, while roll **12**, is rotated at a surface speed of 1200 feet per minute to draw the yarn Y four to one between the pairs of rolls.

The drawn yarn Y next enters a steam propulsion device indicated generally at **14.** This steam propulsion device **14** is of the type disclosed in the aforesaid application. Within device **14** saturated steam at 130 p.s.i. is fed in an annular path past the lower end of a hypodermic needle **27** which projects into a cylindrical cavity **24** in extension **22.** When arcuate surfaces ¼″ thick are used, as will be described hereinafter, extension **22** too is about ¼″ thick and preferably slightly less, e.g. 242″, for clearance, and in the embodiments shown is rectangular in exterior cross-section except where cut away to provide complementary arcuate surfaces **33, 34,** to be described hereinafter. The lower end of the needle terminates a substantial distance short of the lower terminus of this cavity **24** which terminus in turn is located at the lower faces of extension **22.** Projection **22** has lower concave faces **33, 34** shaped to arcs substantially complementary to the arcs of the surfaces next to be described.

The yarn Y, which is fed into the upper end of the hypodermic needle **27,** in hurled from its lower end and toward the nip of a pair of arcuate surfaces, as appears best in FIG. 2. In this embodiment a first, smooth, arcuate surface **35** is the radially outer surface of a segment **36** of a cylindrical metal disc-like member about ¼″ wide or thick, i.e. measured normal to the plane of the paper in FIG. 2. A second generally arcuate but rugose surface **38** is formed on the radially outer surface of a 6″ outer diameter cylindrical roll **39,** also about ¼″ wide or thick, i.e. measured normal to the plane of the paper in FIG. 2. In one example segment **36** is .253″ thick while roll **39** is .243″, the difference providing clearance for roll **39** to rotate between side plates **49,** to be described, which are bolted to segment **36.** The rugosity of surface **38** is formed by 280 48 pitch, 14½° pressure angle teeth of .045″ depth which are cut in from the outer periphery of the cylinder roll **39.** Although gear toothike surfaces are now preferred, other rugose surfaces, such as knurled surfaces, may be employed. Desirably the arc of surface **35** may have the same outer diameter as the outer diameter of the gear tooth-like projections on surface **38**, i.e., in this embodiment 6", although slightly different diameters may be used, for example, a diameter may be used which is equal to the root diameter on the gear tooth-like surface **38**, i.e., 5.91" when a 6" diameter, .045" gear depth roll is employed. Roll **39** is rotatably mounted on the machine frame with its axis substantially parallel to the axis of arcuate surface **35**, to be driven about its axis by means (not shown) in the direction indicated by the arrow on FIG. 2 to advance the surface **38** toward and through the nip in the same direction as the yarn is hurled toward the nip.

Extension **22** fits into the nip between surfaces **35** and **38** with faces **33** and **34** opposed thereto and closely spaced therefrom. Thus a chamber in which yarn Y may by packed is provided beneath the lower tip of the hypodermic needle and in advance of the line of nearest approach of surfaces **35**, **38** to each other.

Although surface **35** is fixed in the embodiment shown, in the sense it does not advance toward the nip, it may be moved slightly to enlarge the spacing of the surfaces in a direction normal thereto at the narrowest part of the nip to accommodate the passage of a thicker yarn pack therethrough. In this embodiment this is achieved by bolting segment **36** on a plate **40** which in turn is pivoted about an axis pin **41** mounted on the machine frame. Plate **40** carries lever arm **42** against which an extension **43**, fixed to the piston **44** of an air cylinder **45**, presses. For the above-mentioned 14,800 denier polypropylene example, a suitable arrangement utilizes air under 40 pounds pressure which is admitted to the rear of a 1" diameter piston **44** in cylinder **45** through inlet pipe **46** to urge segment **36** toward roll **39**. In the embodiment shown the extension **43** impinges upon lever arm **42** along a horizontal line passing through the axis of rotation of roll **39** and through the lowermost tip of surface **35** on segment **36** which tip is also disposed substantially at the line of nearest approach of surfaces **35**, **38**, i.e. at the narrowest part of the nip.

Means are provided to maintain surface **35** on segment **36** spaced a finite distance from the path followed by the radially outermost faces of the teeth on surface **38** at the nearest approach of these faces to surface **35**. In the embodiment shown, this means is adjustable and comprises a fixed, but adjustable, screw stop **47** threaded in fixed nut **64** so stop **47** moves longitudinally of itself toward or away from plate **40** as head **65** is rotated. A pressure pad **48** on plate **40** impinges against stop **47** to limit movement of segment **36** toward roll **39**. For the above-mentioned 14,800 denier polypropylene example, a suitable minimum gap between surface **35** and the path followed by the outermost faces of the teeth on roll **39** in their rotation is .015" at the line of nearest approach between surface **35** and this path, and a suitable linear peripheral speed of such faces along this path is 220 feet per minute. For the above-mentioned example, a suitable minimum spacing between surface **33** and the opposed surface **35** and, between surface **34** and the opposed path travelled by the outermost faces of the teeth on roll **39**, is .025", each, measured in a direction normal to the surface **35** or path of travel of the teeth on roll **39**, as the case may be. In one operating position of the above example the true center of segment **36** is on the same horizontal line as the center of roll **39**, and the lowermost tip of surface **35** lies from ½" to 9⁄16" below the lower end of extension **22**.

In the now preferred embodiments, the width, or thickness, of surfaces **35** and **38** which determines the width of the nip is kept relatively small, desirably less than 1 inch, and the above described ¼" width gives excellent results. The sides of the nip are closed by a pair of side plates bolted to the segment **36**. One of these side plates **49** is seen in FIG. 2 at the front of the device and it is duplicated by a second, not visible in the drawing, which is bolted to segment **36** at the rear of the device. As can be seen, the side plates bridge the nip between the two surfaces **35**, **38** from at least as far down as, or slightly below, the line of nearest approach of the surfaces to each other, and at least as far thereabove as, or slightly above, the point at which the interior of extension **22** is first in communication with the nip which occurs where the cuts made to form surfaces **33**, **34** first intersect cavity **24**. Thus these side plates **49** closely embrace the sides of segment **36**, roll **39** and extension **22** and close the sides of the nip.

In the embodiment shown in FIGS. 1 and 2 a series of holes **50** are drilled through the plates **49** at the nip so that steam from the jet device **14** is vented to the atmosphere through these holes in the fixed plates **49** after escaping from the interior of projection **22**. In one embodiment of the device shown in FIG. 2, 16 holes **50**, each 3⁄64" in diameter, are drilled through side plates **49** in three side-by-side columns of **9**, **5** and **2** respectively, which open into the nip as shown, to vent the space between the surfaces **35**, **38** above their line of nearest approach to each other.

A modified device is shown in FIG. 3 of the drawing. This device is generally identical to the device shown in FIG. 2 excepting that the side plates **49'** in the FIG. 3 device are imperforate and the surface **35'** in segment **36'** has a number of steam escape holes **51** drilled radially therethrough adjacent the nip.

In this embodiment of the device as shown in FIG. 3a 17 holes **51**, each 3⁄64" in diameter, are drilled through segment **36'** in three side-by-side columns extending over approximately the lowermost ½" of arc of surface **35'** of segment **36'** with 6 holes in the two outside columns (as viewed from a position spaced from surface **35'** in a direction normal thereto) and five holes in a middle column vertically staggered between horizontally aligned holes in the two outside columns.

Although the theory of operation of devices of this type is only imperfectly understood, when the surfaces **35**, **38** are too close together tension is lost on the yarn entering the propulsion device **14**, and the driving force on the yarn is lost. It is thought this driving force created by the steam is due to aspiration of yarn from the lower end of the hypodermic needle and in part results from friction of the advancing steam on the yarn. If the surfaces are too far apart, the yarn is blown through the nip without extensive crimping because a resistance against which the driving force must act in order to crimp the yarn by compressing the same longitudinally of itself as desired herein is lost.

Rolls **38** or **38'** are driven to rotate toward the nip, counterclockwise as viewed in FIGS. 2 and 3, respectively to carry yarn through the nip. From the nip the yarn in a crimped condition falls under substantially no tension greater than that created by its own weight onto a bent sheet metal trough **52** which directs the same into an annular cross-section chamber in cylindrical can **53** carried on a turntable **54** rotatable about the center of can **53** by drive means (not shown). Turntable **54** is carried by driven shaft **55** journaled in bearings in stand **57**. A rod **58** is fixed to trough **52** and, reciprocates back and forth, toward the viewer in FIG. 1, to distribute the crimped yarn in a uniform manner within can **53** as the can rotates with turntable **54**.

The yarn as it is delivered from the nip to be collected in can **53** is in the form of a somewhat ribbon-like band in which the crimped yarn follows a somewhat chevron shaped path from side to side of the band. The width of the band is substantially equal to the width of the surfaces **35**, **38** between the plates **49**; in embodiments where these surfaces are ¼" wide the ribbon-like band is approximately ¼" wide and generally is a single yarn strand thick.

The can 53 has louvered sides and a central hollow pipe or tube 60 passing from its top to its bottom. A perforated false bottom 61 is held spaced slightly above the true bottom of can 53 by spacers 62, 62′ and tube 60 has perforations therethrough communicating with the space between the perforated false bottom 62 and the true bottom of can 53. The yarn received from the nip is collected in a mass 63 in the can 53. When saturated steam is used in the texturing jet at the delivery speeds discussed above, the yarn is still at an elevated temperature as it is delivered from the nip. Conveniently it may be cooled, still in substantially the crimped condition in which it is received from the nip, while still in the can 53.

Although a can is shown as the receptacle in the drawing and this is found to be convenient for the sometimes preferred reheating step next to be described, it will be obvious that the yarn may be received on a belt or any other suitable device where it may be cooled to set the crimp to the extent desired before being "pulled-out" under slight tension as disclosed in the aforesaid copending application.

It is sometimes desirable to reheat the yarn while still in substantially the crimped condition in which it is received from the nip. In this case the use of a can 53 of the construction shown is especially desirable. When the desired mass of crimped yarn has been deposited in the can 53, the can may be removed from the turntable 54 and transported to a heating area where a tube 64 is placed in the central pipe 60. Hot air is blown through the tube 64, down the pipe 60 and out the holes in pipe 60 beneath the perforated false bottom 61 to be blown up through the mass of fiber in can 53.

In this reheating, when polypropylene is being processed, hot air at a temperature at least 200° F. is blown through the mass for a period of time of at least one hour to thoroughly heat the fiber after which cool air at room temperature is blown through the mass for at least 10 minutes to cool the fiber beneath its heat forming temperature. In one example of heat setting the above-described 14,800 denier polypropylene yarn in a substantially full can 3″ high and 13″ in diameter, hot air at 210–240° F. is blown through the mass for one and one-half hours to heat the same after which room temperature air is blown through the mass for 15 minutes to cool the same. Although a louvered can has been shown in the drawing, it will be appreciated that a can may be used whose sides are closed all the way to the top and not merely opposite the space between the false and true bottoms, in which case the hot air blown through the mass can escape only through the open upper end of the can.

The relative treating conditions may be varied within limits. The yarn should be fed to the hypodermic needle at a linear speed not less than five times faster than the linear speed of the surface 38 of roll 39. Other thermoplastic yarns, for example, nylon, polyester, and cellulose acetate, may be processed on this apparatus, and the process conditions would be modified as appropriate for such yarns.

Other heated gases may be used in place of steam but this is most commonly available in economical form. Whatever gas is used, desirably it should be at an elevated temperature of 212° F. or higher.

Having thus described our invention, what we claim and desire to protect by Letters Patent is:

1. A method of texturing thermoplastic multi-filament yarn, which comprises introducing the yarn to be textured into a moving stream of heated gas, hurling the yarn longitudinally of itself by means of said gas toward the nip of a pair of converging arcuate surfaces at least one of which is movable about the center of its arc, said movable surface being a rugose surface to which the yarn does not strongly adhere, advancing said rugose surface toward said nip, maintaining the surfaces at their nearest approach to each other spaced from each other

a finite distance sufficiently small to provide a resistance to the longitudinal advance of the yarn but not large enough to lose the compressive force on the yarn, packing the yarn into a chamber at such nip, venting the gas from said chamber at such nip through vents in a surface past which the yarn passes, advancing the packed yarn through the nip by means of said rugose surface, removing said yarn in its crimped condition from said surface under substantially no tension, and setting the crimp induced in the yarn.

2. A method according to claim 1 including the step of packing the yarn into a chamber formed at least in part by said surfaces and a pair of side plates at said nip, venting the steam at least in part through fixed vents, and removing the yarn from said surface while under no tension substantially greater than that induced by its own weight.

3. A method according to claim 2 including the step of venting the steam through vents in said side plates.

4. A method according to claim 2 including the step of venting the steam through vents in a fixed one of said arcuate surfaces.

5. A method according to claim 2 including the step of reheating the yarn to above its heat setting temperature and subsequently cooling the same while the yarn is in a condition in which it retains a major part of the crimped configuration it has as it is delivered by said advancing surface.

6. A method of texturing thermoplastic yarns which comprises introducing the yarn to be textured into a moving stream of steam, hurling the yarn longitudinally of itself by means of said stream toward a nip formed by a first arcuate surface and a rotatable roll having a rugose surface to which the yarn has no substantial adherence, each said surface toward which the yarn is hurled having a width less than about one inch at the nip and the nip being closed at each side by side plates throughout the nip zone toward which the yarn is hurled, packing the yarn into a chamber at said nip, venting the steam from the nip away from said roll, rotating said roll to advance its rugose surface through the nip in the direction of yarn advance thereforward and to carry the yarn through the nip, maintaining said surfaces at their nearest approach to each other spaced from each other a finite distance less than that at which longitudinal compressive force on the yarn is lost, dropping the crimped yarn from said nip under substantially no tension greater than that induced by its own weight, collecting the dropped yarn, and setting the crimp induced in the yarn.

7. A method according to claim 6 in which the first arcuate surface and the side plates are fixed and the steam is vented through openings in the side plates.

8. A method according to claim 6 in which said first arcuate surface is fixed and the steam is vented through openings in said fixed arcuate surface.

9. A method according to claim 6 including the step of reheating the yarn to above its heat setting temperature and subsequently cooling the same while the yarn is still in substantially the crimped condition in which it was collected.

10. A method according to claim 9 in which said first arcuate surface is fixed, the steam is vented through openings in said fixed arcuate surface and the yarn is hurled toward said nip at a linear speed at least five times the linear speed of said rugose surface toward the nip.

11. A method of texturing polypropylene yarn according to claim 10 in which the crimped yarn is reheated by blowing air at least 200° F. through a mass of the yarn for at least one hour and subsequently cooled by blowing air at substantially room temperature through the mass of yarn for at least 10 minutes.

12. Apparatus for texturing yarn comprising a pair of arcuate surfaces arranged to form a nip therebetween, at

least one of said surfaces being movable about the center of its arc and having a rugose surface to which the yarn does not strongly adhere, said surfaces at their nip being spaced a finite distance apart but not far enough to lose the compressive force on a yarn to be passed therethrough, a gas jet device projecting into said nip in close proximity to said surfaces through which yarn may be hurled toward said nip to crimp the same, means closing said nip at each side of said surfaces, fixed means venting the gas from said nip, means to advance said rugose surface toward the nip in the direction of yarn advance thereto to advance the crimped yarn through the nip, and receiving means beneath the nip to receive the crimped yarn as it falls from said nip under substantially its own weight.

13. Apparatus in accordance with claim **12** in which said rugose surface is on a rotatable roll and in which the other surface is fixed, said means closing said nip at each side of said surface being fixed and having openings therein at the nip through which the gas is vented.

14. Apparatus in accordance with claim **12** in which said rugose surface is on a rotatable roll and in which the other surface is fixed, said fixed surface having openings therein adjacent the nip through which the gas is vented.

15. Apparatus in accordance with claim **14** including means to receive a container positioned beneath said nip in which the crimped yarn may be collected.

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