Jan. 9, 1968 D. SHICHMAN ET AL 3,363,041

METHOD OF JET CRIMPING FOR TEXTURING THERMOPLASTIC YARN

Filed June 9, 1964 5 Sheets-Sheet 1

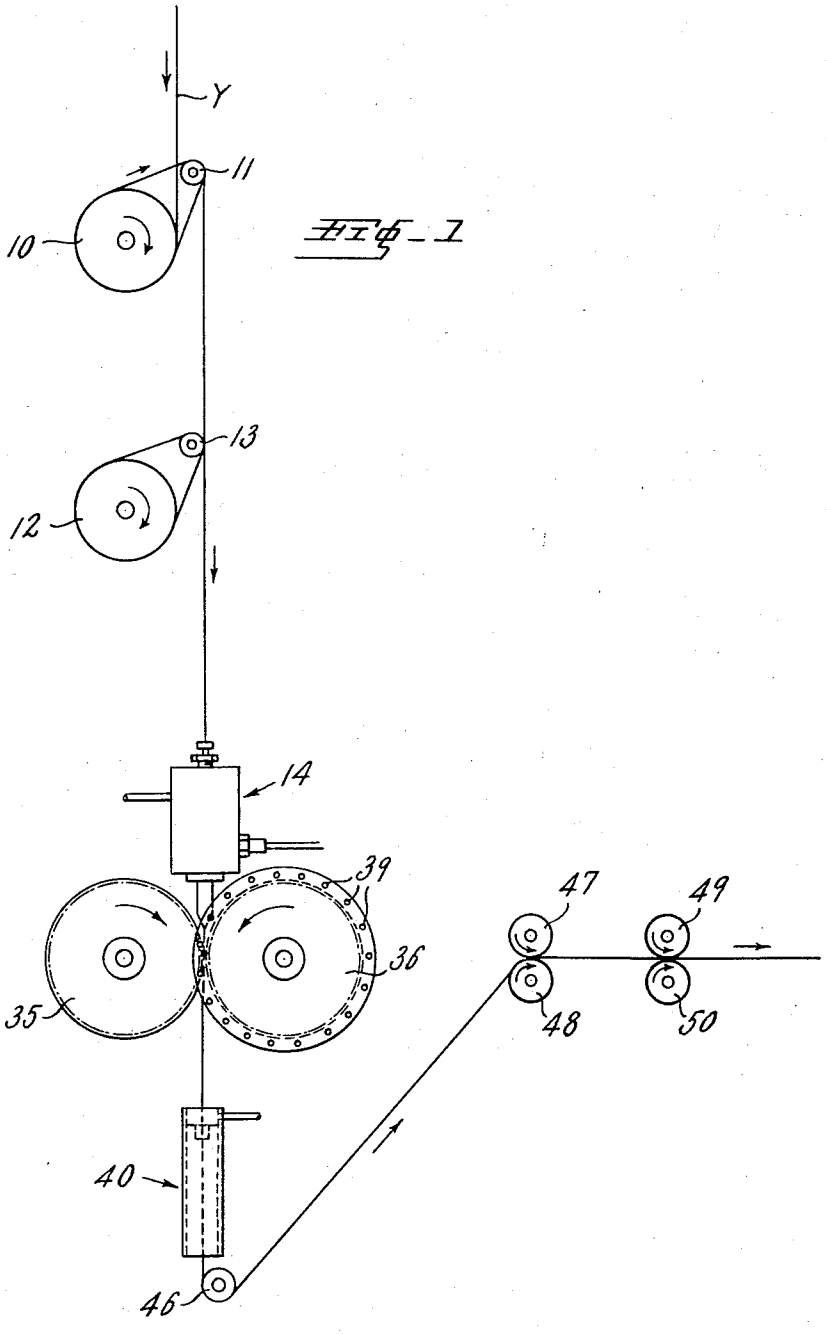


Fig. 1

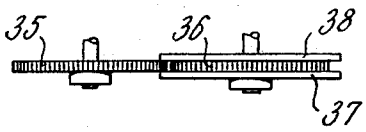


Fig. 2

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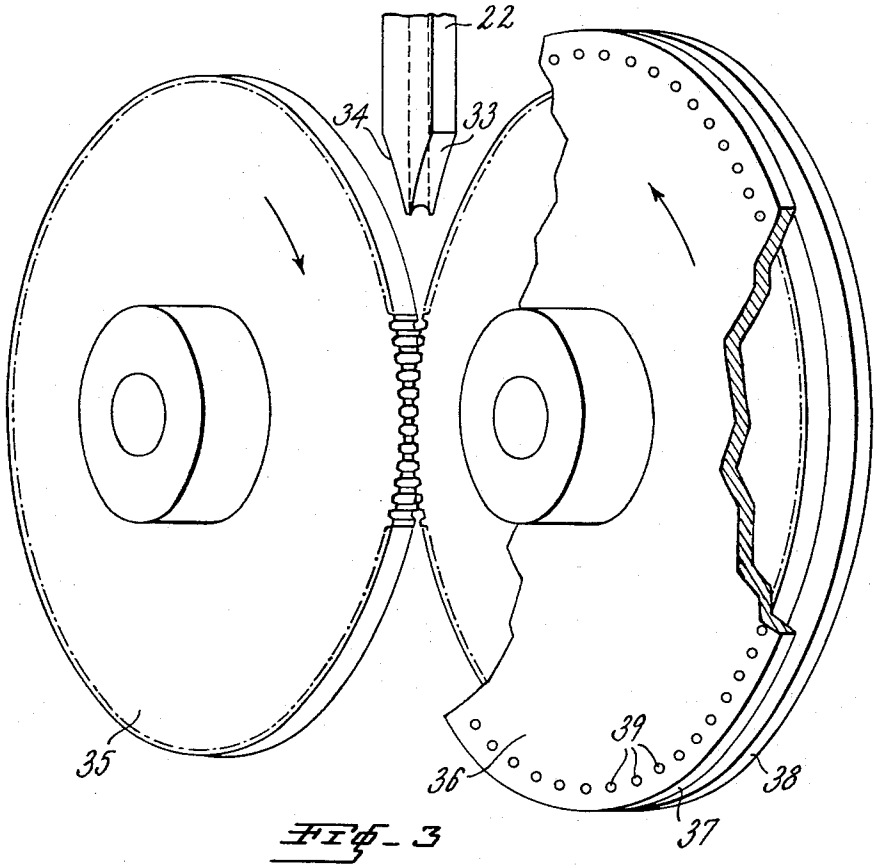


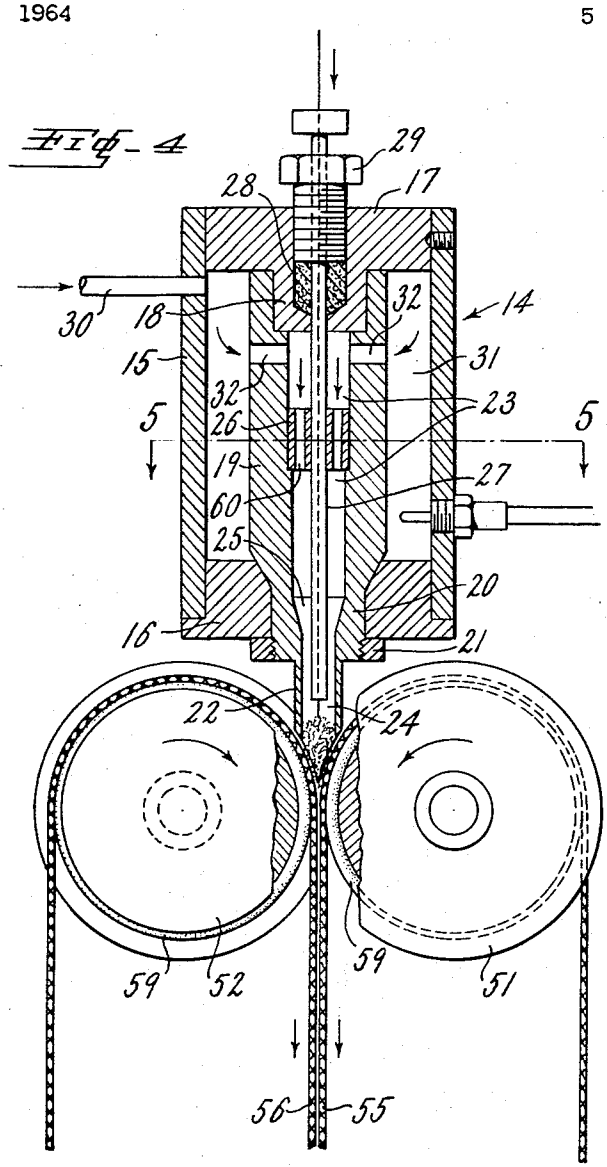
Fig. 3

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METHOD OF JET CRIMPING FOR TEXTURING THERMOPLASTIC YARN

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Fig. 4



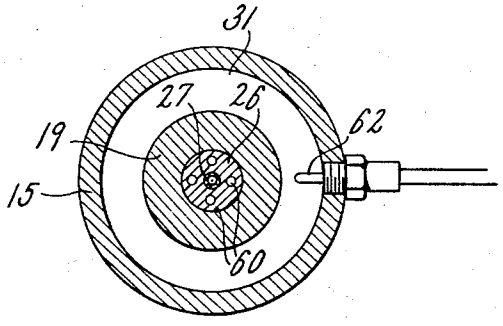


Fig. 5

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METHOD OF JET CRIMPING FOR TEXTURING THERMOPLASTIC YARN

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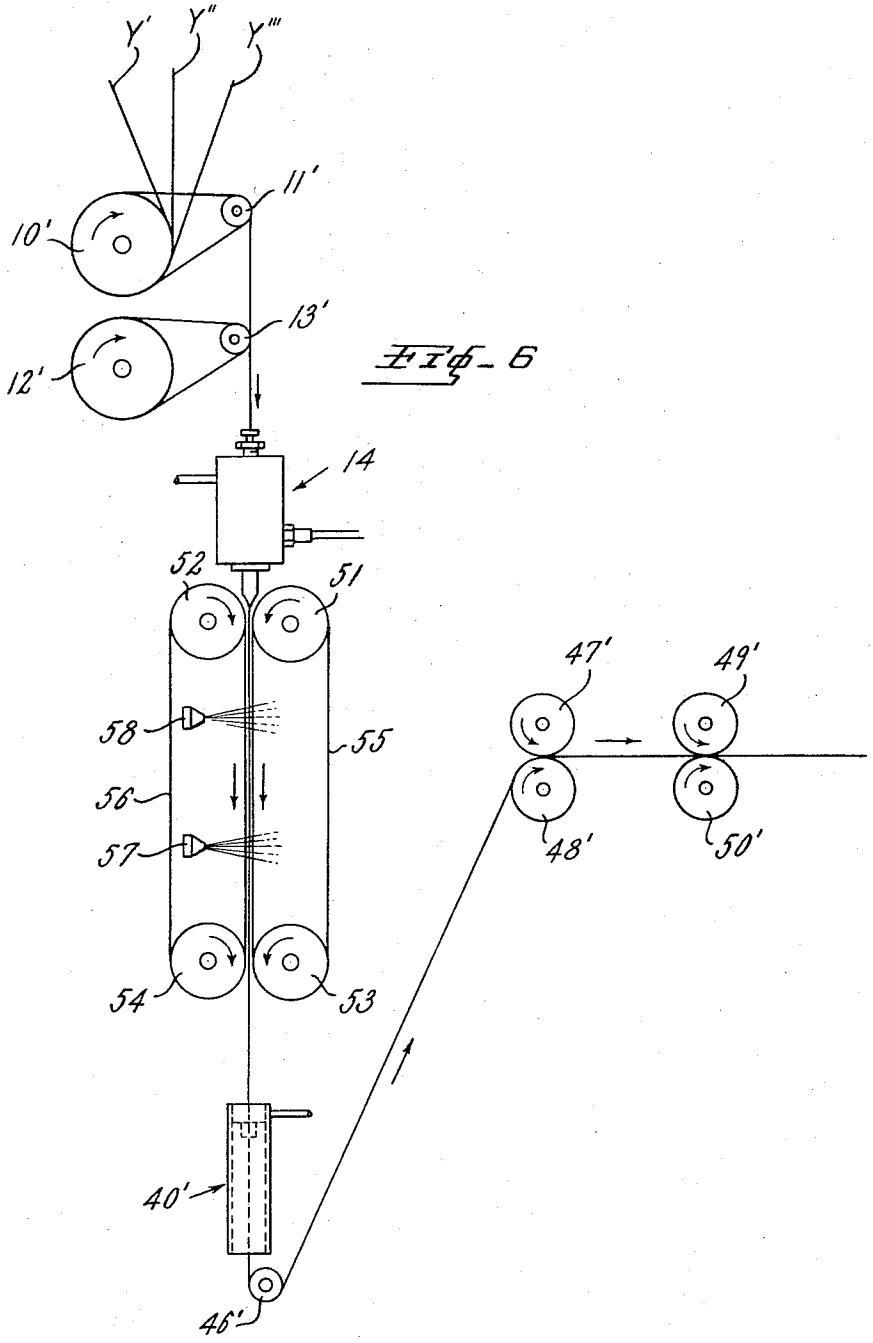


Fig. 6

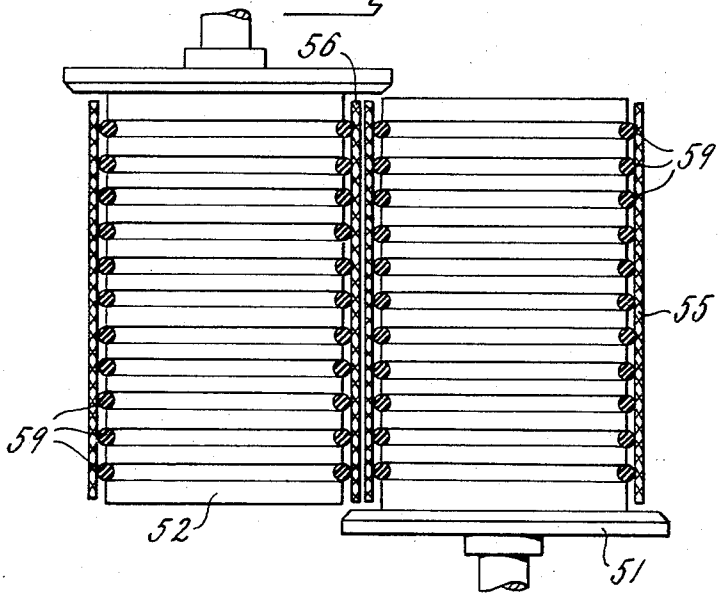
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METHOD OF JET CRIMPING FOR TEXTURING THERMOPLASTIC YARN

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Fig. 7



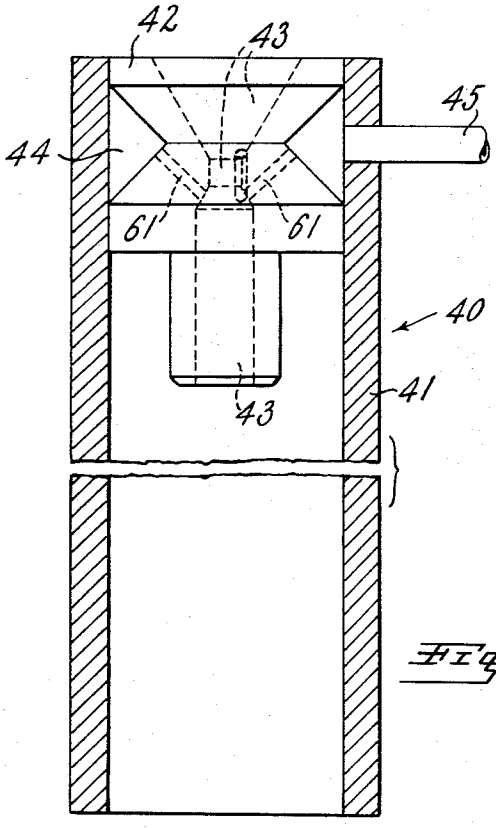


Fig. 9

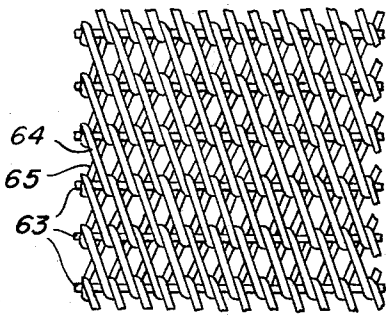


Fig. 8

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METHOD OF JET CRIMPING FOR TEXTURING THERMOPLASTIC YARN

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Filed June 9, 1964, Ser. No. 373,686
10 Claims. (Cl. 264—282)

This invention relates to a method of jet crimping for texturing thermoplastic yarn.

In United States Patent 2,435,891 granted Feb. 10, 1948, there is disclosed a method of crimping textile yarns in which the yarn is jetted toward the nip formed by a cylindrical cage like roller and a cylindrical roller with a resilient cover.

This invention relates to an improved method of jet crimping 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 rotatable rolls each having a roughened yarn contacting surface. At the nip these surfaces are spaced from each other a finite distance sufficiently great that the driving force generated by a hot gas, to be described, on the yarn is not lost, yet not far enough apart to lose the compressive force on the yarn. Yarn to be textured is introduced from a central tube into a moving stream of heated gas and is hurled longitudinally of itself toward the nip to pack the yarn into a chamber partially blocked by the roughened surfaces. These surfaces are converged into the nip to carry the yarn through the nip, the yarn is cooled 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 a top view of the nip rolls shown in FIG. 1;

FIG. 3 is an enlarged fragmentary perspective view of the nip rolls and delivery tube used in the apparatus of FIG. 1;

FIG. 4 is an enlarged elevational view, partly in section, of a second embodiment of a nip apparatus showing in detail one embodiment of a jet nozzle also used in FIG. 1;

FIG. 5 is a transverse sectional view taken along the line 5—5 of FIG. 4;

FIG. 6 is a view similar to FIG. 1 of a second embodiment of apparatus of the invention suitable for carrying out the method of the invention;

FIG. 7 is a plan view of the nip rolls of FIG. 6 with the O-rings and belts shown in section;

FIG. 8 is a plan view of a chain belt used in the apparatus of FIG. 6, and

FIG. 9 is a partly sectional view of the aspirator of FIGS. 1 and 6.

A first embodiment of apparatus according to this invention is illustrated in FIGS. 1 through 3. A detail of the apparatus used in this embodiment appears in FIGS. 4 and 5. A second embodiment of apparatus according to this invention is illustrated in FIGS. 4 through 8. The method will be described in connection with these two embodiments.

Referring first to the embodiment disclosed in FIGS. 1 through 3 a texturizer 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. 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 12,000 denier undrawn multifilament polypropylene yarn is processed, roll **10** is heated to 200–250° F. and is rotated at a surface speed of 250 feet per minute, while roll **12**, heated to a temperature of 200 to 350° F., is rotated at a surface speed of 1000 feet per minute to draw the yarn Y four to one between the pairs of rolls. The drawn yarn next enters the steam propulsion device indicated generally at **14** and shown in detail in FIG. 4.

The steam device **14** for propelling the yarn includes a cylindrical tube **15** partially closed at its bottom by a plug **16** and at its top by a plug **17** which together form the shell of the propulsion device. Plug **17** has a central depending boss **18** projecting into the chamber enclosed by tube **15** which is adapted to fit snugly into, and to substantially close, the open upper end of a second, smaller diameter, generally cylindrical tube **19** arranged coaxially within tube **15**. The reduced diameter lower end **20** of tube **19** is received snugly within the central axial hole through lower plug **16** and is fastened to the outer shell by a nut **21**. Tube **19** has a generally rectangular externally cross-sectioned extension **22** projecting beneath the plug **16** for a purpose to be described.

Tube **19**, arranged coaxially within tube **15** has in its upper end an axial cylindrical chamber **23** in free communication with a smaller axial cylindrical chamber **24** in its lower end which latter extends completely through a depending projection **22** and opens to the atmosphere through the lower faces of projection **22**. The chamber **23** communicates with chamber **24** through a frustoconical shaped chamber **25** which, in this case, has a cone angle of 30°. A fluid directionalizing disc **26** is disposed in the chamber **23** intermediate its ends for a purpose to be described. A hypodermic needle **27** passes axially through chamber **23** and projects axially part way into chamber **24**. Needle **27** is supported in plug **17**, and passes centrally through disc **26**. A polytetrafluoroethylene ("Teflon") packing **28** and packing gland nut **29** of customary design seal the opening where needle **27** passes though plug **17**. The size of the hypodermic needle used can be varied with the size of yarn being textured. A thirteen gauge needle works well when processing 3,000 denier 210 filament polypropylene yarn.

Superheated steam at 140 p.s.i. from a supply pipe **30** is admitted through a bore in the upper end of sleeve **15** into a plenum chamber **31** between sleeves **15** and **19**. A thermocouple **62** extends into chamber **31** to sense the steam temperature. Tube **19** has a pair of $\frac{3}{16}$ inch diameter radial holes **32** therethrough communicating the chamber **23**. Steam from plenum chamber **31** finds its way through these radial holes **32** to the portion of chamber **23** above disc **26**.

Disc **26** seals against both the hypodermic needle **27** and the internal walls of tube **19** to divide chamber **23** into two sections. Communication between the two sections of chamber **23** is obtained through four $\frac{3}{32}$ inch diameter holes **60** whose axes parallel the axis of tube **19** and, as shown in FIG. 5, are symmetrically arranged at 90° intervals about the axis of the hypodermic needle. Disc **26** serves to parallelize the direction of steam flow to the direction of yarn advance through the center of hypodermic

needle 27, so that as the steam is fed past the open lower end of hypodermic needle 27 it is travelling in a direction generally parallel to the yarn leaving needle 27. Chamber 23, which has a substantial length beneath disc 26, and the small 30° cone angle of chamber 25 tend to maintain this parallel flow direction of the steam.

Hypodermic needle 27 projects into chamber 24, but its lower end terminates a substantial distance short of the lower terminus of this chamber 24 at the lower face of projection 22. Thus a cylindrical chamber is provided within projection 22 beneath the lower tip of the hypodermic needle in which yarn may be packed. As will appear in FIGS. 3 and 4 projection 22 has lower concave faces 33, 34 shaped to an arcuate surface substantially complementary to the path of rotation at this point of the roughened surfaces on the wheels next to be described. The yarn Y, fed into the upper end of hypodermic needle 27, is hurled from its lower end and toward the nip of a pair of roughened surfaces advancing toward each other.

As will appear in FIG. 1 projection 22 fits closely into the nip of a pair of rolls 35, 36 rotatably driven in the direction indicated by the arrows in FIG. 1. Although projection 22 is shown spaced a substantial distance from the point of nearest approach of rolls 35 and 36 to each other, this spacing has been exaggerated for the purpose of clarity, and it will be understood that projection 22 has a lower knife-like edge that projects into the nip of rolls 35, 36 as close as can conveniently be obtained. In one embodiment the spacing between arcuate surfaces 33, 34 and the outer path of the roughened surface on rolls 36, 35, respectively, measured radially of the rolls, is .025".

As best appears in FIGS. 2 and 3, rolls 35 and 36 each have a multiplicity of gear tooth-like projections and indentations disposed around their entire peripheries. Although the rolls 35, 36 are equipped with gear tooth-like projections and indentations, these teeth do not mesh; rather the closest approach of the circular path followed by the radially outermost surface of the teeth on roll 35 as this roll rotates about its axis is spaced from the similar path of the teeth on roll 36 a finite distance but not far enough to lose compressive force on the yarn. These paths should not be so close to each other as to lose driving force generated by the steam on the yarn.

Although the theory is only imperfectly understood, when the rolls 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 lower end of needle 27 and in part results from friction of the advancing steam on the yarn. If the rolls are too far apart, the yarn is blown through the nip without extensive crimping because a resistance against which this driving force must act in order to crimp the yarn as described herein is lost.

Rolls 35, 36 are geared to counter-rotate at equal peripheral speeds. Both rolls have the same diameters, and in one embodiment each of two 6 inch diameter wheels is equipped with 280 48 pitch, 14½ degree pressure angle teeth of .045" depth. For the above-mentioned 3,000 denier 210 filament polypropylene yarn and the same draw speeds and temperatures described above for 12,000 denier polypropylene, a typical gap between the rolls is .010", and a typical peripheral speed of the rolls is 120 feet per minute.

As appears best in FIGS. 2 and 3, roll 36 is provided with flanges 37, 38 which project beyond the roughened surface of roll 36 proper at each side thereof and which snugly receive the sides of roll 35 and projection 22 to enclose the space between projection 22 and rolls 35, 36. Flanges 37, 38 have a multiplicity of holes 39 therethrough to permit steam to escape from this enclosed space.

The yarn is withdrawn from rolls 35, 36 by an aspirator indicated generally at 40 in FIG. 1. As shown in FIG. 9, this aspirator consists of a tube 41 having a core 42 fitting

snugly in the upper end thereof. A triangular cross-section plenum chamber 44 communicates with compressed air supply 45. Core 42 has a venturi axial opening 43 therethrough through which the yarn passes. Four downwardly directed bores 61 communicate between the air plenum chamber 44 and the passage 43, opening into the latter beneath the constricted throat of the venturi. This air aspirator simultaneously withdraws yarn from rolls 35, 36 and air quenches the yarn which had been heated prior to texturing by the draw rolls and the superheated steam.

After the yarn leaves air quench aspirator 40, it passes around a pulley 46 and is directed to a first pair of driven draw out rolls 47, 48 and thence to a second pair of draw out rolls 49, 50 driven at a slightly faster speed than the first pair 47, 48. In the heretofore described embodiment processing 3,000 denier polypropylene the first pair of rolls rotate at 760 feet per minute and the second at 860 feet per minute, hence a 14% reduction in length has been effected by the crimping.

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 of rolls 35, 36. 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. Instead of parallel holes through disc 26 as shown in FIGS. 4 and 5, torque holes may be provided having their axes arranged so as to swirl the steam about hypodermic needle 27. This could be used to produce slub and false twist effects.

Other heated gases may be used in place of steam but this is most commonly available in economical form. Superheating the steam to remove liquid is most advantageous. Whatever gas is used, it should be at a temperature to heat the fiber to be crimped to the heat-forming temperature, or if the fiber has been previously heated to such temperature, the gas should be at a temperature sufficiently high as not to cool the fiber before the desired crimp has been induced therein.

Referring next to FIGS. 4 and 6 through 8, a further embodiment of this invention is disclosed. In FIG. 6 certain elements similar to elements appearing in FIG. 1 and operating in the same way and performing the same function have been designated by the same reference numbers but with the addition of the superscript prime mark, i.e., 10', 11', 12', 13', 40', 46', 47', 48', 49' and 50', and will not be again described. The steam propulsion unit 14 used in this embodiment is the same as that previously described, and accordingly will not be further described. In the embodiment shown in these figures three yarn ends Y', Y'' and Y''' are processed as one through device 14 and to a pair of driven rolls 51, 52 rotated in the direction indicated by the arrows. As best appears in FIG. 7 these rolls are generally cylindrical rolls each having a flange on one end, and having a series of peripheral grooves in which toroidal silicone O rings 59 fit. A second pair of driven rolls 53, 54 identical to rolls 51, 52 and containing similar O rings is located about two feet beneath rolls 51, 52. There is trained over rolls 51, 53 a first chain belt 55. A second chain belt 56 is trained over rolls 52, 54. In one specific embodiment, rolls 51, 52, 53 and 54 are each 2 inches in external diameter and 3 inches wide and each is equipped with twelve silicone O rings uniformly spaced therealong. The O rings transmit a tractive force to the chain belts, and they elevate the belts off the rolls so that steam from the steam propulsion unit can pass away from the nip. The rolls in each pair of rolls 51, 52, 53, and 54 are counter-rotated at the same speed.

In this embodiment the roughened surfaces on rolls 51, 52 are provided by the stainless steel chain belts 55, 56. These belts, shown in more detail in FIG. 8 consist of a series of spaced cylindrical rods 63 extending from side to side of the belts and a plurality of open, flattened,

helix wires 64, 65 wrapped thereabout and arranged to produce a balanced construction. These openwork belts have a plurality of holes or cavities therethrough in which segments of the yarn may rest.

One specific example of belting usable for the belts 55, 56 when processing 210 denier polypropylene yarn consisting of 70 filaments average 3 denier per filament is designated D–264–178–22–28 by the manufacturer, the Cambridge Wire Cloth Company of Cambridge, Md. The manufacturer's catalog states that the first number designates turns per foot of width, the second number designates the rods per foot of width and the last two numbers designate the gauge of the wire.

Desirably a pair of water spray guns 57, 58 spray water on the belts and the yarn carried thereby. As will be noted from FIG. 7, the wire belts are spaced a finite distance apart. In one specific embodiment the radial gap between each face 33, 34 and the adjacent belt was .010", the gap between the belts at their nearest approach to each other was .012 inch, the surface speed of the belts was 60 feet per minute and the yarn was fed by the godet rolls 12', 13' at a linear rate of 1,000 feet per minute. When using superheated steam at 140 p.s.i., two nozzles 57, 58 spraying room temperature water was found adequate to cool the fiber.

It has been found that the use of two belts 55, 56 is not essential to convey the fiber, for the filaments are pressed into the cavities in the belt if one only is used, and they will cling thereto to be carried along as this belt moves. Accordingly the belt 56, for example, could be replaced by a belt snugly girdling the complete periphery of roll 52 only, so that no belt extends beneath roll 52, and only belt 55 carries the yarn away from the nip.

In the embodiment of FIG. 6, rolls 51, 53 are mounted on a support pivoted some distance below pulley 53, so that pulleys 51, 53 and belt 55 may be swung downwardly and to the right, as indicated by the broken lines, as a unit to permit yarn to be threaded through the texturizer.

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

1. A method of texturing thermoplastic multifilament 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 the stream of gas toward the nip of a pair of converging arcuate surfaces at least one of which has a roughened yarn contacting surface, advancing at least one of said converging surfaces toward the nip, advancing said yarn toward the nip at a linear rate of speed not less than 5 times faster than the linear surface speed of said advancing converging surface; maintaining the arcuate surfaces at their nearest approach to each other sufficiently small to provide a resistance to the longitudinal advance of the yarn spaced from each other a finite distance but not large enough to lose the compressive force on the yarn compressing the yarn and packing the yarn into a chamber in advance of the nip partially blocked by said surfaces at the nip, advancing the packed yarn through the nip of the surfaces, and setting the crimp induced in the yarn by said treatment.

2. A method in accordance with claim 1 including the step of maintaining such surfaces sufficiently far apart at the nip to prevent loss of driving force created by the heated gas on said yarn.

3. A method in accordance with claim 2 which comprises passing said stream of heated gas along an elongatel path having the cross-sectional shape of an annulus with the yarn to be textured within said annulus but separated from said stream to direct said stream of heated gas generally parallel to the direction of advance of the yarn, and thereafter introducing the yarn into such directionalized stream of gas.

4. A method in accordance with claim 1 including the step of hurling the yarn toward the nip of a pair of converging roll-like conveying surfaces each of which has a roughened yarn contacting surface.

5. A method in accordance with claim 4 in which each of the roughened surfaces is formed by a belt trained over cylindrical rolls and including the step of carrying the yarn on at least one of said belts a substantial distance while cooling the same.

6. A method in accordance with claim 5 including the step of carrying the yarn on a pair of belts from said nip and through a substantial distance while spraying water thereon to cool the yarn.

7. A method in accordance with claim 6 which comprises passing said stream of heated gas along an elongated path having the cross-sectional shape of an annulus with the yarn to be textured within said annulus but separated from said stream to direct said stream of heated gas generally parallel to the direction of advance of the yarn, and thereafter introducing the yarn into such directionalized stream of gas.

8. A method in accordance with claim 7 in which said gas is steam which is in a super heated condition immediately prior to introduction of said yarn into said stream.

9. A method in accordance with claim 1 which comprises passing said stream of heated gas along an elongated path having the cross-sectional shape of an annulus with the yarn to be textured within said annulus but separated from said stream to direct said stream of heated gas generally parallel to the direction of advance of the yarn, and thereafter introducing the yarn into such directionalized stream of gas.

10. A method in accordance with claim 9 in which said gas is steam which is in a super heated condition immediately prior to introduction of said yarn into said said stream.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,363,041 January 9, 1968

Daniel Shichman et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, lines 54 to 56, strike out "sufficiently small to provide a resistance to the longitudinal advance of the yarn" and insert the same after "distance" in line 56, same column 5; column 6, lines 6 and 7, for "elongatal" read -- elongated --.

Signed and sealed this 8th day of April 1969.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents