March 12, 1968 D. SHICHMAN ET AL 3,372,446

JET CRIMPING AND TEXTURIZING APPARATUS

Original Filed June 9, 1964 5 Sheets-Sheet 1

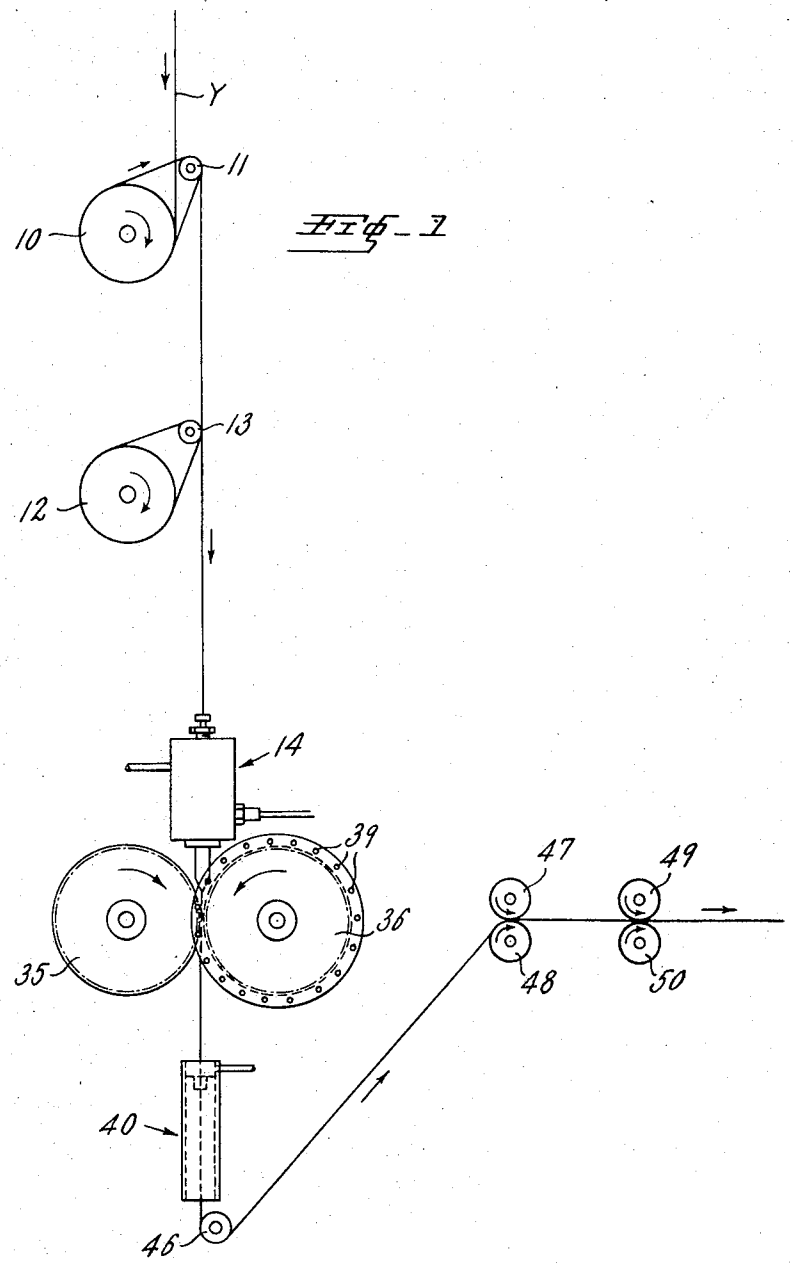


Fig. 1

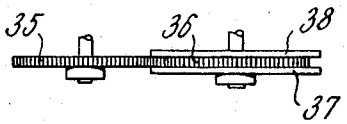


Fig. 2

INVENTORS
DANIEL SHICHMAN
ARTHUR D. SIEGEL

JET CRIMPING AND TEXTURIZING APPARATUS

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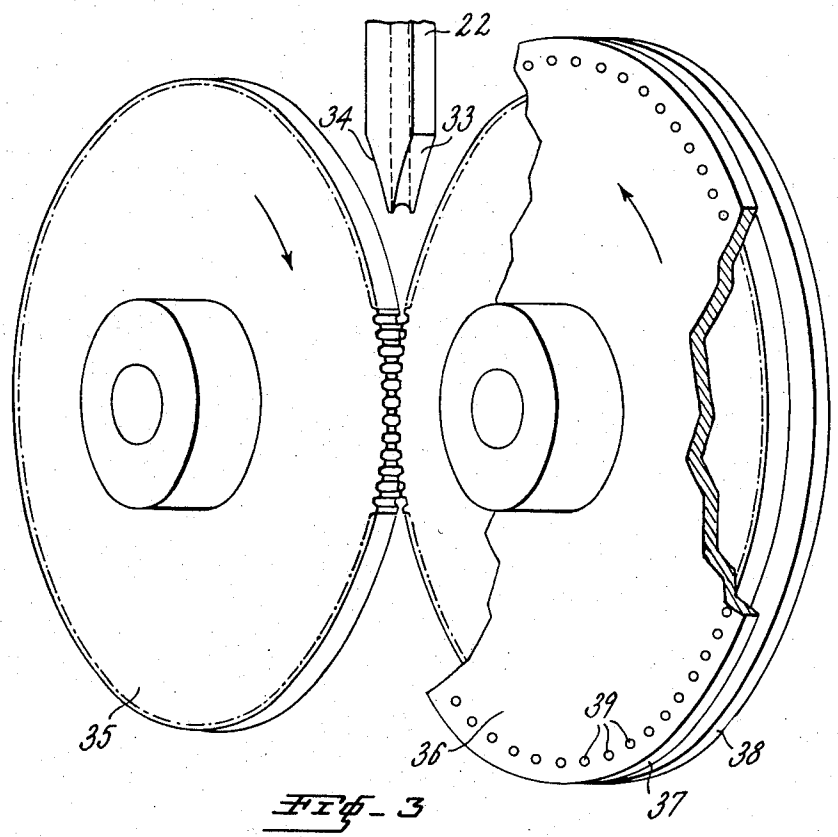


Fig. 3

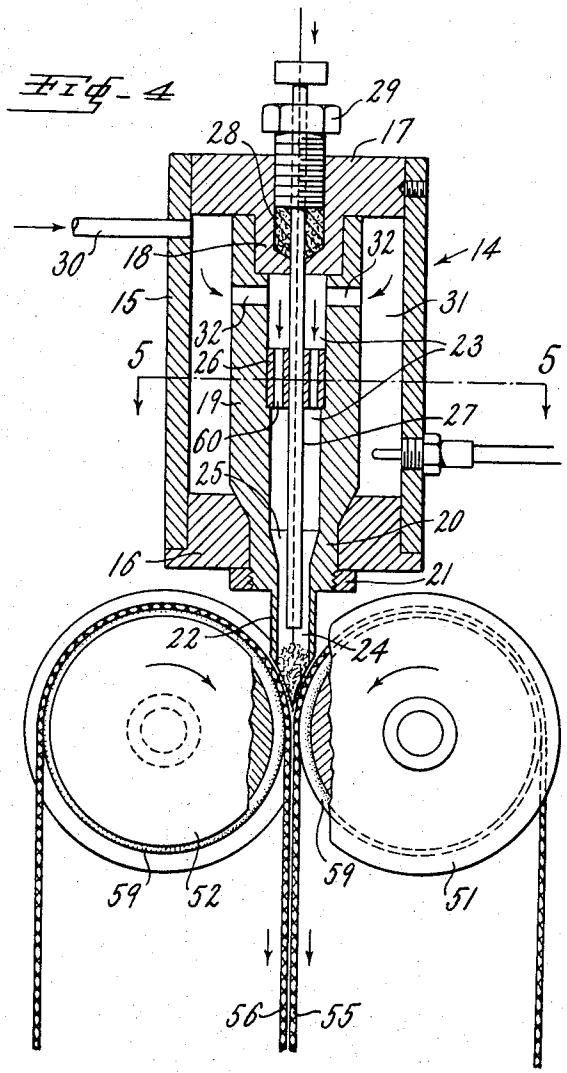
INVENTORS
DANIEL SHICHMAN
ARTHUR D. SIEGEL

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JET CRIMPING AND TEXTURIZING APPARATUS

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Fig. 4



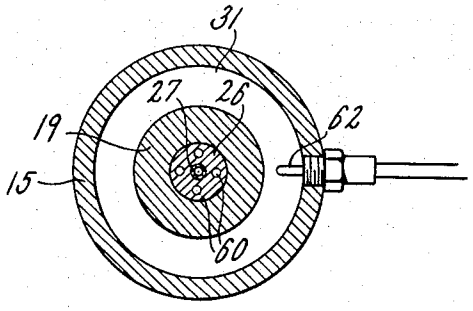


Fig. 5

INVENTORS
DANIEL SHICHMAN
ARTHUR D. SIEGEL

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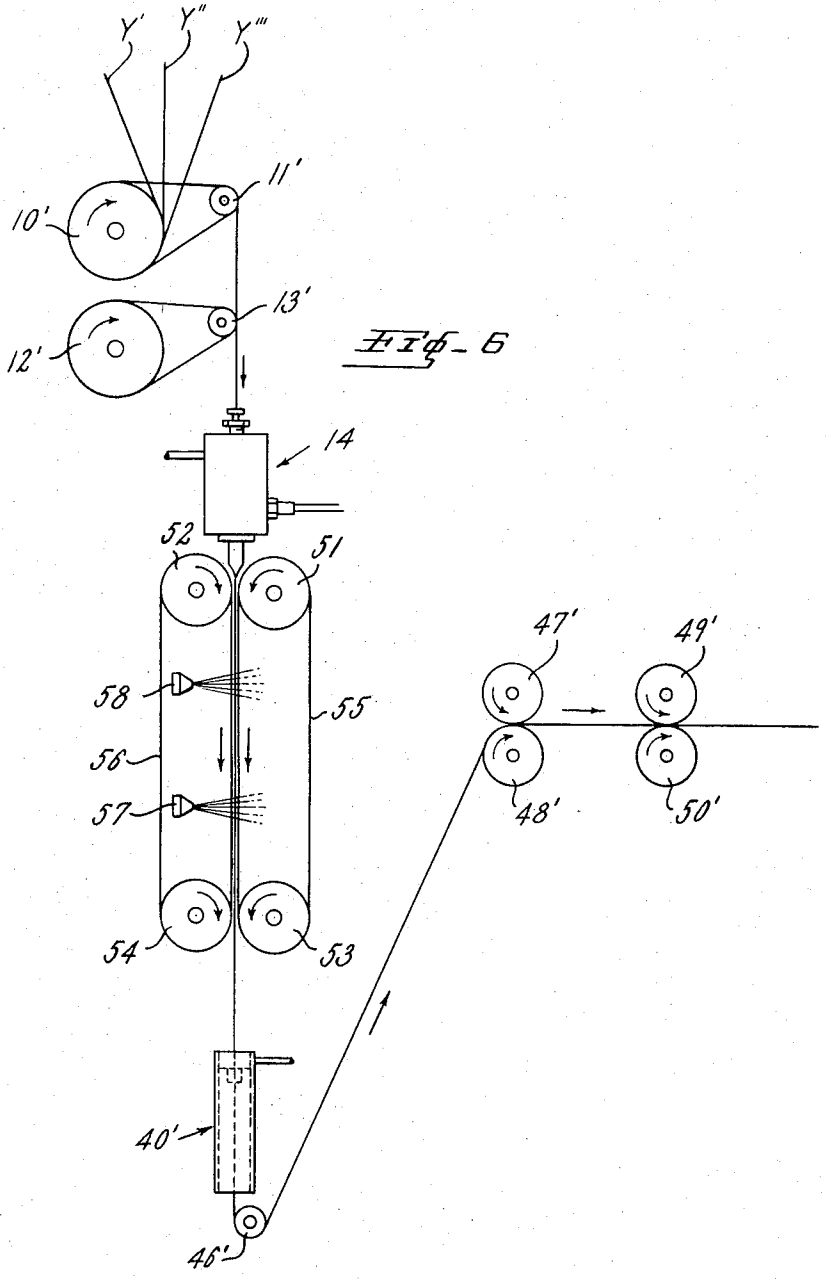


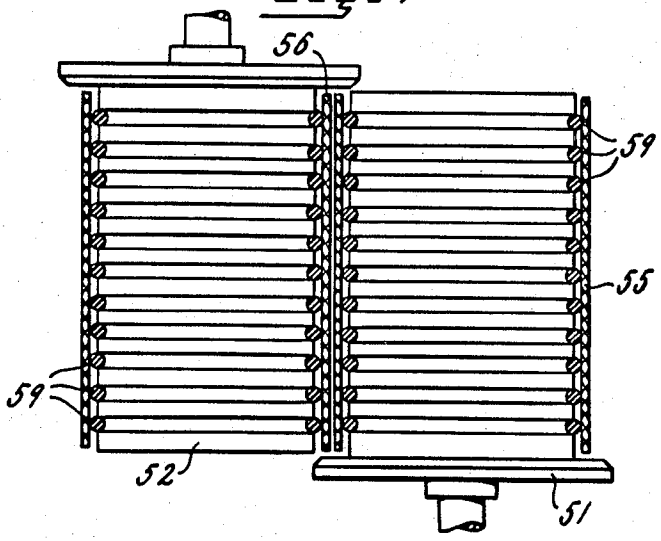
Fig. 6

INVENTORS
DANIEL SHICHMAN
ARTHUR D. SIEGEL

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Fig. 7



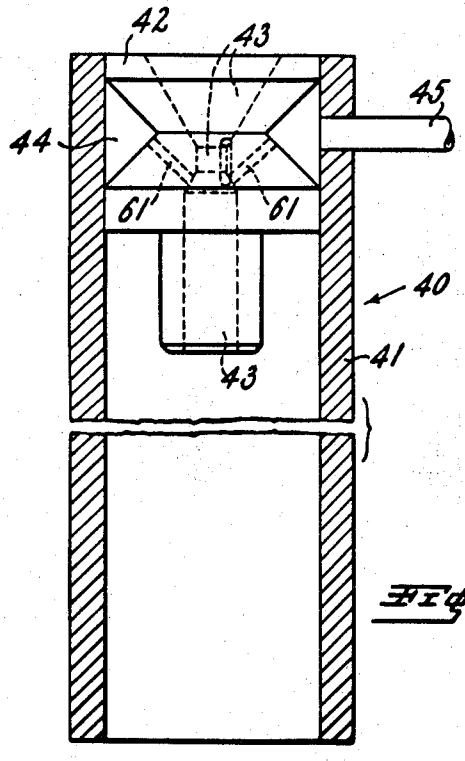


Fig. 9

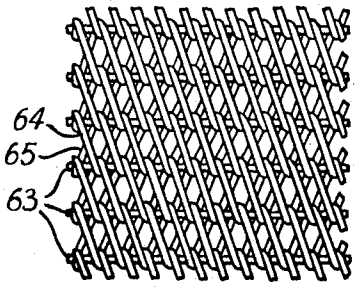


Fig. 8

INVENTORS
DANIEL SHICHMAN
ARTHUR D. SIEGEL

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3,372,446

JET CRIMPING AND TEXTURIZING APPARATUS

Daniel Shichman, Cedar Grove, and Arthur D. Siegel, Upper Montclair, N.J., assignors to Uniroyal, Inc., a corporation of New Jersey

Original application June 9, 1964, Ser. No. 373,686. Divided and this application June 2, 1967, Ser. No. 643,265

10 Claims. (Cl. 28—1)

ABSTRACT OF THE DISCLOSURE

Apparatus for texturing yarn in which the yarn is steam jetted through a hypodermic needle into the nip of arcuate converging surfaces where it is compressed longitudinally and packed into the nip. One of the surfaces is rotated to pass the pack through the nip after which the yarn is taken up.

This application is a division of our co-pending application Ser. No. 373,686, filed June 9, 1964, in which the method disclosed herein is claimed.

This invention relates to an apparatus 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 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 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 multi-filament 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** as 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 frusto-conical 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 seals the opening where needle **27** passes through 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 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 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 desired 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 silicon 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 silicon 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 open work 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 averaging 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. According the belt 56, for example, could be replaced by a belt snugly girdling the complete periphery of roll 52 only, so that no belt span 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. Apparatus for texturing yarn which comprises a pair of converging arcuate surfaces at least one of which has a roughened yarn contacting surface, said surfaces at their nearest approach to each other forming a nip and being spaced a finite distance apart 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 pack to be passed therethrough, means for advancing at least one of said converging surfaces toward the nip therebetween at a linear surface speed not more than one-fifth the linear rate of speed at which yarn is advanced to the nip, hollow means projecting into said nip close to said surfaces to form therewith a yarn packing chamber, a hollow needle through which said yarn advances, said needle extending part way into the portion of the chamber within such hollow means and pointing toward said nip, means defining a passage for hot gas about said needle and in communication with said chamber at the end of said needle, and means for directing a hot gas about said needle toward said chamber to cause said yarn to be hurled toward said nip.

2. Apparatus for texturing yarn, comprising a pair of converging arcuate nip surfaces at least one of which has a roughened yarn contacting surface, said surfaces at their nip being spaced a finite distance apart sufficiently small to provide a resistance to the longitudinal advance of the yarn but not large enough to lose the compressive force on a yarn pack to be passed therethrough, means to rotate said roughened surface to advance said surface toward the nip therebetween at a linear surface speed not more than one-fifth the linear rate of speed at which yarn is advanced to the nip, a steam jet projecting into said nip in close proximity to said surfaces for hurling yarn toward said nip, said jet including a hollow tube-like member having an open end shaped to fit into said nip in close proximity to said surfaces and to be partially opposed to said surfaces, a hollow needle having an end projecting partially into said hollow tube-like member and toward said nip, means for advancing a yarn longitudinally through said needle, a steam chamber surrounding at least said projecting end of the needle and discharging into said tube-like member past said projecting end of the needle, whereby steam passing said projecting end of the needle may cause said yarn to be withdrawn from said projecting end of said needle and hurled toward said nip to be packed upon itself, and thereafter to be advanced through said nip by said roll.

3. Apparatus in accordance with claim 2 in which said roughened surface is formed by a multiplicity of transversely extending gear tooth-like projections and indentation on a roll, the other of said surfaces having flanges at its edges, said roll being adapted to fit within said flanges, and said flanges having holes therethrough, to permit escape of steam.

4. Apparatus in accordance with claim 2 in which said hollow tube-like member has a substantially cylindrical shaped chamber into which said needle projects and in which the end opening thereof has a circular projection in a plane through the axes about which said nip rolls rotate, said surfaces being spaced sufficiently far apart to prevent loss of driving force of the steam on the yarn.

5. Apparatus in accordance with claim 4 including means to admit steam into said steam chamber at a point spaced a substantial distance from the projecting end of said needle, steam directing means within said chamber surrounding said needle and disposed between said projecting end of said needle and said steam admitting means and adapted to direct the steam advance substantially parallel to said needle through said steam chamber and toward said projecting end of said needle.

6. Apparatus in accordance with claim 4 in which surfaces are formed by chain belts on said rolls elevated a little distance from the surface of the rolls.

7. Apparatus in accordance with claim 6 in which at least one of said belts is trained over a second roll spaced a substantial distance from the pair of nip rolls, and including means for removing the yarn from adjacent said belt after it has passed a substantial distance from said nip rolls toward second roll.

8. Apparatus in accordance with claim 7 including a second pair of nip rolls spaced a substantial distance from the first pair of nip rolls, and in which the chain belt on each of said rolls in the first pair of nip rolls passes to said second set of nip rolls along closely spaced substantially parallel paths to carry the yarn therebetween to said second pair of nip rolls, and means for removing said yarn from said chain belts after it passes through the nip of said second pair of nip rolls.

9. Apparatus in accordance with claim 8 including means for spraying water on said belts and said yarn between said two pairs of nip rolls to cool said yarn.

10. Apparatus in accordance with claim 8 including

an air aspirator adapted to withdraw yarn from said belts and to cool said yarn as it passes therethrough.

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LOUIS K. RIMRODT, *Primary Examiner.*