# United States Patent

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[15] 3,665,567

[45] May 30, 1972


## [54] YARN REBOUND TEXTURING APPARATUS AND METHOD


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[21] Appl. No.: **31,206**

[52] **U.S. Cl.** ....**28/1.4,** 28/72.12

[51] **Int. Cl.** ....**D02g 1/16**

[58] **Field of Search** ....28/1.2, 1.3, 1.4, 72.1, 72.11, 28/72.12; 57/34 B, 157 F



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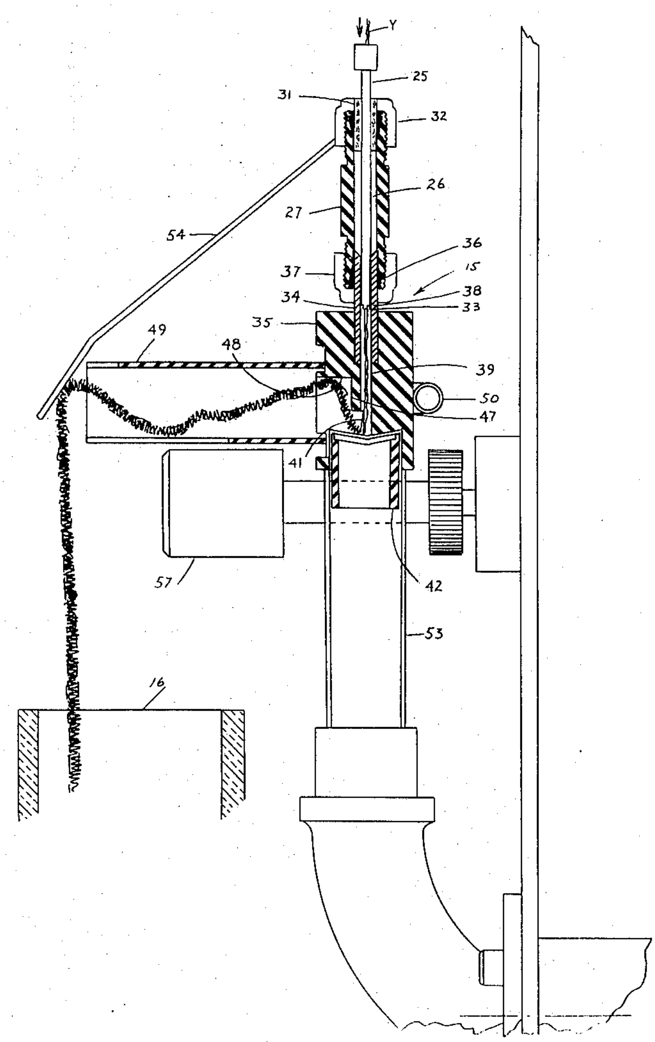
[57] **ABSTRACT**

A thermoplastic yarn texturing machine and method is disclosed in which a yarn to be textured is hurled longitudinally by a heated fluid jet against a foraminous surface and rebounded therefrom in a continuous strand-like stream. The thus compressed yarn is collected without subjecting it to any substantial longitudinal tension, then heated and subsequently cooled to heat set the crimp in the yarn, and finally it is wound-up.


**40 Claims, 7 Drawing Figures**



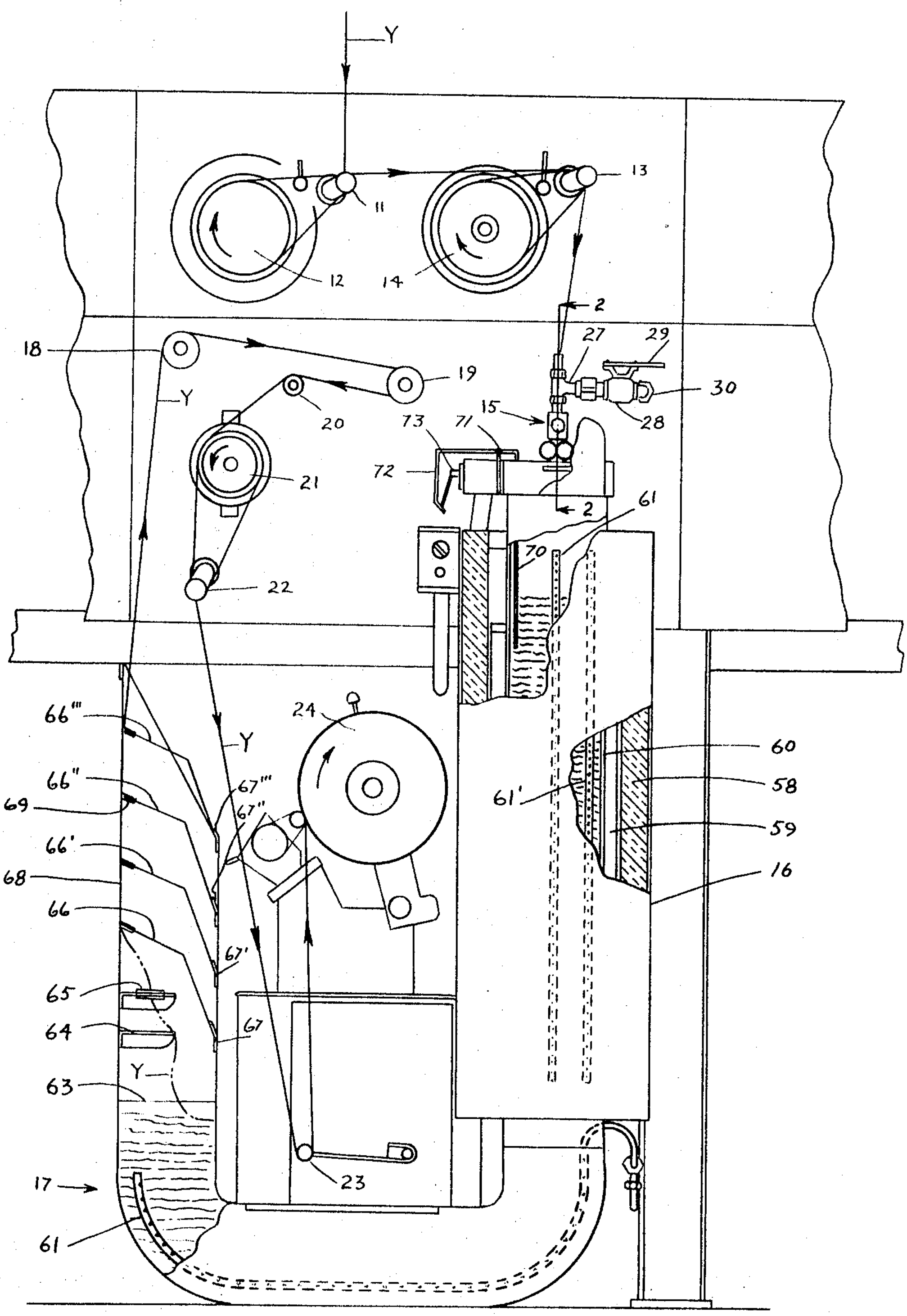



Fig. 1.

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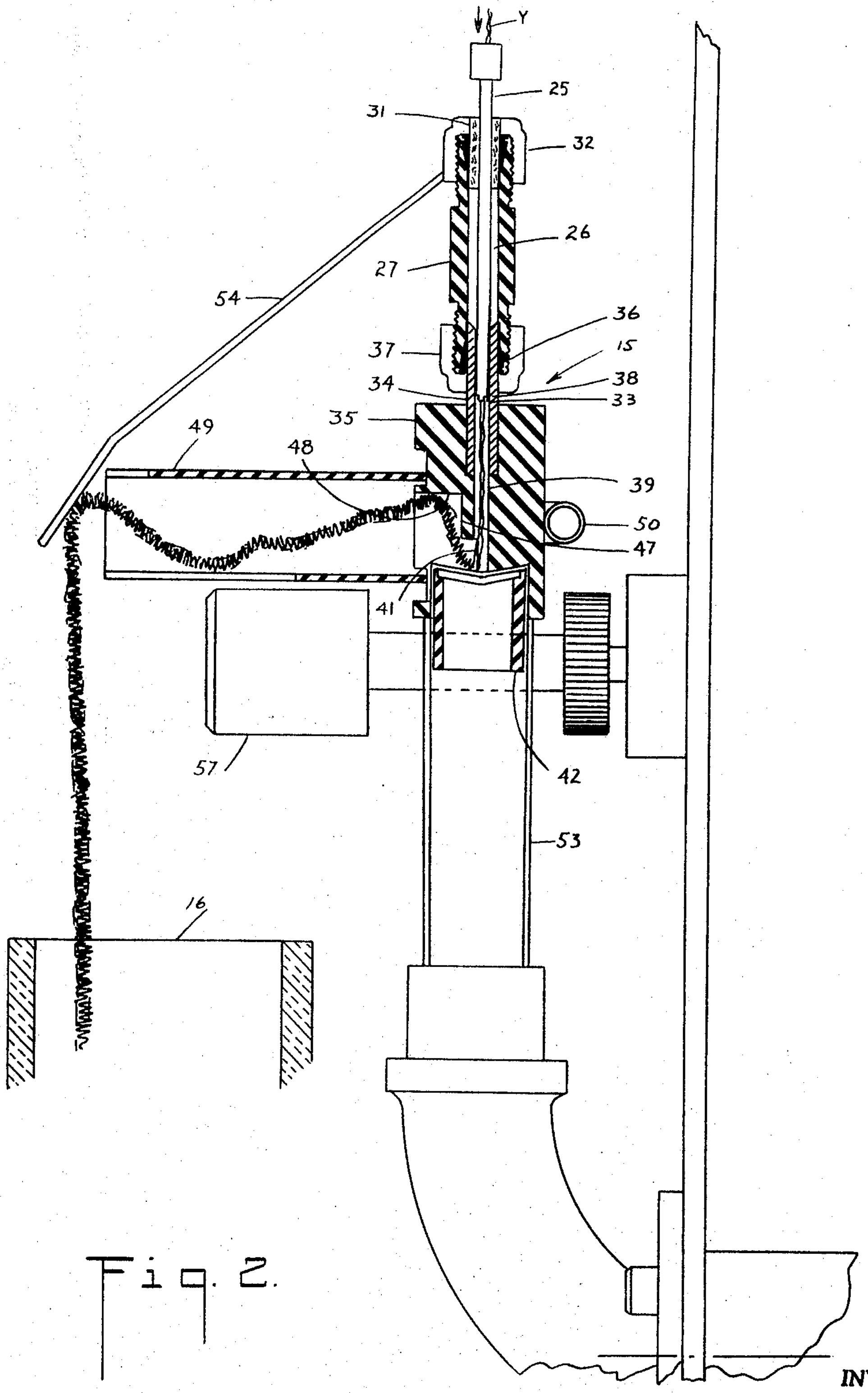


Fig. 2.

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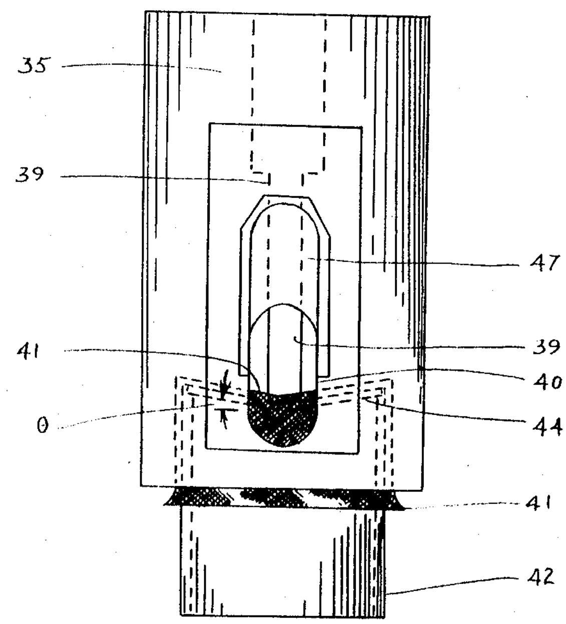


Fig. 3.

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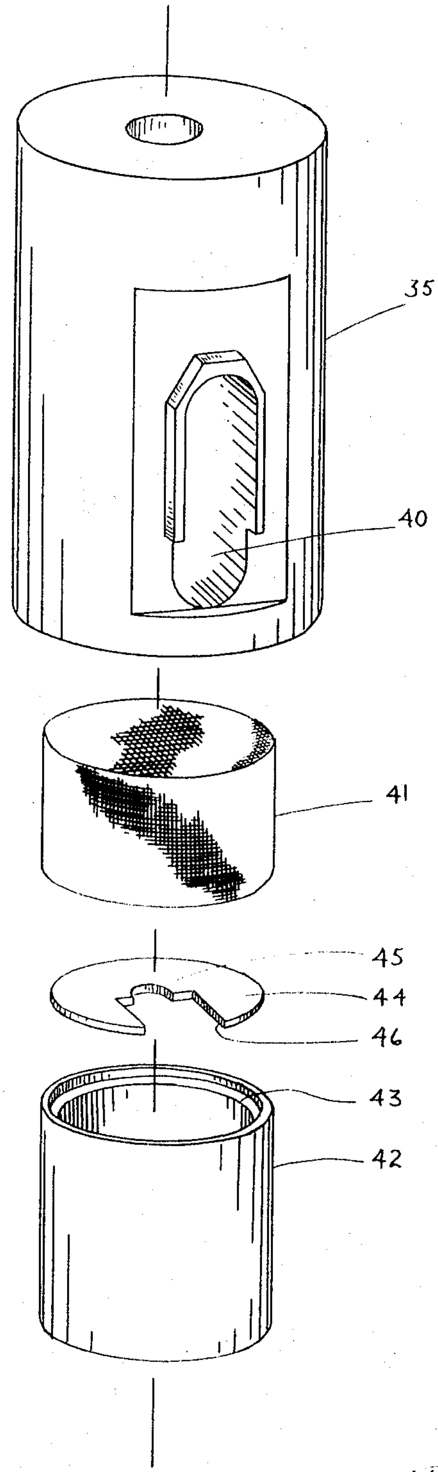


Fig. 4.

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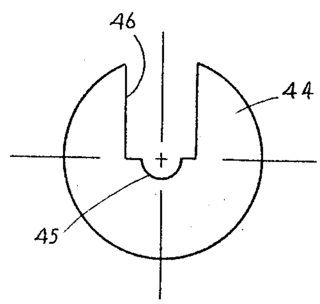


Fig. 5.

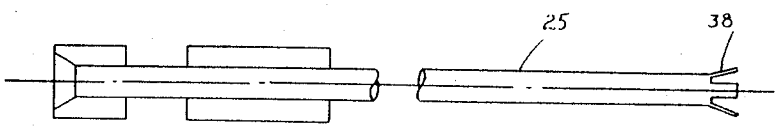


Fig. 6.

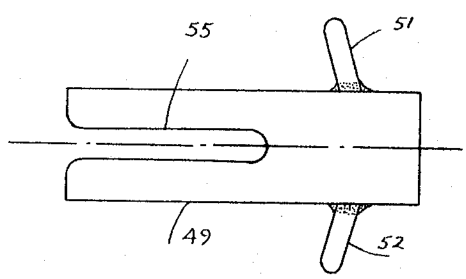


Fig. 7.

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## YARN REBOUND TEXTURING APPARATUS AND METHOD

This invention relates to a method and apparatus for texturing synthetic thermoplastic continuous filament yarns.

The synthetic textile industry is greatly interested in texturing synthetic thermoplastic continuous filament yarns. As produced, these yarns are relatively straight and smooth and have little bulk. It is desired that they be bulked, so the yarns resemble more closely yarns spun from staple fiber. Customarily, these yarns are bulked by bending or crimping the individual filaments in the yarn and heat setting the yarn while the filaments are bent or crimped.

Fluid impacting jets have been used extensively to texture synthetic thermoplastic yarns. One such is shown in U.S. Letters Pat. No. 3,363,041 where a yarn is jetted into the nip of a pair of rolls. When the yarn meets the nip of the rolls and the bank of yarn which has collected there from the preceding length of yarn that has been jetted there, it is compressed longitudinally of itself by the impact.

Various types of impacting yarn jets have been employed. Cones and moving belts have been employed as the resistance element in place of the nip rolls. In one, illustrated in U.S. Pat. No. 3,156,028, the yarn is jetted onto a moving cylindrical deforming screen, thereafter set while held on that screen and subsequently taken up.

This invention relates to a yarn texturing apparatus and method using a heated fluid jet. Conveniently, the jet disclosed in the aforesaid U.S. Pat. No. 3,363,041 may be used. But texture is achieved using this jet in combination with new equipment and in new procedures. Instead of jetting the yarn to be textured into a mass or a barrier and subsequently removing the same, in this invention the yarn is hurled by the heated fluid from the jet in a continuous stream-like flow against a foraminous surface on which it impinges and from which it instantaneously rebounds, or "bounces", still in a yarn-like stream (although greatly compressed and deformed at this point) while the heated fluid, at least in substantial part, passes through the foraminous surface. The rebound yarn in this condition and without having been subjected to any substantial tension progresses under its own inertia, assisted by gravity in some embodiments, to a collecting station where it is heated and subsequently cooled to heat set the same, and thereafter it is wound up.

For a better understanding of the nature of this invention reference should be had to the following detailed description when read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a front elevation partly broken away of apparatus used in the texturing method invention;

FIG. 2 is a sectional view of the texturing jet along the line 2 — 2 of FIG. 1;

FIG. 3 is a front elevation of the screen and jet housing shown in FIG. 2;

FIG. 4 is an exploded view of the screen and jet housing, of the screen, and of the housing closure disc of this invention illustrating the assembly of the screen and disc in the housing;

FIG. 5 is a plan view of a housing closure disc;

FIG. 6 is a view of the yarn jet tube of this invention; and

FIG. 7 is a bottom view of the textured yarn directing tube.

As illustrated in FIG. 1, yarn Y from a supply package (not shown) is led to a first pair of driven godet rolls **11**, **12** and thence to a second pair of driven godet rolls **13**, **14**. Yarn Y is wrapped about each pair of godet rolls in several wraps; rolls **12** and **14** are heated, and rolls **13** and **14** advance the yarn at a much greater speed than do rolls **11** and **12**, so that the yarn Y is drawn between the two sets of godet rolls. The drawing of the yarn Y is accomplished in conventional manner and is described in such patents as U.S. Pat. No. 3,363,041 to which reference may be had for a more detailed description of a specific drawing process.

From roll **13** yarn Y advances first to a texturing jet according to this invention, indicated generally by the reference character **15**, and thence to a heating chamber, indicated generally by the reference character **16**, where it is heated in a loose mass. After it leaves the heating chamber **16** it passes to the cooling chamber **17** where it is cooled in a loose mass. It is withdrawn from cooling chamber **17** in the form of a strand over idler rolls **18**, **19** and **20** by a pair of godet rolls **21**, **22**, the former of which is driven in the direction indicated by the arrow. From godet rolls **21**, **22** yarn Y advances over idler roll **23** to a standard take-up where it is wound in a package **24** for shipment.

Referring to FIG. 2 of the drawing, the texturing jet **15** of this invention includes a tube **25** which is sometimes called a "needle" in this art. Tube **25** passes through a steam plenum chamber **26** which is formed, in the embodiment shown, by the central passage through a plumbing tee (see FIG. 1). Tee **27** is connected through a steam valve **28** with a control lever **29** to a steam pipe **30**, so that steam from the pipe **30** may be fed to steam plenum chamber **26**, and valve **28** may be used to shut off the steam if desired.

As appears in FIG. 2, the upper end of the tee **27** is closed about the tube **25** by packing **31** and nut **32**. Tube **25** passes completely through steam plenum chamber **26** and terminates at the upper end of a yarn passage chamber **33**. Steam plenum chamber **26** communicates with yarn passage chamber **33**, so that steam from plenum chamber **26** may pass downwardly about tube **25** and into the annular space between tube **25** and the upward continuation of the walls defining the yarn passage chamber **33**. In the embodiment shown in the drawing, yarn passage chamber **33** is cylindrical and is formed by the opening in a cylindrical tube **34**, which in turn fits in a central cylindrical bore in the top of an adapter housing **35**. Tube **34** is sealed to tee **27** through packing **36** and nut **37**, so that steam in plenum chamber **26** may only pass downwardly into the annular passage between yarn tube **25** and the upward continuation of the walls defining the yarn passage chamber **33**. Tube **25** is held centered at the yarn entrance end of yarn passage chamber **33** by means of struts **38** on the lower end of yarn tube **25**.

Steam passes through the annular chamber and past the struts **38** to the yarn exit end of tube **25** where the steam picks up the yarn Y exiting from tube **25** and hurls the yarn Y longitudinally of itself through yarn passage chamber **33**. As will be noted, in the embodiment shown yarn passage chamber **33** extends beneath the lower end of tube **34** and is continued as a bore **39** in adapter housing **35**. The diameter of this bore **39** is the same as the internal diameter of the opening in tube **34**, so that a single diameter cylindrical passage is provided for the yarn from its exit from yarn tube **25** until it reaches the area of the yarn exit opening **40** in the side of the adapter housing **35**.

The external lower end of the adapter housing **35** has a convex configuration surrounding the lower end opening of yarn passage chamber **33**; in the embodiment shown it is conical. A member **41** having a foraminous surface, conveniently a screen, closes this lower end opening of chamber **33** to the passage of yarn, but steam may pass through the openings in screen **41**.

In FIG. 4 the manner of assembling screen **41** in adapted housing **35** is illustrated. A hollow cylindrical sleeve **42** is provided with a recessed shoulder **43** in its upper end which is adapted to receive a metal washer **44**. As illustrated best in FIG. 5, the washer **44** has a central semicircular cut-out portion **45** which is the same diameter as the internal diameter of yarn passage chamber **33**. This semicircular cut-out portion **45** continues into a wider cut-out slot portion **46** which extends to the edge of the washer **44**, so that slot **46** and cut-out portion **45** together form an enlarged opening through washer **44**.

As illustrated in the exploded view of FIG. 4, washer **44** is placed on shoulder **43** in sleeve **42** with the slot **45–46** aligned with the yarn exit opening **40** in the adapter housing **35**. The screen thimble **41** is placed over the thus assembled sleeve **42** and washer **44** with screen **41** in surface contact with the upper surface of washer **44**. Sleeve **42** is then driven up into a press-fit in the opening at the bottom of adapter housing **35**.

As sleeve **42** is driven home, screen **41** and washer **44** are deformed as they contact the convex lower end of adapter housing **35** around yarn passage chamber **33**. Consequently, the screen **41** and washer **44** are bent to a concave configuration, and in the case where the adapter housing **35** has a conical or frusto-conical configuration, screen **41** and washer **42** are bent to a generally conical configuration.

As appears best in FIGS. **2** and **3**, the yarn exit opening **40** is wider than the inner diameter of yarn passage chamber **33**. In one example where yarn passage chamber **33** is a bore having a diameter 0.104 inches, yarn exit opening **40** has a width of ¼ inch. In this embodiment yarn exit opening **40** has a semicircular upper end; although the passage for the exit opening through adapter housing **35** has a semicircular lower end also, a consideration of FIG. **3** will make apparent that the effective lower end of yarn exit opening **40** is the concave conical surface of screen **41**.

Referring next to FIG. **2**, it will be noted that in the area immediately above this yarn exit opening **40**, the adapter housing **35** has a relatively thin side wall **47**. For some applications, this wall **47** in this area desirably is not thicker than ⅓ the vertical distance from the screen **41** to the top of the exit opening **40**. Immediately above this thin wall portion **47**, adapter housing **35** has a horizontal surface **48** which, in conjunction with or alternately to the upper surface of tube **49**, may serve as a rebound limiting barrier for the travelling yarn as will be described more fully hereinafter. A hollow cylindrical yarn guiding tube **49** is held next to the adapter housing **35** by means of the spring **50** on ears **51**, **52** (see FIG. **7**) and in communication with the exit opening **40**.

As appears from FIG. **2**, sleeve **42** is in communication with a steam exhaust pipe **53**, so that steam passing through screen **41** will pass into this pipe **53** and may be drawn off by a blower (not shown).

The heretofore described jet **15** textures the thermoplastic yarn by the novel technique of rebound or "bounce" crimping. The yarn Y advances through yarn tube **25** and is picked up by the steam as it exits from the lower end of that tube. It is then hurled longitudinally of itself with great force by the steam downwardly toward screen **41** at the centralmost point of screen **41**'s concavity, but it is thought that yarn Y actually impinges on screen **41** at this point and in a slightly asymmetrical area around it because the exit opening **40** permits the steam at the last moment to deviate slightly from a straight line path. The bulk of the steam passes through screen **41**, but the yarn Y rebounds, or "bounces", from screen **41** instantaneously in a continuous moving strand-like stream to flow upwardly and to the left as viewed in FIG. **2**. As it flows upwardly it contacts a rebound limiting barrier which may be formed by the wall **48** or the upper surface of tube **49** or, occasionally, even by a plug of yarn which has not yet progressed out of tube **49**. In the embodiment shown, wall **48** is semicircular in section as best appears in FIG. **3**.

The yarn Y is hurled with great velocity against screen **41** by the steam. Desirably, steam at a pressure between 105 and 170 psig is employed, and the yarn Y is advanced through the jet at a linear speed of at least 1,200 linear feet per minute. As illustrated in FIG. **2**, the yarn when it impinges upon the screen **41** is compressed longitudinally of itself by the force of the impact, and it has a crumpled cylindrical or sometimes ribbon-like cross-sectional configuration that is several times the diameter or width of the incoming yarn. The force of the rebound is enough to throw the yarn several feet from the screen in the absence of a limiting barrier.

In the embodiment shown a short tube **49** is provided, and a drop wire **54** is pivoted on the nut **32** so that it falls across the end of tube **49**, to limit the lateral movement of the rebound yarn. Wire **54** is urged downwardly by gravity under its own slight weight about its pivot in nut **32**, and it may be lifted slightly by the force of the rebound yarn thereagainst so the lateral movement of the rebound yarn is, if necessary, brought to an end by the wire **54**, and the yarn then falls under its own weight into heating chamber **16**.

Yarn Y is a multi-filament continuous filament thermoplastic yarn. As is well-known, such yarn is formed of a multiplicity of very small filaments. Occasionally, one of these filaments may become imbedded in an opening in screen **41**. When this occurs the oncoming length of this imbedded filament will be fed out through tube **49** and will hang therebeneath. The length of the hanging loop will increase as the yarn continues to feed. As will be noted in FIG. **7**, tube **49** has a slot **55** in its bottom into which this loop of single filament may fall. As appears in FIGS. **1** and **2**, a pair of driven nip rolls **56**, **57** are centered beneath this slot **55**. As the loop of the imbedded filament becomes long enough, it falls into the nip of rolls **56**, **57**; rolls **56**, **57** are driven by a belt and pulley drive in such a direction as to pull on this filament and eventually pull the imbedded portion out of screen **41**, so yarn processing will continue uninterrupted.

Referring next to FIGS. **1** and **3**, there is disposed beneath the end of tube **49** the heating chamber **16**. As shown in FIG. **1**, this chamber consists of an outer sleeve of insulation **58** which surrounds a steam chamber **59** which in turn surrounds an inner cylindrical yarn chamber **60**. Steam is circulated through chamber **59** to heat the walls of yarn chamber **60**, and consequently to heat the yarn contained within chamber **60**.

As best shown in this Figure the rebound yarn Y falls into yarn receiving chamber **60**. The rebound yarn Y has not been subjected to any substantial longitudinal tension between the time it bounces off screen **41** and the time it falls in a loose mass in chamber **60**. This loose mass fills chamber **60**, and as the yarn Y is withdrawn from the cooling chamber, as will be described hereinafter, the loose mass of yarn in the heating chamber **16** progresses downwardly through the heating chamber. A typical dwell of a piece of yarn in the heating chamber is 9 minutes. At an input speed of 1,600 feet per minute of 1,800 denier polypropylene yarn to jet **15**, a yarn chamber **60**, 5 ⅝ inches in diameter and with a heating section 30 inches long, gives excellent results.

To further assist in heating the yarn in chamber **60**, air is blown through tubes which coil first through steam chamber **58**, where the air in the tubes is heated, and thence pass vertically through chamber **60** in the form of bleed tubes **61**, **61'**. In FIG. **1** two of these bleed tubes are shown although in practice three are used spaced 120° apart around the yarn tube **60**. These hot air bleed tubes **61**, **61'** are disposed vertically within chamber **60** and they have holes, spaced at 2 ½ inch intervals, through their sides. Air which is passed through the tube coils to be heated in the steam chamber **58** is blown out the holes in bleed tubes **61**, **61'** into chamber **60** to circulate through the mass of yarn passing through chamber **60** and heat this mass.

Immediately beneath the heating chamber **16**, there is disposed a cooling chamber **17** which is the bottom leg of the J-tube formed by the heating chamber **16** and cooling chamber **17** together. The yarn passes through this cooling chamber **17**, still in a mass. To assist in cooling, two air bleed tubes **62**, only one of which is shown, are disposed inside and at opposite sides of the cooling chamber **17**. Air at room temperature is blown through these cooling tubes and out through bleed holes spaced at 2 ½ inch intervals along their length to circulate through the yarn mass and cool the same. Typically, a dwell of 8 minutes in the cooling chamber is adequate to fully cool the yarn to room temperature.

Not until this point, when the yarn has been fully heat set and cooled, is the textured yarn subjected to substantial longitudinal tension. As appears best in FIG. **1**, the yarn Y is led out of the mass over baffles **63**, **64** and through eyelet **65** which tend to remove gross tangles in the yarn. To further remove any persistent tangles, a series of tension vanes **66**, **66'**, **66''** and **66'''** are provided. These vanes are simply thin pieces of sheet metal shaped to close the chamber and pivoted at hinges **67**, **67'**, **67''** and **67'''** respectively, so that they tend to fall by gravity counterclockwise against the opposite wall **68** of the chamber. These vanes, for example see vane **66**, each have a small piece of window screening **69** bent around its end. The yarn as it advances upwardly from eyelet **65** is pinched gently by the vanes **66**, **66'**, etc. in succession to be rubbed by the screen **69** which in turn tends to pull out any persistent tangles in the yarn as it is led from the mass in cooling chamber **17**.

The yarn now once again in substantially linear form is then pulled over idler rolls **18**, **19** and **20** by pull-out godet rolls **21**, **22** and is fed forward to be wound up in a package **24** in a conventional manner.

width (beneath the arc) is ¼ inch. The distance from the base of the cone formed by screen **41** to the rebound limiting barrier surface **48** was 0.593 inches. The length of the rebound limiting surface **48**, measured radially of housing **35**, was 0.375 inches. Tube **49** was 2 ½ inches long and had an outer diameter of 1 3/16 inches and a wall thickness of 0.049 inches.

The following specific examples of yarn, all textured on the jet of Example I, will further illustrate the invention.

| Examples | II | III | IV | V |
|---|---|---|---|---|
| A. Foraminous rebounding surface 41: | | | | |
| 1. Material | Wire screen | Wire screen | Wire screen | Wire screen. |
| 2. Screen mesh [1] | 50 x 50 | 60 x 60 | 70 x 70 | 50 x 50. |
| 3. Percent open area of screen | 30.3 | 30.5 | 29.6 | 30.3. |
| 4. Width of mesh opening | 0.011" | 0.009" | 0.007" | 0.011". |
| 5. Diameter of wire (all stainless steel) | 0.009" | 0.0075" | 0.0075" | 0.009". |
| 6. Angle θ of surface 41 (as stated in Example I) | 10° | 10° | 10° | 10°. |
| B. Yarn input speed to jet 15 (linear feet per minute) | 1,600 | 1,600 | 2.400 | 1,600. |
| C. Pressure of steam admitted to chamber 26 (p.s.i. gauge). | 110 | 110 | 130 | 110. |
| D. Temperature of circulating air in chamber 16 (° F.) | 274 | 298 | 298 | 274. |
| E. Duration of yarn dwell in chamber 16 [2] | 7 minutes | 7 minutes | 6 minutes | 7 minutes. |
| F. Duration of yarn dwell in chamber 17 (circulating air at room temperature, approximately 70° F.).[2] | 5 minutes | 5 minutes | 5 minutes | 5 minutes. |
| G. Yarn input to jet 15 | 2,000 denier continuous filament polypropylene (104 filaments in yarn). | 2,000 denier continuous filament polypropylene (104 filaments in yarn). | 1,800 denier continuous filament polypropylene (104) filaments in yarn). | 2,000 denier continuous filament polypropylene (104 filaments in yarn). |
| H. Draw ratio from rolls 11, 12 to rolls 13, 14 | 2.5:1 | 2.5:1 | 2.5:1 | 4.0:1. |

[1] All screens were plain woven; "screen mesh" means "openings per inch" in warp and weft (or "shute"); see, for example, catalog "Jelliff Wire Cloth" (copyright 1967 by C. O. Jelliff Corporation, Southport, Connecticut) for screen terminology.

[2] Yarn dwells E and F are approximate average dwells as in the embodiment illustrated the pull-out "hunts". The dwells stated are in excess of those required to heat the yarn to the heat setting temperature and to subsequently cool it to near room temperature in the apparatus illustrated.

In the embodiment shown, the godet rolls **21**, **22** are driven at two selected speeds, so as to control the quantity of yarn in the heating chamber **16** and cooling chamber **17**. The yarn should be heated in the heating chamber at least long enough to bring it up to the desired final heat setting temperature. Similarly, the yarn should dwell in the cooling chamber **17** sufficiently long to be cooled below its heat setting temperature.

A vane **70** hangs inside the upper end of heating chamber **60**. This vane is pivoted about a support **71** in such a manner that it is urged by gravity counterclockwise as viewed in FIG. **1**. Consequently, as the yarn falls into chamber **60** and fills the same, the weight of yarn, when the mass reaches the level of this vane **70**, will bear against this vane and urge the vane counterclockwise. Through a linkage **72**, vane **70** controls a micro-switch **73** which turns the motor control for roll **21** to either a fast drive or slow drive position. If there is so little yarn in the heating chamber that it does not contact vane **70**, gravity permits vane **70** to rotate counterclockwise from the position shown in the drawing and to turn the micro-switch so that yarn is taken out at the slow speed by roll **21**. When yarn builds up against vane **70** and holds it in the position shown in the drawing, the micro-switch is turned to the fast speed and roll **21** takes out yarn at the fast speed.

The following specific embodiments will further illustrate this invention.

## EXAMPLE I

A yarn texturing jet **15** has the following construction. A tube **25**, 2 ¾ inches long, having a 0.083 inches outer diameter and a 0.063 inches inner diameter is provided with a flared lower end. The length of cuts to produce the struts **38** is 0.093 inches measured axially of the tube and before the struts are flared. These struts are flared so that their ends touch the walls of a chamber **33** 0.104 inches in diameter, and struts **38** hold the tube **25** centered in that chamber. Tube **25** has its lower end in chamber **33** a distance equal to 1 5/16 inch from the base of the cone whose surface is screen **41**. A cone angle θ (see FIG. 3) of 10° is provided. Vane **47** is 0.073 inches thick and the vertical dimension of opening **40** measured from the uppermost point of its top arc as viewed in FIG. **3** to the base of the cone formed by screen **41** is ¼ inch, and its maximum

Various screens may be employed for the screen **41**. Of course, the screen should not be so open mesh that the fiber is blown into or made to stick on it in the openings. Desirably, a mesh from about 35 ends and 35 picks per inch up to about 70 ends and 70 picks per inch with an open area between 25 percent and 35 percent gives the best results. The open area should be related to the mesh, so that screens with fewer ends and picks per inch should have wire sizes which leave open areas at the lower end of the range. Balanced weaves, i.e. weaves where the wire has the same number of ends and picks per inch, seem to work best. The roughness of a wire screen seems to contribute materially to the satisfactory working of the invention. As is well-known a screen is made by weaving wires, and the bends induced in the wire in the weaving process give a surface texture or roughness to the screen which is thought advantageous in the process. The angle θ of the screen is also important. Desirably this angle should be between 8° and 12°.

Extremely high processing speeds can be achieved using this invention. Speeds of 2,550 feet per minute have been employed. But lower speeds can be used and still achieve the invention provided the yarn is rebound off the screen. Speeds in excess of 1,200 feet per minute have been found especially desirable.

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

**1**. A method of texturing a thermoplastic multi-filament yarn which comprises advancing the yarn longitudinally of itself in a stream of heated fluid advancing longitudinally of the yarn, hurling the yarn toward a foraminous surface by means of said stream of fluid while passing at least part of said stream of fluid through said surface, impinging said advancing yarn on said foraminous surface with sufficient force to induce a compression crimp in the filaments of said yarn, instantaneously rebounding the yarn from said surface in a continuous strand-like stream and advancing the rebounded yarn away from said surface, and collecting the rebounded yarn.

**2**. A method in accordance with claim **1** in which said foraminous surface is a wire screen at least a portion of which is disposed at an acute angle to the direction of yarn advance toward said screen, and including the step of impinging the yarn on the portion of said screen which is disposed at such acute angle.

3. A method according to claim 2 in which said screen is shaped to a concave configuration, and including the step of impinging the yarn on said screen in the concavity.

4. A method according to claim 3 in which said concave configuration is conical and the angle of said conical surface to the direction of yarn advance theretoward is between 78° and 82°, and including the step of impinging the yarn on said screen in the concavity at the apex of said conical shape.

5. A method according to claim 2 including the step of rebounding the yarn from said screen along a path forming a small angle with the path of yarn advance toward said screen, and impinging the rebound yarn on a rebound impeding barrier after said rebound yarn has traveled less than 1 inch from said screen.

6. A method according to claim 5 in which said screen is shaped to a concave configuration, and including the step of impinging the yarn on said screen in the concavity.

7. A method according to claim 6 in which said concave configuration is conical and the angle of said conical surface to the direction of yarn advance theretoward is between 78° and 82°, and including the step of impinging the yarn on said screen in the concavity at the apex of said conical shape.

8. A method according to claim 7 and including the step of collecting said rebound yarn while maintaining it free of substantial longitudinal tension, heating the so-crimped and untensioned yarn to set the same, thereafter cooling said yarn while maintaining it free of substantial longitudinal tension, and thereafter winding said yarn.

9. A method according to claim 1 including the step of advancing the yarn toward said foraminous surface through a tube centered in an elongated cylindrical chamber by means of strut-like members extending between the exit end of said tube and the inner wall of said chamber, advancing the fluid through the annulus between said tube and said inner wall and past said struts to pick up said yarn as it exits from said tube.

10. A method in accordance with claim 9 in which said foraminous surface is a wire screen at least a portion of which is disposed at an acute angle to the direction of yarn advance toward said screen, and including the step of impinging the yarn on the portion of said screen which is disposed at such acute angle.

11. A method according to claim 10 in which said wire screen is shaped to a concave configuration, and including the step of impinging the yarn on said screen in the concavity.

12. A method according to claim 11 in which said concave configuration is conical and the angle of said conical surface to the direction of yarn advance theretoward is between 78° and 82° and the axis of said conical surface is aligned with the axis of the tube, and including the step of impinging the yarn on said screen in the concavity at the apex of said conical shape.

13. A method according to claim 9 including the step of rebounding the yarn from said screen along a path forming a small angle with the path of yarn advance toward said screen, and impinging the rebound yarn on a rebound impeding barrier after said rebound yarn has traveled less than 1 inch from said screen.

14. A method in accordance with claim 13 in which said foraminous surface is a wire screen at least a portion of which is disposed at an acute angle to the direction of yarn advance toward said screen, and including the step of impinging the yarn on the portion of said screen which is disposed at such acute angle.

15. A method according to claim 14 in which said wire screen is shaped to a concave configuration, and including the step of impinging the yarn on said screen in the concavity.

16. A method according to claim 15 in which said concave configuration is conical and the angle of said conical surface to the direction of yarn advance theretoward is between 78° and 82°, and including the step of impinging the yarn on said screen in the concavity at the apex of said conical shape.

17. A method according to claim 16 and including the step of collecting said rebound yarn while maintaining it free of substantial longitudinal tension, heating the so-crimped and untensioned yarn to set the same, thereafter cooling said yarn while maintaining it free of substantial longitudinal tension, and thereafter winding said yarn.

18. A method according to claim 17 wherein said wire is square woven with the wire end count between 40 × 40 and 70 × 70 with between 25 percent and 35 percent open space.

19. A method according to claim 18 including the step of hurling said yarn at said screen at a speed not less than 1,200 linear feet per minute.

20. A method according to claim 19 in which said fluid is super-heated steam and said steam is at a pressure between 105 psi gauge and 170 psi gauge when it is introduced to the annular chamber.

21. Thermoplastic yarn texturizing apparatus which comprises a member defining a yarn passage chamber, a tube through which the yarn to be textured is advanced, said tube being disposed with its exit end in said chamber, said chamber having an end opening aligned with the axis of said tube and spaced a little distance from the yarn exit end of said tube, a member having a foraminous surface covering said end opening, and aligned with the exit end of said tube, said chamber having a yarn exit opening in a sidewall thereof, said yarn exit opening extending from said foraminous surface toward the yarn exit end of said tube a fraction of the distance from said foraminous surface to the exit end of said tube, and means for introducing a heated fluid into said chamber in the space between said tube and the walls of said chamber and for passing said fluid along said tube past its exit end and toward said foraminous surface to hurl the yarn against said foraminous surface and rebound it therefrom and through said yarn exit opening.

22. Apparatus according to claim 21 in which said member having a foraminous surface is a wire screen at least a portion of which is disposed at an acute angle to the axis of said tube.

23. Apparatus according to claim 22 wherein the said member defining the yarn passage chamber has a convex configuration at said end opening and said screen has a matching concave configuration where it covers said end opening.

24. Apparatus according to claim 23 wherein the concave configuration of said screen is conical, the apex of said conical surface is aligned substantially with the axis of said tube so yarn hurled from said tube impinges in said conical concavity, and the angle of said conical surface to the axis extended of the tube is between 78° and 82°.

25. Apparatus according to claim 24 including a yarn rebound limiting barrier blocking the path of yarn rebound after it passes through said yarn exit opening, said rebound limiting barrier being spaced not more than 1 inch from said screen measured along the path of rebound yarn advance from said screen.

26. Apparatus according to claim 25 in which said yarn exit opening has a longitudinal dimension measured along the axis of said tube which is not longer than ½ the distance between said screen and said rebound limiting barrier, and in which said chamber defining member has a wall thickness in the area between said yarn exit opening and said rebound limiting barrier which is not greater than ⅓ the said longitudinal dimension of said yarn exit opening.

27. Apparatus according to claim 26 including a tube adapted to receive the crimped yarn after it rebounds from said screen and to direct it to a yarn heating chamber.

28. Apparatus according to claim 27 including a crimped yarn treating chamber disposed beneath the exit end of said crimped yarn directing tube and into which said yarn is adapted to fall, means for heating the yarn in said crimped yarn treating chamber, means for subsequently cooling said yarn and means for withdrawing the yarn from said crimped yarn treating chamber.

29. Apparatus according to claim 28 including a pair of driven nip rolls disposed beneath said crimped yarn directing

tube arranged to receive a filament by gravity fall after a portion of such filament becomes imbedded in said screen, said nip rolls being driven in a direction to pull said imbedded filament out of said screen.

**30.** Apparatus according to claim **22** wherein said yarn passage chamber is cylindrical and wherein said yarn tube is centered in said cylindrical chamber, and struts extending between the exit end of said yarn tube and the walls defining said cylindrical chamber to hold the tube centered in said chamber, said means for introducing a heated fluid being arranged to introduce said heated fluid to the annular area between said tube and the walls of said cylindrical chamber.

**31.** Apparatus according to claim **30** wherein the said member defining the yarn passage chamber has a convex configuration at said end opening and said screen has a matching concave configuration where it covers said end opening.

**32.** Apparatus according to claim **31** wherein the concave configuration of said screen is conical, the apex of said conical surface is aligned substantially with the axis of said tube so the yarn hurled from said tube impinges in said conical concavity, and the angle of said conical surface to the axis extended of the tube is between 78° and 82°.

**33.** Apparatus according to claim **32** including a yarn rebound limiting barrier blocking the path of yarn rebound after it passes through said yarn exit opening, said rebound limiting barrier being spaced not more than 1 inch from said screen measured along the path of rebound yarn advance from said screen.

**34.** Apparatus according to claim **33** in which said yarn exit opening has a longitudinal dimension measured along the axis of said tube which is not longer than ½ the distance between said screen and said rebound limiting barrier, and in which said chamber defining member has a wall thickness in the area between said yarn exit opening and said rebound limiting barrier which is not greater than ⅓ the said longitudinal dimension of said yarn exit opening.

**35.** Apparatus according to claim **34** including a tube adapted to receive the crimped yarn after it rebounds from said screen and to direct it to a yarn heating chamber.

**36.** Apparatus according to claim **35** including a crimped yarn treating chamber disposed beneath the exit end of said crimped yarn directing tube and into which said yarn is adapted to fall, means for heating the yarn in said crimped yarn treating chamber, means for subsequently cooling said yarn and means for withdrawing the yarn from said crimped yarn treating chamber.

**37.** Apparatus according to claim **36** including a pair of driven nip rolls disposed beneath said crimped yarn directing tube arranged to receive a filament by gravity fall after a portion of such filament becomes imbedded in said screen, said nip rolls being driven in a direction to pull said imbedded filament out of said screen.

**38.** Apparatus according to claim **34** including crimped yarn directing means adapted to receive the crimped yarn after it rebounds from said screen and to direct it to a yarn heating chamber.

**39.** Apparatus according to claim **38** including a crimped yarn treating chamber disposed beneath the exit end of said crimped yarn directing means and into which said yarn is adapted to fall, means for heating the yarn in said crimped yarn treating chamber, means for subsequently cooling said yarn and means for withdrawing the yarn from said crimped yarn treating chamber.

**40.** Apparatus according to claim **39** including a pair of driven nip rolls disposed beneath said crimped yarn directing means arranged to receive a filament by gravity fall after a portion of such filament becomes imbedded in said screen, said nip rolls being driven in a direction to pull said imbedded filament out of said screen.

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