This invention relates to textile spinning apparatus and method for forming filament yarns, and more particularly relates to a filament yarn spinning apparatus and method adapted to uniformly quench freshly spun filaments to produce yarns of improved quality.

Synthetic thermoplastic filaments manufactured from polymeric compounds such as nylon filaments are customarily melt spun in units called quench chambers, chimenys, or boxes. The filaments are formed by extruding the molten polymeric compound through a plurality of orifices in a spinneret device positioned at the upper end of the quench chamber. The polymer compound issues from the spinneret device in the form of a plurality of continuous, molten filaments that pass vertically downwardly through the quench chamber and then through a convergence guide for converging the filaments into a yarn bundle. To properly cool or quench the molten filaments before they are united into a yarn bundle a stream of gas such as air under pressure is directed perpendicularly across the path of the vertically traveling filaments passing through the quench chamber. In practice, it is important that each filament be properly quenched at substantially the same rate as it passes through the airstream to impart desirable uniform physical qualities to the resulting solidified filaments.

According to present spinning procedures, filaments are extruded from spinnerets in a bunched or clustered group or groups consisting of large numbers of filaments. Since the direction of flow of the airstream is perpendicular to the passage of the filaments through the quench chamber, the airstream first contacts one side of the filament cluster and is prevented from flowing unrestrictedly through the cluster because of the density of filaments within the central region of the cluster. Consequently, the velocity of the airstream is reduced and a direct flow of air through the bundle is obstructed. The filaments in the central region and on the downstream side of the bundle are cooled at a slower rate than the filaments at the upstream side of the bundle. Hot gas zones often develop in the core of the filament bundle. The variation in the interfilament cooling rate causes variances in interfilament physical properties. Continuous yarns formed from such filaments possess a large degree of variance particularly in tensile and elongation properties.

It is an object of this invention to provide filament yarn spinning apparatus adapted to produce yarns having improved physical property uniformity.

Another object of the invention is to provide filament yarn spinning apparatus including spinneret means having orifices arranged in substantially V patterns to effect uniform cooling of freshly spun molten filaments for providing continuous filament yarn having uniform interfilament physical properties along the length thereof.

Another object is to provide a filament yarn spinning method for producing yarns having uniform interfilament physical properties.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

Accordingly, the filament yarn spinning apparatus embodying the invention comprises, in brief, an enclosure including means for establishing a converging airstream at substantially V patterns to effect uniform cooling such as air therethrough. Spinneret means having a plurality of orifices therein for extruding a group of filaments therefrom is positioned at the upper end of the enclosure. The orifices in the spinneret means are arranged in a substantially V pattern and the spinneret means is positioned in the enclosure so that the open side of the V orifice pattern or arrangement faces in the direction of the upstream side of the airstream passing through the enclosure. In method, melted polymer compound is metered to the spinneret means and is extruded through the orifices. The polymer compound issues from the orifices in the form of molten filaments arranged in a V formation and pass longitudinally downwardly through the quench chamber and through the airstream in V formation.

The airstream spreads the filaments apart and flows unrestricted through the filament group thereby effectively quenching each filament at a uniform rate.

The filament group is converged into a yarn bundle at the lower end of the enclosure by convergence guide means and the yarn bundle is then collected on a take-up means. The spinning apparatus of the invention yields a continuous yarn having a low physical property variance value along the length thereof.

A better understanding of the invention will be gained by reference to the detailed description which follows and to the accompanying drawing.

In the drawing:

FIGURE 1 is a schematic perspective view showing the filament yarn spinning apparatus embodying the invention and illustrating a spinneret having the orifices arranged in the form of a horizontal row of a plurality of V's with orifices deleted in the area of the apices of the V's;

FIGURES 2-8 are plan views of spinnerets having modified V patterns of orifices in accordance with the invention;

FIGURE 9 is a plan view of a prior art type spinneret having a cluster pattern of orifices; and

FIGURE 10 is a plan view of a spinneret having a preferred V pattern of orifices according to the invention.

Referring to the drawing, one form of the filament yarn spinning apparatus embodying the invention is illustrated in FIGURE 1. The apparatus comprises an uprightly positioned enclosure 1 formed by a pair of spaced opposite sidewalls 2, and upper and lower endwalls 3 suitably connected to the side walls 2. The backside of the enclosure has a perforated wall 4 such as a screen. A plenum chamber 5 is formed adjacent to the perforated wall 4 by a housing 6 connected to the side and end walls. The plenum chamber 5 is normally supplied with fluid under pressure such as air from 7 so that the open side of a conduit 8 opening into chamber 5. The front side of enclosure 1 is preferably uncovered; however, if desired a partial covering may be provided.

The enclosure formed defines an elongated central chamber 9 open at one side to the plenum chamber 5 via openings in the perforated wall 4 and open to the ambient air at the opposite uncovered side thereof. Air normally supplied to the plenum chamber 5 flows in a stream through the perforated wall 4 to the open front side of the enclosure 1 transversely through the central chamber 9 and exhausting therefrom.

A spinneret 9 having a plurality of orifices 10 extending therethrough for extruding filaments therefrom is positioned within an aperture in the upper endwall 2 with the filament issuing side of the spinneret facing downwardly into chamber 9.

The orifices 10 in the spinneret 9 are arranged to form a plurality of V patterns with the V patterns disposed in a horizontal row with the open side of the V's facing in the same direction. Preferably, the orifices are deleted in the areas surrounding the apices of the V's and each V defines a right angle. The spinneret 9 is positioned in the upper endwall 2 so that the open side of the V patterns face in the direction of the perforated wall 4.

A plurality of spaced convergence guides 11 are posi-
tioned each over a respective opening in the lower end-wall 2 and are suitably secured to the walls of the enclosure 1.

A pigtail guide 12, a traverse device 13, and a take-up device 14 are provided adjacent to and exteriorly of the lower end of the enclosure 1 for guiding, traversing, and collecting a plurality of yarn ends, respectively.

In operation, a polymeric compound such as a polyamide compound for producing nylon filaments is metered to the upper face of spinneret 9. The compound extrudes through the orifices of the spinneret 9 and issues therefrom in the form of molten continuous filaments that fall downwardly and longitudinally through central chamber 8. As illustrated in FIGURE 1, the filaments in two separate groups and each group of filaments after passing through chamber 8 extends through a respective convergence guide 11 where the filaments of each group are converted into a yarn bundle. The converged yarn bundles pass outwardly of the enclosure 1 and travel through the pigtail guide 12 and thence to the traverse device 13 before being taken up on separate driven bobbins of take-up device 14. Traverse device 13 displaces the yarn back and forth laterally across the bobbins.

The V orifice patterns in the spinneret 9 cause the filaments to extrude into chamber 8 in a V formation with the open side of the V being presented to the perforated wall 4 so that the upstream side of the airstream flowing at right angles to the direction of travel of the filaments funnels into the filament formations and spreads the filaments apart causing the filaments to slightly bow or arc in their travel through chamber 8. The air passes freely between the filaments and the velocity of the airstream remains substantially the same through the central chamber 8. The airstream cools each of the filaments uniformly at a rate permitting proper solidification and maturation of the filaments thereby imparting desirable physical qualities in the yarn formed from the filaments.

Modified variations of spinneret orifice pattern arrangements are shown in FIGURES 2–8. The orifice pattern as illustrated in FIGURE 2 comprises a single V chevron grouping having a plurality of V patterns arranged in a column one behind the other. The orifices are deleted at the apices of the V patterns to permit maximum funneling of the air through the filament group.

FIGURE 3 shows a spinneret 9 similar to that shown in FIGURE 2 except that orifices 10 are provided in the apices of the V's.

The spinnerets 9 shown in FIGURES 6 and 7 correspond to those shown in FIGURES 4 and 5, respectively, with the exception that the walls forming the V's in FIGURES 6 and 7 are rounded in parabolic configurations.

FIGURE 8 shows a spinneret 9 having several stratified orifices 15 formed between the walls of a V pattern. Although the use of stratified filaments is not the preferred construction, it is possible to spin more filaments with their provision, and if the stratified orifices are held to a minimum the effectiveness of the operation is not substantially affected.

FIGURE 10 shows a spinneret 9 having the orifices 10 formed in a chevron arrangement with the orifices of one V being aligned horizontally with those of the other V pattern. Such an arrangement is preferable because the airstream is more readily funneled between the V patterns of filaments extruded from such an arrangement of orifices.

Comparative tests made of nylon yarns containing a like number of filaments, one yarn having filaments spun from a conventional type spinneret 16 having a cluster arrangement of orifices 17, as shown in FIGURE 9, and the other yarn having filaments spun under identical conditions from a spinneret having the same number and size of orifices but having the orifices arranged in a V pattern in accordance with the invention, revealed that in each case the yarn according to the invention had a lower breaking strength variance value and a lower elongation variance value indicating more filament uniformity in the yarns made according to the invention. The procedure used for obtaining the breaking strength and elongation variance values was in accordance with that outlined in the textbook "ASTM Standards on Textile Materials," 33rd Edition, 1962, Appendix 11, pp. 911–917. Yarns made according to the invention had lower breaking strength standard deviations from 100 percent to 500 percent and lower elongation standard deviations from 100 percent to 300 percent than those manufactured from spinnerets 16 with conventional cluster arrangement of orifices 17.

It will be understood that variations and modifications of the apparatus and method as described and illustrated are contemplated within the spirit of the invention and that the invention is intended to be limited only by the scope of the following claims.

I claim:

1. A method for spinning filament yarns comprising:
   (a) extruding a plurality of filaments in a V formation,
   (b) longitudinally passing said V formation of filaments through a quench region,
   (c) flowing a stream of air under pressure perpendicularly to the longitudinally passing filaments and into the mouth of the V filament formation in said quench region, whereby the filaments produce a funneling of the airstream toward the apex of the V formation.

2. Filament yarn spinning apparatus comprising:
   (a) spinneret means having a plurality of orifices therein arranged to form converging rows of orifices forming a V pattern for issuing a plurality of filaments formed from a molten compound delivered to said spinneret and extruded through said orifices into a quenching region below said spinneret means in a V formation, said filaments normally traveling longitudinally through the quench region,
   (b) means in said quench region adapted to flow a stream of air under pressure in a direction perpendicularly to the longitudinal passage of the filaments through the quench region and into the open side of the V formation of filaments whereby the filaments produce a funneling of the airstream toward the apex of the V-filament formation for uniformly cooling the filaments.

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