Nov. 21, 1967 M. S. HERRING 3,353,210

RECTANGULAR CONVERGENCE GUIDE

Filed Dec. 9, 1965

FIG. 1

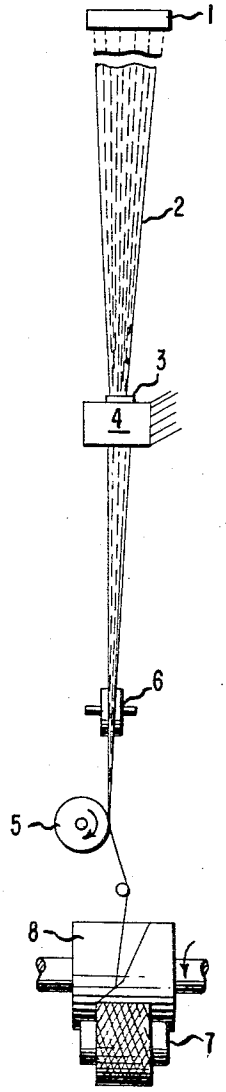


FIG. 2

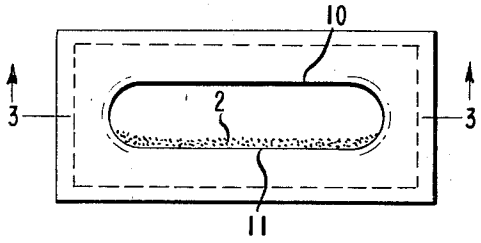


FIG. 3

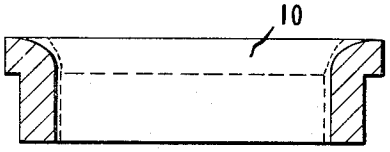
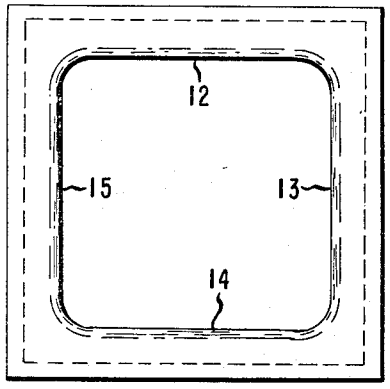


FIG. 4



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RECTANGULAR CONVERGENCE GUIDE

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ABSTRACT OF THE DISCLOSURE

An improvement in an apparatus for melt spinning a large number of filaments at high speed from a single spinneret in which the filaments are converged into a bundle and finish is applied before the filaments pass to a take-off wheel, the improvement being a convergence guide for assembling the filaments into a yarn bundle of uniform, essentially rectilinear cross sections, the guide having an essentially linear primary yarn-contacting surface of smoothly rounded contour for converging the filaments into a flat bundle and contiguous yarn-contacting surfaces of smoothly rounded contour for controlling the yarn bundle width, the surfaces being joined in smoothly rounded contours, and the yarn-contacting surfaces of the guide form an essentially rectilinear aperture having rounded ends.

This invention is concerned with guides for synthetic filamentary materials and more particularly with an improved guide for unfinished, freshly melt-spun yarns which are especially susceptible to mechanical damage or twining.

In the production of melt-spun fibers, such as commercial polyamide and polyester yarns, it is common practice to shape a multiplicity of filaments by continuous extrusion of the molten polymer through a single spinneret. Prior to application of a finish, which serves to protect the filaments against mechanical damage, the large number of filaments must be converged to a bundle having a relatively small cross-sectional area for convenience in subsequent handling. The convergence guide previously used for this purpose has a circular aperture and is mounted somewhat off-center of the straight line extending from the center of the spinneret to the first point of yarn contact downstream from the convergence guide. This results in crowding of all the filaments against a fraction of the circular guide's circumference and forces the bundle into a roughly oval shape. It has been found that the shape of the filament bundle obtained with a guide of this type is not optimum for at least two reasons: (1) The oval shape results in a fundamentally unstable filament orientation in that the filaments tend to wander from position-to-position within the limits of the bundle cross-section. This results in an undesirable degree of filament-to-filament contact between the guide and the spinneret, and leads to mechanical damage and adherence of two or more still-molten filaments to form a single filament of larger denier; these effects are exaggerated with high speed operation. (2) The oval shape is reflected in a non-uniform spread of filaments downstream from the convergence guide on the rotating roll employed to apply the protective finish. Some filaments near the edge of the bundle are excessively exposed to the film of finish on the roll, while others near the center of the bundle receive no finish at all. It has been found that, even when the filaments are apparently closely packed in a bundle, they intimately contact each other only infrequently and that a thin layer of protective finish on a given filament will migrate to an adjacent, unfinished filament very slowly, if at all. This is especially true of

a finish which, after evaporation of the water in which it is dispersed, has a high viscosity.

This invention provides an improved means for the convergence of hot, freshly melt-spun filaments of synthetic linear condensation polymer. It further provides means for converging freshly melt-spun filaments which is capable of maintaining rectilinear distribution of filaments in the bundle cross-section. It also provides a means for obtaining an improvement in uniformity of finish application among filaments in a bundle. Other advantages will be seen as the description of the invention proceeds.

These advantages are provided, in apparatus for melt spinning a large number of filaments at high speed from a single spinneret wherein the hot filaments are converged into a bundle and a protective finish is applied before the filaments pass to a take-off wheel, by the improvement of a convergence guide for assembling the filaments into a yarn bundle of uniform, essentially rectilinear cross-section. The guide has an essentially linear primary yarn-contacting surface of smoothly-rounded contour for converging the filaments into a flat bundle and contiguous yarn-contacting surfaces of smoothly-rounded contour for controlling the width of the flat bundle. The surfaces are joined in smoothly-rounded contours to minimize filament damage. Preferred guides have the surfaces arranged to form essentially rectilinear or square apertures.

A preferred embodiment of this invention comprises a guide with an essentially rectilinear aperture having rounded ends. Such a guide can be rotated 180° to present a second surface to the yarn when said first surface has become so eroded by contact with the running yarn as to be unacceptable. Another guide embodiment has an essentially square aperture with rounded corners; it can be reset at 90° index angles to present, successively, each of four yarn-contacting guide surfaces. While obvious economy is found in such embodiments, successful operation of this invention depends only on a guide with a closed aperture which has at least one essentially linear rounded surface of suitable length to provide a uniform, essentially rectilinear cross-section in the bundle of filaments passed thereover.

This invention is more readily understood by reference to the following description taken with the drawings.

FIGURE 1 is an over-all schematic diagram of the spinning apparatus showing location of the convergence guide of this invention,

FIGURE 2 is a plan view of a preferred embodiment of the guide of this invention,

FIGURE 3 is a sectional elevational taken on line 3—3 of FIGURE 2, and

FIGURE 4 is a plan view of an additional embodiment of convergence guide.

With reference to FIGURE 1, molten polymer from source (not shown) is melt spun through a conventional spinneret **1** and shaped thereby into multiple filaments **2**. Convergence guide **3**, mounted in fixed support **4**, is set forward of the threadline such that the filaments slide across the back surface of its aperture as indicated by the layer of filaments **2** in FIGURE 2. Convergence of the filaments within the substantially vertical plane which includes the back surface of the convergence guide continues beyond the guide as required by contact of the bundle with a driven take-off wheel **5**, which rotates at a fixed speed around a shaft oriented perpendicular to said vertical plane. The filaments may make a full wrap around the take-off wheel, as shown, or several wraps around a take-off wheel and a separator roll, or may only wrap part way around the wheel. Between convergence guide **3** and feed wheel **5** is positioned finish

roll 6 to which finish is supplied. The axis of rotation of the finish roll is horizontal and parallel to the back surface of the convergence guide aperture. The essentially rectilinear cross-section of the filament bundle confers stability in orientation of individual filaments between the spinneret and the guide, and during further convergence of filaments from the guide to the finish roll. The uniformly finished filaments are wound up on a bobbin 7 surface driven by roll 8. Alternatively, the product of a plurality of such positions may be combined into a tow for treatment in subsequent processing steps. Such an alternative is frequently of greater interest because of the economy represented by elimination of the preliminary packaging of individual bundles on bobbins.

FIGURES 2 and 3 are, respectively, plan and cross-sectional elevation views of a preferred embodiment of the convergence guide of this invention. In FIGURE 2 a schematic representation of the approximate distribution of filaments 2 in the bundle cross-section during yarn production is shown. This embodiment has two equivalent rounded guide surfaces 10 and 11. In the alternative embodiment shown in FIGURE 4 there are four equivalent guiding surfaces 12, 13, 14 and 15. A sectional elevation of this embodiment would correspond to FIGURE 3. With either embodiment, scheduled indexing of the guide to present an unworn surface to the yarn provides a desirable economy.

The advantages of this invention are seen in improved yarn quality, particularly with respect to a reduction in number of twinned filaments and in improved uniformity of finish application. An immediate observable improvement in yarn quality is presumed to be due to fewer and less-severe filament interactions in the "hot zone" between the spinneret and the convergence guide, where the filaments are particularly prone to merge into larger filaments or to be damaged by contact with each other. More uniform filament-to-filament finish application provides superior protection for the filaments in subsequent processing steps, as in intermediate packaging on individual-bundle bobbins or in handling as a tow representing a plurality of individual bundles, and in guiding to the drawing step wherein the filaments are drawn to several times the as-spun length. Generally the spin finish is extracted from the fiber in hot-wet drawing, and is subsequently replaced by a final finish before drying and relaxing, crimping, cutting and packaging. It has been found, however, that uniform finish application in the as-spun yarn is important to uniform distribution of filaments in the tow bundle fed to the draw zone and minimizes mechanical damage to filaments during the guiding employed to accomplish this uniform distribution.

In a direct comparison between use of the circular convergence guide of the art and the rectangular guide of this invention in high-speed melt spinning of polyethylene terephthalate, the advantages in uniformity of finish application are clearly apparent, as summarized in the following table:

	Circular Guide	Rectangular Guide
Number of Samples	7	8
Average finish on yarn, percent	0.13	0.13
Coefficient of variation, percent	30.8	10.0

In another test, the yarn was examined for fused filaments which result from filament-to-filament contact near the spinneret while the filaments are still molten. At one condition of air-flow rate, instances were reduced 95% by substitution of the rectangular guide for the circular guide of the art. At high air-flow rate in this sensitive zone of filament travel between the spinneret and the guide, a reduction in frequency of 85% was accomplished by substitution of the rectangular guide for the circular convergence guide of the art.

Although additional embodiments beyond those specifically described will meet the critical requirements of this invention, i.e., that the guide present an essentially-linear rounded surface for yarn contact of suitable length to result in a uniform distribution of filaments along said linear surface and that the said surface be contiguous with other surfaces which combine to enclose the running yarn, the combination of straight pins as a substitute for such structure has not been found satisfactory due to entanglement of filaments on such a combination guide with an occasional break-back of a bundle of filaments.

Since many different embodiments of the invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited by the specific illustrations except to the extent defined in the following claims.

I claim:

1. In apparatus for melt spinning a large number of filaments at high speed from a single spinneret wherein the hot filaments are converged into a bundle and a protective finish is applied before the filaments pass to a take-off wheel, the improvement of a convergence guide for assembling the filaments into a yarn bundle of uniform, essentially rectilinear cross-section, said guide having an essentially linear primary yarn-contacting surface of smoothly-rounded contour for converging the filaments into a flat bundle and contiguous yarn-contacting surfaces of smoothly-rounded contour for controlling the width of the yarn bundle, wherein said yarn-contacting surfaces of the convergence guide form an essentially rectilinear aperture having rounded ends, said surfaces being joined in smoothly-rounded contours.

2. An apparatus for melt spinning a large number of filaments at high speed from a single spinneret wherein the hot filaments are converged into a bundle and a protective finish is applied before the filaments pass to a take-off wheel, the improvement of a convergence guide for assembling the filaments into a yarn bundle of uniform, essentially rectilinear cross-section, said guide having an essentially linear primary yarn-contacting surface of smoothly-rounded contour for converging the filaments into a flat bundle and contiguous yarn-contacting surfaces of smoothly-rounded contour for controlling the width of the yarn bundle, wherein said yarn-contacting surfaces of the convergence guide form an essentially square aperture with rounded corners, said surfaces being joined in smoothly-rounded contours.

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