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FILAMENT DRAWING

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Fig. 1

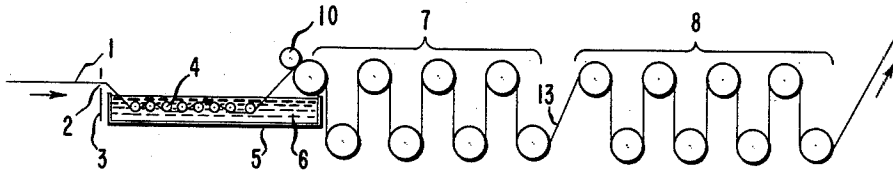


Fig. 2

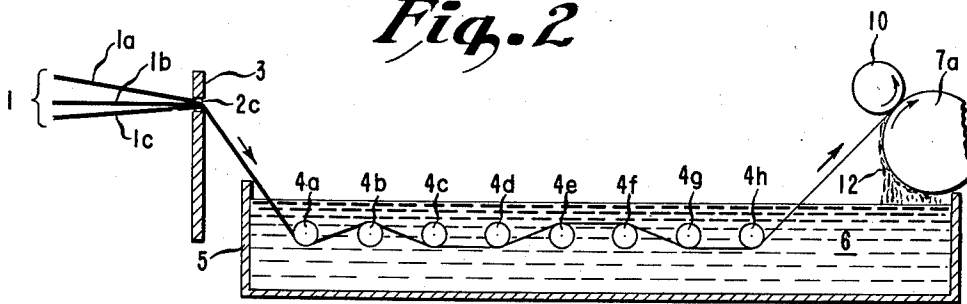
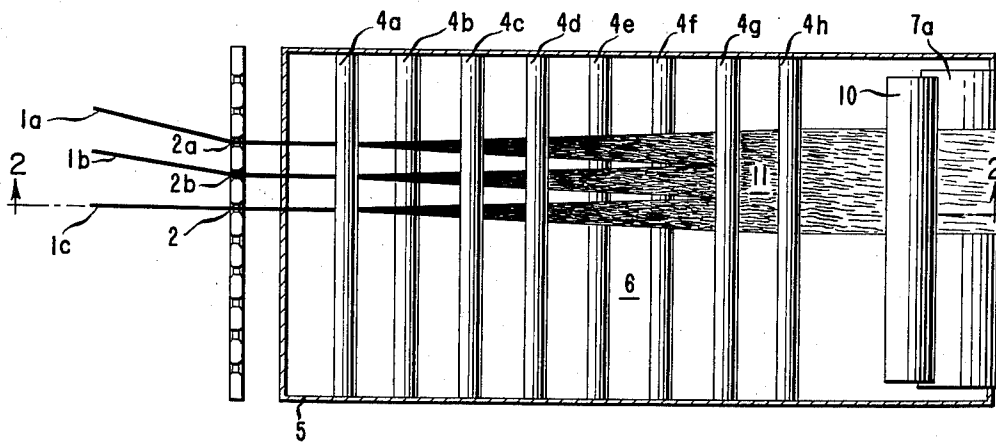


Fig. 3



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2 Claims. (Cl. 18-48)

This invention relates to drawing of synthetic organic filaments to increased length, concerning particularly improved drawings of continuous filaments produced as multifilament bundles or "tow."

A well-known step in manufacture of filaments from synthetic organic polymers involves a permanent increase in filament length; this "drawing" of the filaments gives rise to macromolecular orientation along the filamentary axis, as evidenced by characteristic X-ray patterns, along with increased tenacity and reduced elongation at break. Suitable drawing procedure for multifilament is described by Babcock in Patent 2,289,232; however, inclusion of very large numbers of filaments in a single bundle, as is customary with continuous filaments to be cut into staple fiber, is detrimental to uniform drawing of the individual filaments. Presence of resulting knots, tangles, undrawn portions, and overdrawn portions or breaks is especially undesirable in the relatively difficultly dyeable melt-spun filaments usually composed of linear condensation polymers.

A primary object of the present invention is improvement in uniformity of drawn synthetic organic continuous filaments and staple fiber. A particular object is uniform drawing of each filament in tow containing on the order of thousands of filaments. Other objects of this invention, together with means and methods for attaining the various objects, will be apparent from the following description and the accompanying diagrams.

FIGURE 1 is a schematic elevation of apparatus useful according to this invention. FIGURE 2 is an enlarged sectional elevation of part of the apparatus of FIGURE 1. FIGURE 3 is a plan representation of the apparatus of FIGURE 2.

In general, the objects of the present invention are accomplished by immersing tow composed of filaments of synthetic organic polymer in a bath of liquid non-solvent for the polymer, forwarding the immersed tow through the bath, meanwhile spreading it into a sheet of essentially parallel filaments, and then drawing the wet filaments to increased length. The invention comprehends, as apparatus for carrying out this procedure, at least a half dozen essentially parallel cylindrical elements fixedly located in the bath, adjacent elements being spaced more than the thickness of the tow from one another and means for drawing the filaments to increased length outside the bath. According to this invention a uniform warp sheet is formed readily from many separate bundles of tow, if desired.

In FIGURE 1, tow 1 is represented as passing through aperture 2 in guide plate 3 and into pan 5 containing bath liquid 6. Immersed in this bath are fixed parallel rods 4 (eight in number) some of which the tow passes over and some of which it passes under. Sets 7 and 8 of identical draw rolls (eight rolls to the set) receive the tow over and under alternate rolls after its departure from the bath. Squeeze roll 10 presses the emergent filaments against first draw roll 7a conveniently mounted with its axis over the pan and its lowermost surface above the bath level. From the second set of draw rolls, whose peripheral speed is greater than that in the first set so as to establish drawing zone 13 between the last roll of the first set and the first roll of the second set, the tow proceeds to further processing or windup (means not shown).

The arrangement of elements in the vicinity of the

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bath appears in greater detail in FIGURE 2, with corresponding reference characters. Strands 1a, 1b, and 1c of tow are shown passing through the guide plate, shown sectioned at aperture 2c, which admits the corresponding strand of tow. Excess 12 of bath liquid is visible dripping back from the nip of the squeeze roll and the first draw roll. The tow line is noticeably thinner in its visible transverse dimension at the exit from the bath than at the entrance to it, corresponding to simultaneous transverse spreading visible in the next view.

FIGURE 3 shows the change in configuration of each group of filaments from bundle to sheet form upon passage through the bath. The three illustrated strands pass through their respective guide apertures and enter the bath to pass under rod 4a, over rod 4b, under rods 4c and 4d, and over and under alternate pairs of rods thereafter. Each rod against which the strands are tensioned during passage through the bath exerts slight spreading effect with the result that at about the sixth rod (4f) the outermost filaments of the adjacent strands lie closely side by side, whereupon the respective strands lose their identity and become filamentary sheet 11. The squeeze roll useful in adjusting the liquid content of the sheet may be omitted, or other moisture-removing means may be substituted for it, as desired. Upon subsequent passage over the draw rolls, the individual filaments are subjected to substantially identical forces, with the result that each of them is drawn very nearly the same, after which the filaments may be gathered together again into one or more bundles for subsequent processing, such as crimping or cutting into staple.

The bath liquid plays an important role in facilitating the sidewise movement or spreading of the filaments from the original axis of the strand. Water usually is suitable, as are many other ingredients that do not act to dissolve the filaments or react chemically with them in undesirable manner. Ordinarily the bath will be primarily aqueous with minor content of lubricant, antistatic agent, or even softening or swelling agent for the filament composition. Exposure of individual filaments to the bath is very even, which is highly desirable for application of any finishing agent or the like.

As an example, when an undrawn bundle of tow totalling slightly over 1,500,000 denier and made up of 128,000 filaments composed of polyethylene terephthalate was processed in the illustrated manner using a half dozen ¾" bars spaced on 2" centers in dilute aqueous solution of a conventional textile finishing agent (1.4% of a sulfated fatty alcohol known to the trade as "Avitex R") at about 60° C. a uniform warp sheet 8 inches wide, which subsequently was drawn satisfactorily, resulted under maximum forwarding tension of 0.2 gram per denier. This filamentary sheet, in which the moisture content at the drawing stage was 19±1%, was 4 times as wide as that produced by like treatment of identical tow wet by such solution while in creel supply containers immediately before entering the illustrated apparatus lacking the bath.

When thirty bundles, each of 43,000 filaments of 12 denier per filament and the same composition as above, were combined into a single sheet and then drawn to 4 times the original length in the manner illustrated and described above, some of the tow later being cut into staple lengths and recombined as sliver, the result was eminently satisfactory. As compared with a control run in which the tow was fed directly to the draw rolls after spray-wetting with the same solution, the described operation according to this invention gave rise to only one-half as many defects per given amount of tow and slightly over one-fourth as many per amount of sliver. The defects noted were associated with undrawn portions, determined readily by visual inspection after dyeing with

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a dark dye, inasmuch as dye-receptivity decreases markedly with the increased molecular orientation produced by drawing. Such defects also show up as objectionable spots or streaks in dyed fabric composed of the non-uniformly drawn fibers or filaments.

The amount of contact between a filament bundle and the rods or similar cylindrical elements employed to spread it will depend to some extent upon physical characteristics of the various materials, including composition of the filaments, the bath, and the rods themselves. Oily bath liquid and matte-finished rods favor spreading, as might be expected; however, there is little to choose between polished rods of stainless steel and polished or matte-finished chrome-plated rods, and the major ingredients of the bath also may be determined by other considerations. Increase in bath temperature, as from 60° C. to 70° C., favors spreading. Furthermore, the arrangement of tow with respect to the rods themselves is a convenient variable; it is simple enough to increase the total angle of contact with the bars, or even to increase the number of bars contacted, until the desired sheet formation is accomplished. To accommodate changes in composition of bath or filaments, it is well to have more rods than normally needed, whereupon the tow may pass under or over two or more in succession for a total contact of somewhat less than the maximum possible, as suggested in the diagrams. After at most a few tries, proper string-up is readily determined without difficulty. Excessive spreading of adjacent bundles is undesirable because overlapping of filaments from different bundles is conducive to non-uniformity in thickness of the sheet. Any number of filament bundles may be combined, the illustrated apparatus being adapted to ten, although only three are shown, and their paths through the bath may vary, especially if the bundles are not identical.

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This invention is suited to any stretchable filaments. Ordinarily the filaments will be drawn while wet, although they can be dried wholly or partially after spreading and before drawing by heated rolls or other conventional means. It has proved especially useful in the processing of filaments composed of polyethylene terephthalate, as suggested above, but is also well adapted to filaments of other polyester composition, including copolyesters, as well as filaments composed of polyamides, copolyamides, polyesteramides, and acrylonitrile polymers, for example.

The claimed invention:

1. Process comprising immersing tow composed of filaments of synthetic organic polymer in a bath of liquid non-solvent for the polymer, forwarding the immersed tow through the bath meanwhile spreading it into a sheet of essentially parallel filaments, removing the sheet of filaments from the bath and then drawing the wet sheet of filaments to increased length.

2. The process of claim 1 in which a plurality of bundles of tow are spread alongside one another, thereby merging into a single sheet of filaments.

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