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METHOD OF MOLDING SPINNERETTES

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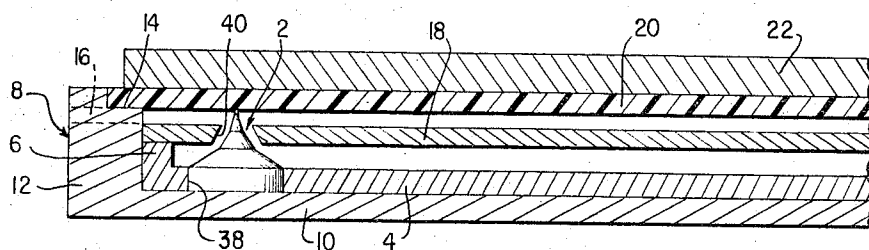


FIG. 1

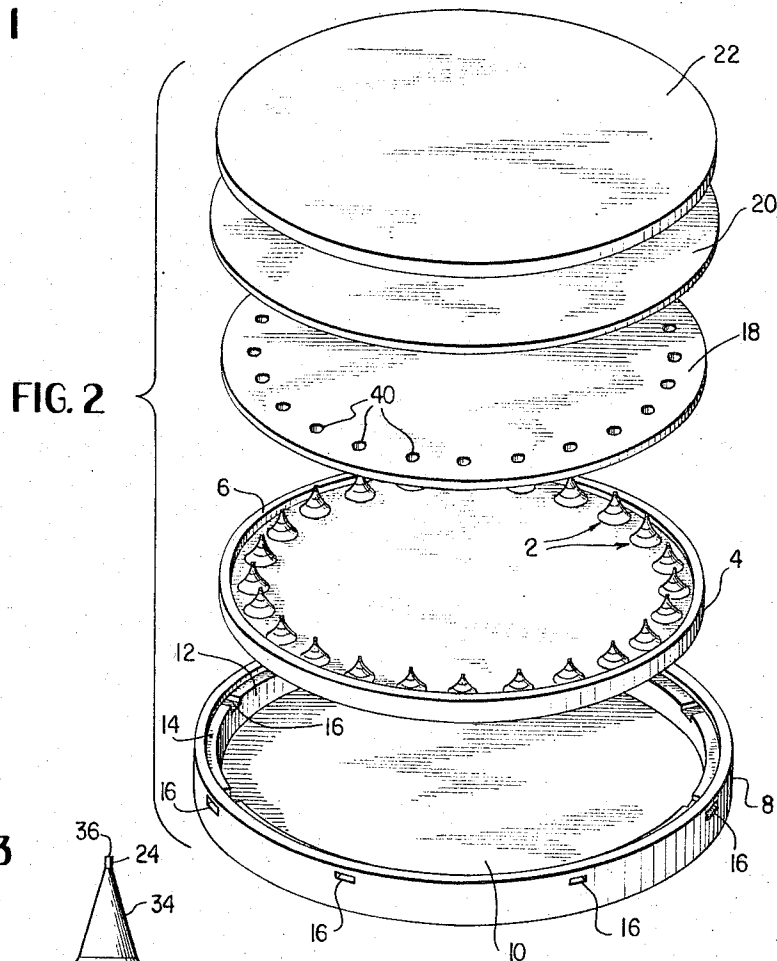


FIG. 2

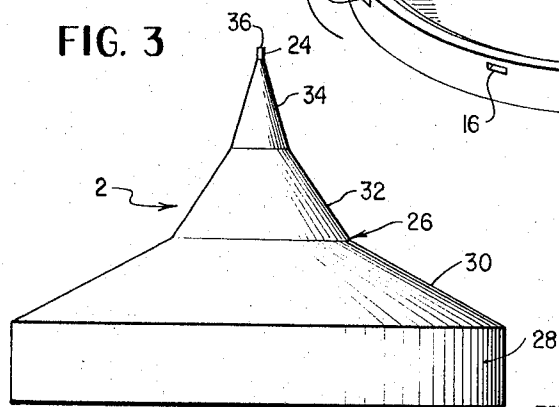


FIG. 3

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METHOD OF MOLDING SPINNERETTES

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This invention relates to a process for forming spinnerettes for use in the manufacture of artificial fibers and to a novel spinnerette construction.

In the manufacture of artificial fibers, great difficulty is experienced in producing the spinnerettes through which the fluid forming the fiber is forced. Such spinnerettes generally comprise an outlet member in the form of a solid body including two opposed surfaces having a plurality of transverse spinnerette jet openings extending between them. The spinnerette jet openings are frequently countersunk at their upstream ends, and the downstream ends of the spinnerette jet openings should form sharp edges with the downstream surface of the solid body. For best results all the spinnerette jet openings in a spinnerette should be of the optimum spinning diameter for the fiber desired. In the usual case where it is desired that all the fibers issuing from a given spinnerette be the same, it is also important that all of the spinning jet openings be completely identical so that the fibers issuing from the openings will possess uniform characteristics.

The method of making spinnerettes most frequently used is to form the spinnerette jet openings in the solid body or disc by drilling. However, drilling the spinnerette jet openings results in variations in their shapes which leads to the production of a considerable number of holes having less than optimum spinning characteristics. Diameter variations, off-center countersink positions, local scoring on the walls of individual jet openings and burrs at the downstream extremities of the hole walls are defects often resulting from attempts to drill jet openings. Furthermore, the buffing procedures frequently employed to remove burrs at the downstream extremities of the holes produced during drilling sometimes produce rounding of the edges of the holes at the downstream surface. Each of these defects has a deleterious effect upon the fiber produced from the spinnerette.

Other disadvantages associated with drilling the spinnerette jet openings arise from the tendency of the drilling hazards described above to increase with the length of the hole drilled. Thus, although it is known that longer hole length leads to enhanced tenacity and elongation characteristics in the fiber produced, it is frequently necessary to limit the lengths to those that can be drilled within the range of drilling variation considered acceptable. Complicated jet opening shapes cannot easily be produced by drilling. One form of spinnerette jet opening requires three separate countersink forming operations, each of which may contribute to non-uniformity. Finally, the drilling of the jet openings as presently performed usually involves the use of highly trained operators and the provision of special drills which become degraded in use and have to be replaced with resulting increase in the cost of the finished spinnerettes.

In recognition of the difficulties associated with the existing methods of making spinnerettes discussed above, it is therefore an object of the present invention to provide a method for making spinnerettes which substantially obviates or minimizes problems, such as those previously noted.

It is a particular object of the invention to provide a method for making spinnerettes that enables a plurality of identical spinnerette jet openings having optimum spinning characteristics to be produced in a spinnerette.

It is another object of the invention to provide a meth-

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od for making spinnerettes that produces smooth un-scored walls of the spinnerette jet openings of the spinnerette, so as to enable superior fibers to be formed therefrom.

It is a further object of the invention to provide a method for making spinnerettes that enables holes of longer length than heretofore achievable to be produced without any sacrifice in uniformity of the jet openings or of jet opening wall smoothness.

It is another object of the invention to provide a method for making spinnerettes that enables complicated spinnerette jet opening shapes, including jet openings of other than circular cross section, to be produced economically.

It is still another object of the invention to provide a method for making spinnerettes at lower cost than heretofore by enabling an indefinite number of spinnerettes to be produced from a single master without requiring tools which must be replaced as they become worn out.

Yet another object of the invention is the provision of a novel spinnerette construction which can be manufactured with greater reliability of performance capabilities than has generally been feasible heretofore, without sacrificing durability.

In achieving these and other objects which will become apparent hereinafter, the present invention includes the step of forming a core element having a portion provided with surfaces conforming to the walls of a spinning jet opening having an inwardly tapered inlet portion and a capillary communicating with the tapered inlet portion. A spinnerette jet end member then is molded about the portion of the core element, after which the core element and the molded end member are separated to provide a spinning jet opening of the desired size and shape in the molded end member.

The novel spinnerette construction contemplated by the invention includes a jet end member molded from a suitable casting material, such as a synthetic resin, to provide jet openings of precisely the desired shapes, and having embedded therein a strength imparting insert of metal forming a back-up for the cast walls of the jet openings.

A more complete understanding of these and other aspects of the invention will be gained from a consideration of the following detailed description of preferred embodiments of the invention, reference being made to the accompanying drawings, in which:

FIGURE 1 is a sectional, elevational view showing a portion of the core elements and mold used to form a spinnerette in accordance with my invention;

FIGURE 2 is an exploded view of the mold shown in FIGURE 1; and

FIGURE 3 is a side view of a core element utilized in making a spinnerette according to my invention.

Referring now to FIGURES 1 and 2, a reusable master mold includes a plurality of identical cores 2 each having a profile identical to that of the desired spinnerette jet opening. The cores are mounted on a rigid disc-like base plate 4 provided with an upwardly projecting rim 6 about the periphery thereof. In assembling the master mold to form a spinnerette, the base plate 4 is positioned within a housing 8 comprising a base 10 and an upwardly extending annular wall 12 extending upwardly from the base. The annular wall 12 includes an internal annular shoulder 14 in, or slightly above, the plane of the free extremities of the cores 2. A plurality of spaced channels 16 extend radially through the annular wall of the housing 12.

A casting cavity defined by the upper surface of the base plate 4 and the annular wall of the housing is filled with a liquid casting material such as an epoxy resin. A reinforcing metal plate 18 is then positioned about the cores 2 with its periphery resting on the rim 6 of the base

plate 4. A surface plate 20 is then positioned on the free extremities of the cores 2 with its periphery resting on the shoulder 14 of the annular wall. A disc-shaped retaining plate 22 rests on the upper surface plate to maintain the surface plate in contact with the cores during molding. Excess fluid displaced during positioning of the surface plate 20 escapes through the radial channels 16. The resin is cured to form a spinnerette end member within the casting cavity after which the mold parts are removed, leaving the finished jet end member. The reinforcing plate 18 remains embedded in the cast material to reinforce it.

Considering the cores 2 in more detail, each core 2 comprises, as best seen in FIGURE 2, an accurately dimensioned, highly polished stem 24 of a uniform diameter equal to that of the desired capillary portion of the spinnerette jet opening, a tapered portion 26 and a securing head 28. The tapered portion 26 of the core in a preferred embodiment is formed as three frusto-conical bands 30, 32, and 34 of progressively reducing inclination to the outer surface of the stem so as to provide a smooth lead-in to the capillary of the finished spinnerette jet. It will be appreciated that the lead-in to the capillary of the finished spinnerette jet may be of any suitable profile. For example, a smooth unbroken curve may be provided. The stem 24 of the core is exactly concentric to the tapered portion 26, and the extremity of the stem is provided with a flat radial surface 36 at right angles to the axis of the stem.

The cores 2 may be produced by turning. Known methods of turning, utilizing automatic lathes and the like, enable large numbers of identical cores of any desired length and surface smoothness to be produced within dimensional tolerances considerably more exact than those that can be achieved for drilled holes. However, it will be observed that other known methods of forming such as shaping, grinding, or the like, may be utilized, either separately or in combination with turning, to form the cores, particularly where cross-sectional shapes other than circular are desired. Suitable finishing or final polishing operations may be employed to provide a highly polished outer surface on the core.

Alternatively, the cores may be formed directly from spinnerettes of known jet opening characteristics, by employing casting or molding techniques and utilizing the existing spinnerettes as forms. Silastic resin material is particularly suitable for use as the casting material when the cores are formed in this manner. When silastic resin is used, no release agent is required.

It should be noted also that the production of the desired multiplicity of identical core elements may be achieved in various ways. Instead of forming the several cores in separate operations, one core only may be formed and then used as a master core in the production of a plurality of identical cores therefrom by any known reproductive method, such as casting or electroforming.

In order to mount the cores 2 in the mold, the disc-like base plate 4 is provided with a plurality of spaced sockets 38 therein for receiving the securing heads 28 of the cores 2. The securing heads 28 are slip-fitted into the sockets and sealed therein by a suitable adhesive. Electrical gauging against a planar metal surface plate may be employed to insure that the free extremities of the cores 2 are at a uniform height above the level of the upper surface of the base plate 4 before final securing. It will be appreciated that other known methods of securing the heads 28 in the base plate, such as for example tapping and threading, may be employed if desired.

The metal reinforcing plate 18 is positioned over the cores intermediate the base plate and the free extremities of the cores with the peripheral portion of the reinforcing plate resting upon the rim 6 on the base plate 4. Oversize, countersunk apertures 40 are provided in the reinforcing plate 18 at positions corresponding to the locations of the cores 2, so as to enable the material of the reinforcing

plate 18 to be disposed about and in spaced relation to the cores 2.

The reinforcing plate 18 strengthens the finished spinnerette and prevents it from bursting outwardly during use under the pressure exerted by the fiber-forming fluid on the spinnerette. The reinforcing plate 18 maintains the dimensional stability of the finished spinnerette jet and assists in preserving the shape of the walls of the finished spinnerette holes.

The surface plate 20, which may be a sheet of plastic material such as polytetrafluoroethylene, or the like, is placed on the extremities 36 of the cores 2. Slight pressure is applied to the surface plate 20 by the weight of a retaining plate 22 to establish a seal between the extremity 36 of each core 2 and the surface plate 20, thereby assuring the formation of sharp edges at the outer ends of the capillaries during casting.

The details of the actual casting operations may vary somewhat, depending on the materials employed. A suitable release coating may be applied to the cores and to the inner surfaces of the base plate, surface plate and the housing forming the casting cavity, to enable the subsequently produced spinnerette to be easily removed. The casting fluid ordinarily is introduced by pouring the fluid into the stationary mold, but any known method of casting, such as pressure casting or centrifugal casting, may be utilized. The casting material is cured or allowed to set as appropriate, after which the mold parts are separated from the set casting material.

The essential characteristics of the casting material are that it have minimum shrinkage on cure, good flowing properties when in the fluid state, good abrasion resistance when cured, and that it be chemically resistant to the effects of the solvents used with the fiber-forming fluid. Casting materials that have been found to be satisfactory in fulfilling these requirements include epoxy and phenolic resins. Where the fiber-forming fluid with which the finished spinnerette is to be used includes an acetone solvent, epoxy resins have proved to be a very satisfactory casting fluid for forming the spinnerettes. Improved resistance to the chemical effects of acetone at elevated temperatures can be obtained by the use of an epoxy acrylic polymer. Phenolic resins may be used as the casting material where the fiber-forming fluid utilizes methylene chloride as a solvent. However, it will be appreciated that metal alloys or other plastics may be utilized as desired.

Some examples will serve to further illustrate the invention.

EXAMPLE I

In forming a spinnerette jet for spinning cellulose acetate fibers from a solution utilizing acetone as solvent, a plurality of metal cores of identical contour, diameter and length are produced by turning and these are then slip-fitted into a disc-like base having opposed parallel faces. The base portions of the cores are secured in place by an epoxy adhesive. A metal reinforcing plate having oversize, countersunk holes correspondingly positioned with respect to the cores is placed about the cores and located in spaced relation from the base plate by a projecting annular rim provided on the upper surface of the base plate. A surface plate of polytetrafluoroethylene having a planar polished lower surface is positioned on the free extremities of the cores and is just sufficiently gravitationally loaded to secure a seal between the surface plate and the free ends of the stems of the cores.

A standard release agent, paraffin, was initially applied from solution in xylene to all parts of the mold except the reinforcing plate and the polytetrafluoroethylene surface plate.

A fluid epoxy resin composition made by reacting stoichiometric quantities of p,p', dihydroxy diphenyl dimethyl methane (bisphenol A) and epichlorohydrin, is mixed with diethylene triamine, which serves to harden the epoxy resin, and is poured into the mold. The resin is

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cured at ambient temperature for a period of one day and heat cured for one hour at 200° F. The molded part then is removed from the mold.

This epoxy resin molding has a shrinkage of less than one percent, thus enabling the dimensional accuracy of the spinnerette jet openings to be maintained. The epoxy resin spinnerette jet thus produced is resistant to the chemical effects of acetone solvent used in spinning artificial fibers and also possesses excellent abrasion resistance qualities.

EXAMPLE II

A spinnerette intended for spinning a cellulose triacetate polymer fiber from a solution utilizing methylene chloride and methanol also may be formed in accordance with the invention. A commercially available fiber of this nature is sold under the designation "Arnel," by Celanese Corporation of America.

In this instance, mineral filled phenolic molding powder is employed as the molding material and a compression molding cycle is utilized. A mold, similar to that referred to in Example I but designed to withstand the pressures involved in this type of operation, is filled to a very slight excess with the phenolic molding powder and then placed in a heated pressure cylinder. The resin is molded and heat-cured at a temperature of 145° C. for a period of 3 minutes at a pressure of 3,000 p.s.i.

The phenolic resin spinnerette jet thus produced possesses excellent abrasion resistant qualities and, in addition, is chemically resistant to the effects of methylene chloride solvent used as a solvent in forming artificial fibers.

It will be seen that an improved method of forming spinnerettes in which a plurality of accurately dimensioned, identical spinnerette jet openings is produced, has been provided. Furthermore, each of the spinnerette jet openings provided may have a greater length to diameter ratio than heretofore achievable, thus resulting in improved tenacity and elongation qualities in the artificial fibers spun therefrom. Additionally, the method provides walls for the jet openings free from scorings which would otherwise impair the quality of the fibers produced. Moreover, the method does not require the separate production of special drills to provide the holes, nor does it require any separate finishing operations on the spinnerette jet.

It is to be understood that while the invention has been described with specific reference to particular embodiments, it is not to be so limited since variations may be made within the scope of the invention as defined in the appended claims.

What is claimed is:

1. In the manufacture of spinnerette jets for use in the spinning of manmade fibers, the process which comprises:

forming a core element having a portion provided with surfaces conforming in size and shape to the walls of a spinning jet opening having an inwardly tapered inlet portion and a capillary communicating with said tapered inlet portion;

molding a spinnerette jet end member about said portion of said core element;

separating said core element and said molded end member to provide a spinning jet opening of the desired size and shape in said molded end member.

2. The process of claim 1 in which said core element

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is reusable and in which a plurality of spinnerette end members are sequentially molded about said portion of said core element to provide separate spinnerette end members having identical spinning jet openings there-through.

3. The process of claim 1 additionally characterized by the forming of a plurality of said core elements, positioning the core elements of said plurality with said portions thereof disposed in parallel relation to each other, and molding said spinnerette jet end member about said plurality of core members to provide a plurality of spinning jet openings each having a size and shape corresponding to the size and shape of said portion of one of said core elements.

4. The process of claim 3 in which said portions of all of said core elements are identical in size and shape.

5. The process of claim 3 in which, prior to the molding step, a metal reinforcing member having holes therein is positioned over said core elements with said core elements extending through the holes.

6. The process of claim 1 in which the forming of said core element includes turning metal stock material on a lathe to provide the desired size and shape for said portion of the core element.

7. The process of claim 1 in which the forming of said core element includes a casting operation in which moldable material is inserted into a spinning jet opening of the desired size and shape in an existing spinnerette and then removed as a shape-retaining solid having a portion which is a negative replica of such spinning jet opening.

8. In the manufacture of spinnerettes for use in the spinning of manmade fibers, a method for making a spinnerette jet end member having two spaced apart surfaces and a plurality of spaced spinning jet openings extending therebetween, said method comprising the steps of:

forming a plurality of core elements each having a portion provided with a smooth-surfaced, external profile corresponding to that of the internal profile desired for a spinning jet opening;

fixedly mounting the core elements on a mold cavity base member with said portions of the several core elements extending outwardly from said base member in spaced parallel relation one of another;

positioning a housing provided with outlet ports about the base member and the cores so as to form a mold having an enclosed casting cavity;

introducing a fluid casting material into the casting cavity;

positioning a surface plate on and in sealing relation to the free extremities of said portions of the core elements;

setting the casting material to its solid state; and removing the mold parts, including said cores, from the set casting material to provide a spinnerette jet end member having spinning jet openings conforming in size and shape to said portions of said core elements.

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