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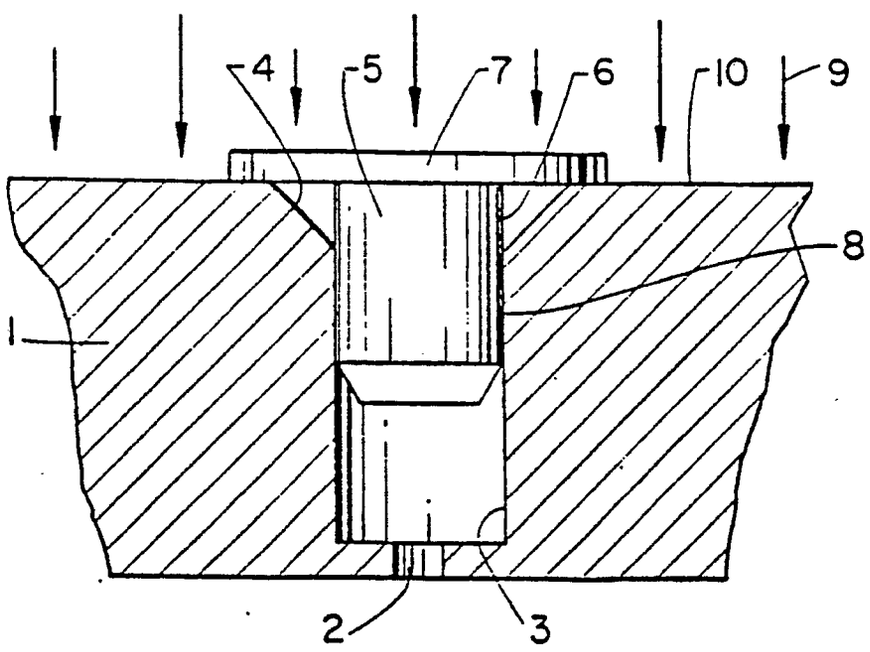
(54) Capillary seals for spinnerets.

(57) Spinneret closure means are disclosed for plugging selected capillaries. Disclosed also is a means for varying filament configurations spun from a single spinneret by selectively plugging and opening spinneret openings.

FIGURE 1



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CAPILLARY SEALS FOR SPINNERETS

BACKGROUND OF THE INVENTION

Significant strides have been made since man first began attempting to duplicate the spinning of the silkworm early in this century. With first cellulosic fibers, then later thermoplastic/setting resin fibers, man has significantly changed the world in which he lives in terms of apparel, carpets, and other coverings.

The same basic system of the silkworm is still in use, however. Continuous filaments are forced through capillaries, or small openings roughly the size of a human hair, in an otherwise solid plate due to a force pressing upon the filament resin. The solid plate -- part of an overall spinning assembly appropriate for the filamentary material to be spun -- is commonly referred to as a spinneret in the same manner as the silk spinning passages of the silkworm.

Spinnerets used in the manufacture of "artificial" filaments -- such as rayon, nylon, polyester, acrylic, acetate, and the like -- will have from one to several thousand capillaries, depending upon the particular use the filamentary product is to be put to. The filament size will be determined by the spinning material and spinning conditions, as well as the "size" of the capillary. Many capillaries are round in cross-section. It has become increasingly prevalent, however, to have various shapes of capillaries to impart different characteristics to the filamentary product.

Due to their small size, the spinneret capillaries can become "plugged" with foreign matter in the spinning resin. When this occurs, the filament resulting will be smaller in size or, in worst case, nonexistent. When a capillary plugging occurs, the spinneret will be removed and the capillary cleaned.

Cleaning of capillaries, depending on the resin used, can be quite difficult. The cleaning process also may damage the spinneret capillary beyond use. Having an additional spinneret capillary "plugged" purposely, which can be called into service to replace a plugged capillary, can be quite useful. Also, having additional capillaries available in a spinneret will permit flexibility in the overall "size" or "weight" or other characteristics of the resultant group of filaments. The weight is often referred to as "denier" and is called by that name (nominally the weight in grams of 9,000 meters of the filaments) or by another convention -- decitex (10/9 denier). Further, it is of benefit to have the capability of "marking" a filamentary product by having a capillary different from others. The marking may be for temporary purposes, in which case the different capillary would be sealed at times other than when the marking should occur. There exist numerous instances, then, when it would be helpful to plug or seal a capillary temporarily, but have the capillary fully usable otherwise.

The shape of the capillary for resinous materials may be varied, but usually consists of two or more cavities in serial, usually concentric in nature. The lower section (i.e., the last section through which polymer flows) or shaping section of the spinneret capillary will be constructed to impart the final desired shape of the filament. The lower section will usually be thin to reduce the cost of odd shaped filament construction. Upper sections connecting to the lower section or "face" section will be larger and usually cylindrical or tapering to the face section.

A typical capillary construction is found in U.S. Letters Patent 3,006,026. This reference also shows one means of constructing removable inserts in the lower section by having such insert constructed to press fit into a blank spinneret body.

Additionally, it is known to use a similar technique to plug a capillary by compressing a soft aluminum rod into the upper capillary sections. The difficulty with inserting such a rod is that it must bottom on the face section in order to be compressed outwardly to seal the upper section, possibly damaging the face section.

Having a positive seal of a capillary without the potential of damaging the face section would be of great benefit. Attempts were made to use threaded bolts and screws in capillary openings to seal them. These attempts failed because the spinning environment quickly corroded the screw/bolt threads. Further, the capillary openings were damaged from the screw/bolt thread removal, affecting the flow characteristics and therefore the spinning uniformity of the capillary.

BRIEF DESCRIPTION OF THE PRESENT INVENTION

The present invention is to a method of sealing a capillary in a manner that positively seals the capillary tube, but does not damage the capillary, especially the face section of the capillary that forms the filament definition. The invention is a plug which provides a positive seal, is inexpensive, and can be reused, if desired.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic sectional side view of a spinneret capillary and a seal of the invention.

Figure 2 is an exploded view depicting a typical spinneret and the plug used in the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

In the Figure 1, a cross-section of a typical spinneret plate 1 is shown, much in the manner as that depicted in U.S. Letters Patent 3,006,026. A spinneret capillary comprising a face section 2, an upper section 3, and an entrance section 4 is depicted.

The invention herein, a capillary seal 5 is shown inserted into the entrance 4 and upper section 3. The total depth of the plug section 6 of the seal is less than the combined depths of the entrance 4 and upper section 3. This depth limitation is to prevent damage to the face section.

A slight interference fit between the plug section 6 and the wall 8 of the upper section will retain the seal in place until pressure from a polymer extrusion source (shown as arrows 9) is placed on the seal. The seal will normally be constructed of a material softer than the capillary wall and capable of withstanding the extrusion conditions above the spinneret plate. Aluminum alloys like 6061T6 are acceptable for machinability and relative hardness. More permanent plugs may be constructed of type 316 stainless steel; however, copper based materials have a tendency to corrode in a spinning environment.

The sealing element or cap section 7 formed on the upper end of the plug will have a diameter larger than the entrance diameter in order to form a flat sealing surface on the upper face 10 of the spinneret. While the interference fit of the plug 6 initially retains the seal in place and contributes by maintaining the seal in position, the downward force 9 on the cap section 7 forms an operationally tight seal of the capillary at the contact section between cap section 7 and the spinneret plate 1 during spinning conditions. When the spinning conditions are removed and the spinneret cleaned, the seal 5 may be easily removed and the previously sealed capillary may be placed into service.

Claims

1. A method of sealing a spinneret capillary, comprising inserting into said capillary a plug seal consisting of a plug section 6 having an interference fit in the capillary, said plug section being inserted to a depth less than the face section of the spinneret, and further consisting of a cap section 7 having a diameter greater than the capillary, said cap section conforming to the upper face of the spinneret surrounding the capillary; and applying an extrusion force pressure to the upper face of the spinneret and plug seal cap.

2. A spinneret plug seal comprising a plug section and a cap section, the plug section forming a cylindrical rod shape of a length less than the depth of the capillary to the capillary face section and diameter sufficient to form an interference fit with said capillary; the cap section being formed to the plug section and having a diameter greater than the entrance of the capillary, the upper face of the spinneret around the capillary and the portion of the cap section of greater diameter than said capillary forming a sealing section upon the application of an extrusion force to the spinneret.

3. A method of temporarily sealing at least one capillary in a spinneret, comprising inserting into said capillary a plug seal consisting of a plug section and a cap section, said plug section consisting of a cylindrical rod of length less than the capillary upper section and diameter sufficient to form an interference fit with the wall of the capillary; the cap section being formed to the plug section and having a diameter greater than the capillary entrance; and applying a filamentary extrusion force to the upper face of the spinneret and cap section.

4. A method of varying the characteristics of a filamentary product produced from a spinneret having capillaries of varying forms and shapes comprising temporarily sealing selected capillaries and melt spinning fibers from remaining capillaries exhibiting the desired fiber forming characteristics.

5. A method of temporarily identifying a filamentary product from a spinning assembly having at least one identifying spinneret hole having a temporary plug seal, comprising removing the plug seal and spinning fibers through the spinneret openings including the identifying spinneret hole.

6. A filamentary product spinning assembly containing a spinneret plate having a number of spinneret openings of one selected type and at least one spinneret opening of a second type and means for temporarily plugging the second type spinneret opening, comprising a plug seal having a plug section and a cap section, the plug section forming a cylindrical rod shape of a length less than the capillary depth in the spinneret opening, the cap section of greater diameter than the spinneret opening.

7. In a spinneret for forming a determined number of filamentary products simultaneously, the method of extending the useful life of the spinneret

by forming at least one additional spinneret opening in the spinneret and temporarily plugging the additional opening.

FIGURE 1

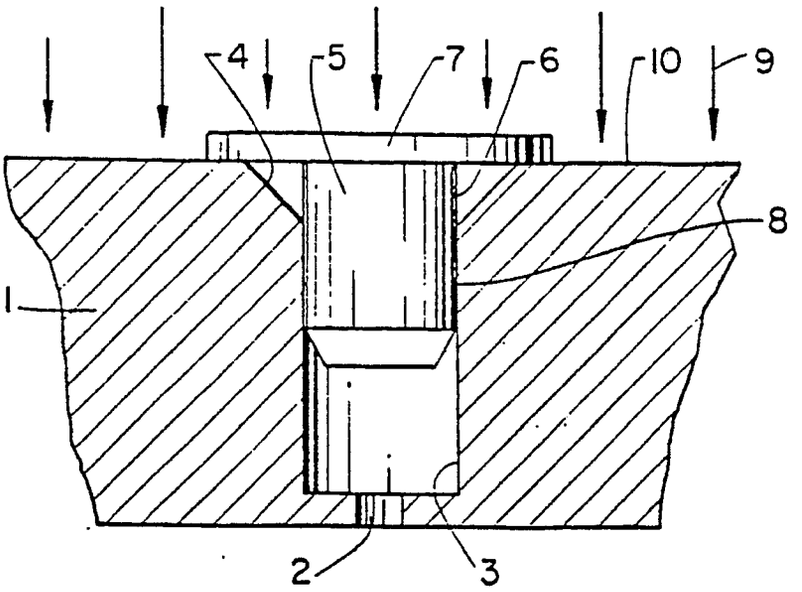

FIGURE 2