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(54) Spinneret.

(57) An improved spinneret and method for cleaning the same are disclosed in which the spinneret comprises a flat plate having a plurality of orifices passing therethrough wherein the cross-section of each orifice is uniform throughout the thickness of the spinneret. The spinneret can be cleaned by peeling solidified polymeric material from the inner face and the outer face of the spinneret and thereby removing the solidified polymeric material from each spinneret orifice. This cleaning procedure eliminates the need for high heating techniques or potentially dangerous chemicals.

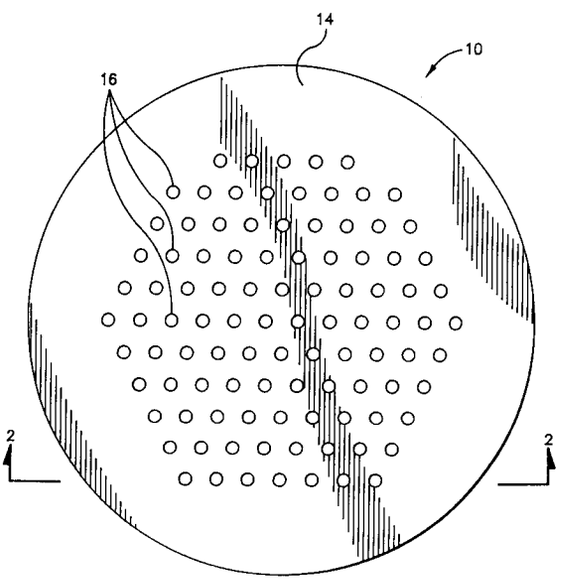

FIG. 1

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Background of the Invention

This invention relates to a method and apparatus for spinning artificial fibers, and is more particularly concerned with improved spinnerets and improved methods of melt spinning which are accomplished by the utilization of such spinnerets.

Filaments of various polymeric materials such as for example, polyolefins, polyamides, polyesters, etc., are produced by feeding the polymer, which is solid and in particulate form, to a screw extruder in which the polymer is melted and extruded through a spinneret. A spinneret is essentially a plate having a plurality of orifices therein. The orifices form the molten polymer into filaments which are then cooled or quenched by a cooling medium, generally conditioned air, and then further processed as known in the art.

One of the continuing problems in the use of spinnerets is that after spinning has been in progress for a period of time, solidified polymeric material becomes deposited within the spinneret orifices and around the orifices on the spinneret face causing blockage or restriction of the spinneret orifices. This blockage or restriction results in deterioration of the fiber quality. In order to avoid such deterioration, the spinneret must be changed and cleaned for reuse. Additionally, when spinning is stopped for other reasons, such as to clean the spin pack filter or to change the spinneret orifice size or shape, polymeric material will solidify on the faces and within the orifices of the spinneret thereby creating a need for the spinneret to be cleaned. The usual method of cleaning the spinneret involves the utilization of high heating or chemical treatment to remove the adhering polymer. This can be a very expensive and dangerous procedure.

Summary of the Invention

It is one object of the invention to provide a spinneret useful for spinning artificial fibers wherein the spinneret can be easily cleaned without the use of high heating or chemical treatment.

Another object of this invention is to provide an improved method for spinning artificial fibers.

In accordance with this invention, there is provided a spinneret having a plurality of circular orifices passing therethrough wherein the diameter of each orifice is uniform throughout the thickness of the spinneret. In accordance with another aspect of the invention, a process is provided for spinning artificial fibers, wherein an improved spinneret is utilized having a plurality of circular orifices passing therethrough wherein the diameter of each orifice is uniform throughout the thickness of the spinneret so as to provide a spinneret that can be easily cleaned without the use of high heating or chemical treatment.

Brief Description of the Drawings

FIG. 1 is an elevation view of a spinneret constructed in accordance with the invention.

FIG. 2 is a cross-sectional view taken along line 2-2 of FIG. 1.

FIG. 3 is an enlarged cross-sectional view more clearly illustrating the orifice shape within the spinneret of the invention.

FIG. 4 is an enlarged cross-sectional view illustrating the orifice shape of a standard spinneret not within the scope of the present invention.

Detailed Description of the Invention

Referring to the drawings, specifically FIGS. 1 and 2, spinneret 10 comprises a circular plate having an inner face 12 and an outer face 14 and a plurality of orifices 16 passing through the spinneret 10 from the inner face 12 to the outer face 14. Although a circular shape is preferred in the present invention, the spinneret 10 can have any desired shape.

The number of orifices 16 extending through the spinneret 10 can range from 1 to several thousand depending upon the desired number of fibers to be produced by the spinneret 10. The spinneret shown in FIG. 1 has 100 orifices.

The orifices 16 of FIG. 1 are equally spaced upon the corners of a network of equilateral triangles. Although the spacing configuration is preferred, the orifices 16 can be arranged in any pattern that will allow even cooling of polymeric material to all parts of the outer face 14 of the spinneret 10. Possible patterns include concentric annuli, rectalinear rows of holes, scatter arrangements, or clusters of holes with relatively wide spaces in between.

Generally, both the inner face 12 and the outer face 14 of the spinneret 10 have a highly polished surface. This highly polished surface allows polymeric material that builds up on inner the face 12 and the outer face 14 during spinning to be easily peeled away from the inner face 12 and the outer face 14 in order to clean the spinneret 10.

The spinneret 10 can have any desired thickness. The thickness of the spinneret 10 between the inner face 12 and the outer face 14 is generally in the range of from about 1 millimeter to about 10 millimeters. Preferably, this thickness is in the range of from about 3 millimeters to about 5 millimeters.

The cross-section of each orifice 16 must remain constant throughout the thickness of the spinneret 10. This is critical in order for the spinneret

10 to be cleaned by peeling solidified polymeric material from the outer face 14 of the spinneret 10. If the orifice cross-section is not uniform throughout, solidified polymeric material will remain within the orifice when solidified polymeric material is peeled from the inner face 12 and the outer face 14 of the spinneret 10. Therefore, for orifices having circular cross-sections, the diameter of the orifice cross-section must be equal at every position between the inner face 12 and the outer face 14 of the spinneret 10, as shown in FIG. 2 and more clearly illustrated in FIG. 3.

Although a generally circular cross-section is presently preferred, the orifice cross-section can have any desired shape if this cross-section shape and size remain constant throughout the thickness of the spinneret 10.

For the preferred circular cross-section, the orifices 16 can have any desired diameter. The diameter of each preferred orifice 16 is generally in the range of from about 0.175 millimeters to about 0.750 millimeters. Preferably, the diameter is in the range of from about 0.4 millimeters to about 0.6 millimeters. The diameter of the orifices may be larger, depending upon the thickness of the spinneret 10. In all cases it is important that the surface area of the interior wall of each orifice 16 is kept to a minimum, so that the contact area between the spinneret 10 and the solidified polymeric material is also kept to a minimum. The less contact area between the spinneret 10 and the solidified polymeric material, the easier it will be to separate the solidified polymeric material from the spinneret 10 by a peeling motion.

In operation of the spinneret 10, polymeric material will build up over a period of time and solidify on the inner face 12, the outer face 14 and within the orifices 16. This can eventually cause blockage or restriction of the orifices 16 to occur which will bring about deterioration of the fiber quality. To avoid such deterioration, the spinneret 10 must periodically be removed, cleaned, and replaced.

One important feature of the spinneret 10 of the present invention is that it is capable of being cleaned without the use of high heating techniques or the use of chemicals. The solidified polymeric material is peeled away from the inner face 12 and the outer face 14 of the spinneret 10. The solidified polymeric material will peel away more easily if the inner face 12 and the outer face 14 are highly polished. When the solidified polymeric material is peeled away from the inner face 12 and the outer surface 14 it will pull with it the solified polymeric material remaining within most of the orifices 16. The orifice shape of the present invention, as shown in FIG. 3, allows the solidified polymeric material remaining within most of the orifices 16 to be pulled through the inner surface 12 and the outer surface 14 in one piece. This peeling step will remove the solidified polymeric material from approximately 80% to 90% of the orifices 16.

The solidified polymeric material is removed from the remaining 10% to 20% of the orifices by use of a steel pin having approximately the same diameter as that of the orifices 16. The steel pin is pushed through each orifice 16 that has solidifed polymeric material remaining in it after the peeling step one by one until all orifices are clear. This two-step process results in a clear spinneret, free from solidified polymeric material, without the need for expensive, high heating techniques or potentially harmful chemicals.

FIG. 4 shows a spinneret orifice not within the scope of the present invention. This type of orifice is generally known and commonly used in the spinneret art. The orifice extends through the spinneret thickness from the inner face 18 to the outer face 20. The orifice has a circular cross-section, however, the orifice does not have a uniform diameter throughout the thickness of the spinneret. The orifice contains two sections, a capillary section 22 and a counterbore section 24. The capillary section is adjacent to the outer face 20 of the spinneret but is shorter in length than the spinneret thickness. The capillary section 22 generally has a diameter in the range from about 0.175 millimeters to about 0.750 millimeters. The length to diameter ratio of the capillary section 22 is generally between 1 and 5.

The counterbore section 24 extends between the inner face 18 and the capillary section 22. The diameter of the counterbore section 24 is greater than the diameter of the capillary section 22. The orifice cross-section is sometimes shaped to give a gradual rather than abrupt reduction in diameter between the counterbore section 24 and the capillary section 22 to avoid flow discontinuities.

A spinneret having orifices as shown in FIG. 4 cannot be cleaned by the method of the present invention. The orifice of FIG. 4 has a larger diameter near the inner face 18 than at the outer face 20. Therefore, solidifed polymeric material within the orifice cannot be pulled through from the outer face 20 by peeling the solidifed polymeric material away from the outer face 20 because the diameter of the orifice at the outer face 20 is smaller than the diameter of the solidified polymeric material remaining in the counterbore section 24. Also, steel pins could not be used to push solidified polymeric material from the orifice because of the diameter size differential within the orifice.

The spinneret of the present invention is useful to form filaments of most any material which is capable of existing as a viscous fluid. Generally, thermoplastic polymers are employed that form

viscous fluids upon heating, such as for example, polyolefins, polyamides, polyesters and poly-(arylene sulfides).

It will be seen that the method and apparatus described above provides advantages for spinning artificial fibers, notably in the increased ease of cleaning the spinneret without the need for high heating or potentially harmful chemicals.

Claims

1. A spinneret having a first face and a second face and a plurality of orifices passing through said spinneret from said first face to said second face wherein said orifices have a uniform cross-section throughout the thickness of said spinneret between said first face and said second face.

2. The spinneret of claim 1, wherein said orifices have a generally circular shaped cross-section, in particular wherein said orifices have a circular shaped cross-section.

3. The spinneret of claim 1 or 2, wherein said first face and said second face of said spinneret comprise smooth polished surfaces.

4. The spinneret of one of the preceding claims, wherein said spinneret has a uniform thickness between said first face and said second face in the range of from about 1 millimeter to about 10 millimeters, in particular in the range of from about 3 millimeters to about 5 millimeters.

5. The spinneret of one of the preceding claims, wherein said orifices have a cross-section with the largest dimension across said cross-section being in the range of from about 0.175mm to about 0.750mm, in particular wherein said orifices have a circular shaped cross-section with a diameter in the range of from about 0.175mm to about 0.750mm.

6. A spinneret having a first face and a second face and a plurality of orifices passing through said spinneret from said first face to said second face wherein said orifices comprise a capillary section extending from said first face to said second face and wherein said orifices do not contain a counterbore section extending between said first face and said capillary section, in particular wherein these spinnerets have the features of one of the preceding claims.

7. A method for spinning artificial fibers comprising melting and extruding a polymer through a spinneret to form filaments, then quenching the filaments, wherein said spinneret has a first face and a second face and a plurality of orifices passing through said spinneret from said first face to said second face, wherein said orifices have a uniform cross-section throughout the thickness of said spinneret between said first face and said second face.

8. The method of claim 6, wherein a spinneret is used as defined in one of the claims directed to a spinneret.

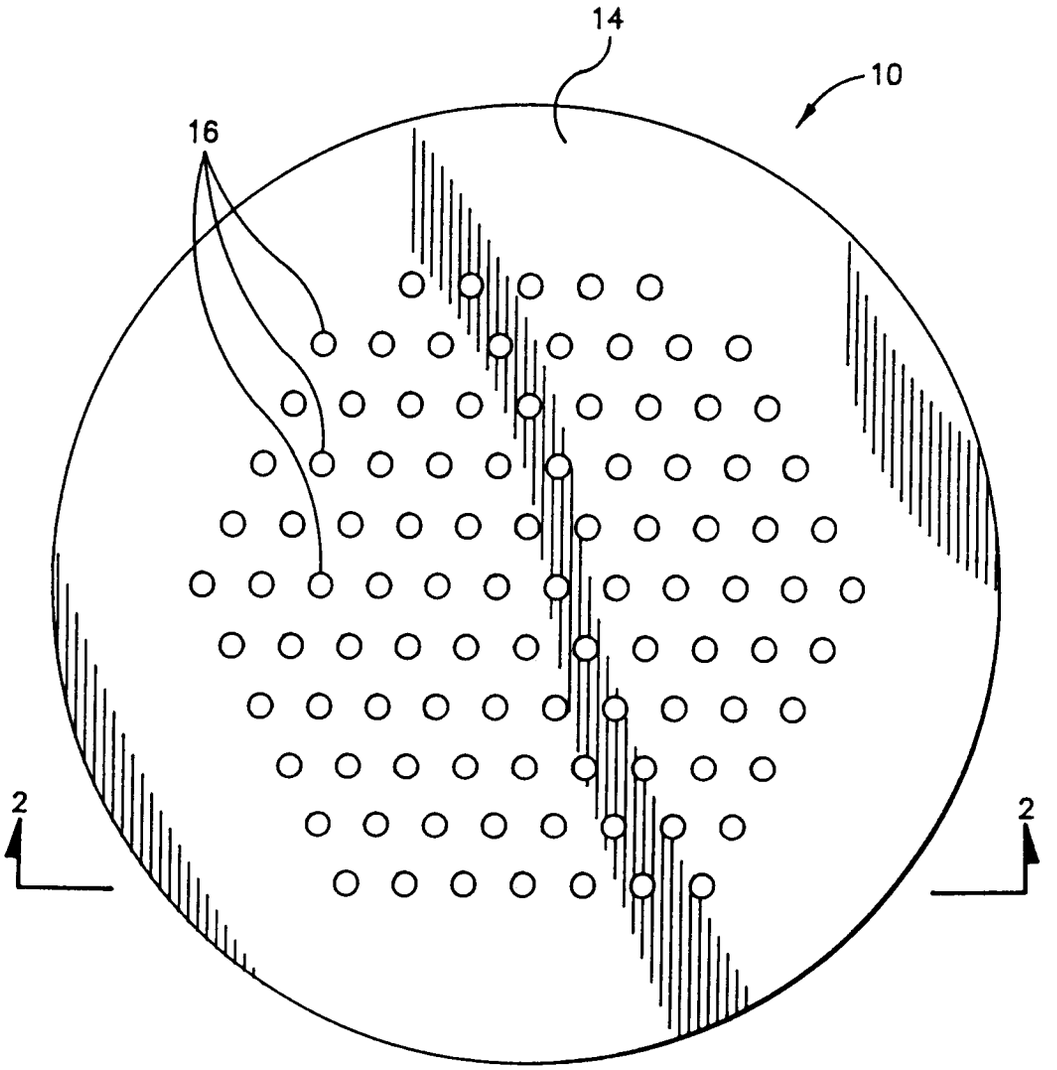

FIG. 1

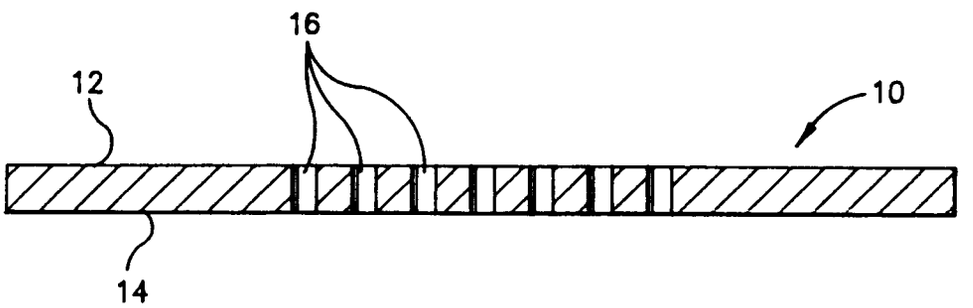

FIG. 2

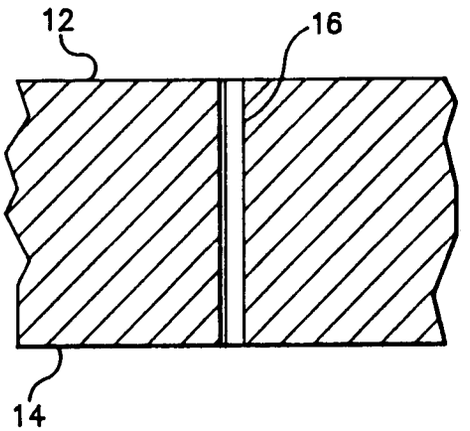

FIG. 3

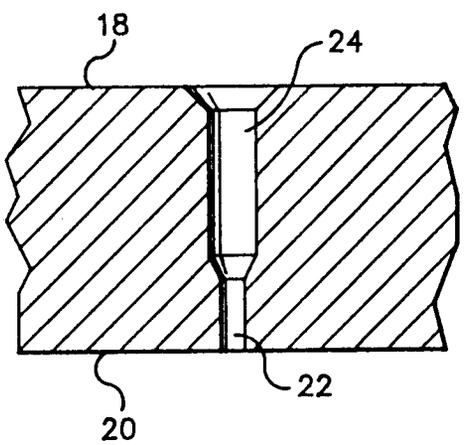

FIG. 4