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(54) **Spinneret plate for melt spinning and method of manufacture thereof.**

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(73) Proprietor: **TOA NENRYO KOGYO KABUSHIKI
KAISHA
1-1 Hitotsubashi, 1-Chome Chiyoda-Ku
Tokyo 100 (JP)**

(72) Inventor: **Takazawa, Kiyoshi
1902-5, Oaza-Kamekubo Ohi-machi
Iruma-gun Saitama-ken (JP)
Inventor: Izumi, Takayuki
1906-7, Oaza-Kamekubo Ohi-machi
Iruma-gun Saitama-ken (JP)**

(74) Representative: **Holdcroft, James Gerald, Dr.
et al
Graham Watt & Co. 3 Gray's Inn Square
London WC1R 5AH (GB)**

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Description

The present invention relates to a spinneret plate provided with a spinning nozzle which is most suitably employed in melt spinning such as the spinning of pitch carbon fibers, i.e. fibers made of a carbon derived from pitch.

Hitherto, the spinning of materials such as pitch has been carried out using a spinneret plate with a plurality of nozzle holes formed therein and arranged in circumferential rows around the center of the plate. In order to satisfactorily melt-spin a fine fiber over a long period of time, it is important that each nozzle hole provided in the spinneret plate should be sufficiently small and have a smooth inner surface and a uniform inner diameter, i.e., a uniform aspect ratio.

In the manufacture of such a spinneret plate the nozzle holes are generally formed by boring through a nozzle plate using a drill or an electron beam. The method in which boring is effected using a drill, however, encounters various problems as the nozzle hole diameter decreases. The first of the problems is that it is difficult to machine the nozzle holes to a high degree of accuracy. More specifically, the drill itself has a tendency to oscillate when rotating. In addition, when drilling the nozzle plate, the drill oscillates owing to drilling resistance, resulting in a hole which had different diameters at the start of drilling and the end of drilling, as shown in Fig. 1. Moreover, as the drill diameter is reduced, the edge of the drill blunts faster, resulting in a marked reduction in drilling capacity. It is impossible to grind the edge of such a small-diameter drill; hence, it is necessary to replace the drill frequently. In addition, the frequency with which the drill breaks increases, which not only lowers the drilling efficiency, but also increases the cost of manufacturing the spinneret plate.

The electron beam method has been proposed in order to overcome these disadvantages with the boring method using a drill. This method, however, has the disadvantage that the electron beam remains inside the hole during the boring to form a hole whose inner part is expanded, as shown in Fig. 2, so that a nozzle with such a hole would degrade the orientation of the fiber. It has also been proposed to provide tubular inserts in a spinneret plate (DE—B—1102340) to control the uniformity of flow through the inserts by controlling the length of the inserts.

Summary of the invention

Accordingly, it is a primary object of the invention to provide a spinneret plate which has a plurality of nozzles, each with a smooth inner surface as well as a uniform hole diameter so that it is able to spin a fine fiber, such as a pitch carbon fiber, over a long period of time.

It is another object of the invention to provide a method of manufacturing a spinneret plate which makes it possible to manufacture a spinneret plate provided with a plurality of nozzles, each with a smooth inner surface as well as a uniform

hole diameter, at an extremely high accuracy and a high efficiency within a short period of time.

The present invention is a spinneret plate for melt spinning according to the characterizing part of claim 1.

Brief description of the drawings

Figures 1 and 2 illustrate in cross section nozzles prepared in accordance with prior art techniques;

Figure 3 illustrates in vertical cross section an embodiment of a spinneret plate of the present invention; and

Figures 4a to 4d illustrate the sequential preparation of a spinneret plate as shown in Fig. 3

Description of the preferred embodiments of the invention

A spinneret plate 1b constructed in accordance with the present invention in the embodiment shown in Fig. 3, comprises a nozzle plate 2 of a predetermined thickness, and a hollow tube or pipe 4 of a desired diameter which is mounted in or attached to the nozzle plate 2 by press fitting or the like, into a hole formed in the plate. The interior of the pipe 4 defines the nozzle hole for the spinneret.

Preferably, the nozzle plate 2 is made of a stainless steel plate, and typically has a thickness of 4 mm when melt spinning pitch carbon fibers or the like. The hollow pipe 4 may also be made of a stainless steel and, by way of example, may have the following sizes: inner diameter of 0.55 mm and an outer diameter of 1.5 mm. In addition, although the nozzle holes formed by the hollow pipes 4 can be disposed in any desired arrangement, they preferably are arranged in one or more concentric rows in the circumferential direction around the center of nozzle plate 2, when melt spinning pitch carbon fibers, for example.

The pipe 4 does not extend through the entire thickness of the nozzle plate 2, but is provided through a substantial portion (e.g., about half) of the thickness of the nozzle plate 2 on the outlet side thereof and projects slightly beyond the outlet surface of the nozzle plate 2. An enlarged, tapered inlet 6 in the upstream side of the nozzle plate 2 guides the molten spinning material into the nozzle hole defined by the hollow pipe 4, the inlet comprising an uppermost section of constant diameter followed by a frustoconical section forming a smooth inlet to the pipe 4. The projecting nozzle provides an excellent shedding effect between the molten spinning material and the spinneret plate. In order to reinforce the projecting part of the hollow pipe 4 on the outlet side of the nozzle plate 2, the projecting part is secured to the nozzle plate 2 by forming brazed reinforcing shoulders 8.

A spinneret plate 1b may be manufactured by the processes which will be described with reference to the sequential drawings of Fig. 4.

Fig. 4 illustrates the method of manufacturing the spinneret plate of Fig. 3. The hole is formed in the nozzle plate 2 by drilling a small-diameter part

4' through the plate 2 and then enlarging the inlet side of the hole at 4''' and tapering the section between 4' and 4''' forming transition section 4''. The hollow pipe 4 is press-fitted into the small-diameter part 4' of the preliminary hole. The press-fitting operation may be carried out as follows. When a stainless steel pipe with an outer diameter of 1.5 mm and an inner diameter of 0.55 mm, for example, is employed as the hollow pipe 4, the preliminary hole 4' is finished so as to have an inner diameter of 1.5 mm, and the nozzle plate 2 is heated to between 150 and 300°C to expand the hole slightly. The hollow pipe 4 is maintained at room temperature, or is cooled at lower temperature and is inserted into the preliminary hole 4', and then the nozzle plate 2 is cooled resulting in a shrink fit. The part of the hollow pipe 4 projecting upward from the small-diameter part 4' of the preliminary hole is then expanded toward the transition part 4'' of the preliminary hole to bring it into close contact with the wall surface of the transition part 4'' (see Fig. 4c).

Brazing 8 is then applied to the outer peripheral portion of the projecting part of the hollow pipe 4 (see Fig. 4c). This brazing operation may be effected by a conventional method, e.g., by heating in an electric furnace. Upon completion of the brazing operation, both the part of the hollow pipe projecting from the outlet side of the nozzle plate 2 and the brazed part of the hollow pipe 4 are ground to a predetermined configuration. Finally, if desired, the part of the hollow pipe 4 in close contact with the transition part of the prepared hole can be ground by a special tip to cut off the bent part forming the plate 1b illustrated in Fig. 4d.

The present invention thus provides a spinning nozzle from a ready-made hollow pipe which has excellent roundness and straightness. Therefore it is possible to provide an accurate spinneret plate which has a spinning nozzle with an extremely smooth inner surface and a uniform aspect ratio. Further, according to the invention, it is possible to provide a multi-nozzle spinneret plate provided with a plurality of such accurate nozzle holes. The employment of the spinneret plate in accordance with the present invention makes it possible to spin pitch carbon fibers or the like stably over a long period of time.

Claims

1. A melt spinneret plate for melt spinning to produce fiber, comprising a nozzle plate (2) having at least one hole (4') formed therein perpendicularly to the plane of the nozzle plate, a pipe (4) located in said hole and having a uniform outer surface and a smooth inner surface, one end of the pipe (4) extending beyond one face of the plate and the other end being located beneath a smooth tapered inlet (4'') therefor formed in the plate, characterised in that the hole has a first axial section (4''') of uniform diameter, a second axial section (4') of uniform diameter in which the pipe (4) is located and a frustoconical section (4'') joining the first and second sections and forming

said tapered inlet, the pipe (4) being a shrink fit in the second section and having reinforcing shoulders (8) formed around the projecting end of the pipe (4) to fix the pipe (4) securely to the nozzle plate (2).

2. A spinneret plate as claimed in claim 1, characterised in that said nozzle plate and nozzle are made of stainless steel.

Patentansprüche

1. Spinnplatte für das Schmelzspinnen zur Faserherstellung, bestehend aus einer Düsenplatte (2) mit zumindest einer in dieser senkrecht zur Düsenplattenebene gebildeten Öffnung (4') und einem in der Öffnung angeordneten und eine gleichmäßige Außenfläche sowie eine glatte Innenfläche aufweisenden Rohr (4), wobei sich ein Ende des Rohres (4) über eine Fläche der Platte hinaus erstreckt und das andere Ende unterhalb eines in der Platte gebildeten glatten sich verjüngenden Einlasses (4'') für dieses angeordnet ist, dadurch gekennzeichnet, daß die Öffnung einen ersten axialen Abschnitt (4''') mit gleichmäßigem Durchmesser, einen zweiten axialen Abschnitt (4') mit gleichmäßigem Durchmesser, in dem das Rohr (4) angeordnet ist, und einen kegeltumpfförmigen Abschnitt (4'') aufweist, der den ersten und den zweiten Abschnitt verbindet und den sich verjüngenden Einlaß bildet, wobei das Rohr (4) in dem zweiten Abschnitt einen Schrumpfsitz hat und um das vorstehende Ende des Rohres (4) gebildete Verstärkungsschultern (8) zur sicheren Festlegung des Rohres (4) an der Düsenplatte (2) aufweist.

2. Spinnplatte nach Anspruch 1, dadurch gekennzeichnet, daß die Düsenplatte und die Düse aus nichtrostendem Stahl hergestellt sind.

Revendications

1. Plaque-filière de filage à chaud pour la production de fibres par filage au fondu, comprenant une plaque à ajutage (2) dans laquelle un trou (4') au moins est formé perpendiculairement au plan de la plaque à ajutage, un tube (4) placé dans ce trou et ayant une surface extérieure uniforme et une surface intérieure lisse, l'une des extrémités du tube (4) s'étendant au-delà de l'une des faces de la plaque et l'autre extrémité étant située au-dessous d'une admission associée (4'') de section progressivement décroissante, formée dans la plaque, caractérisée en ce que le trou comprend un premier segment axial (4''') de diamètre uniforme, un second segment axial (4') de diamètre uniforme, dans lequel le tube (4) est placé, et un segment tronconique (4'') reliant le premier et le second segments et constituant ladite admission de section décroissante, le tube (4) étant fixé dans le second segment par ajustage serré par retrait et des épaulements de renfort (8) étant formés autour de l'extrémité saillante du tube (4) pour fixer fermement le tube (4) à la plaque à ajutage (2).

2. Plaque-filière selon la revendication 1, caractérisée en ce que la plaque à ajutage et l'ajutage sont faits d'acier inoxydable.

FIG.1

PRIOR ART



FIG.2

PRIOR ART



FIG.3

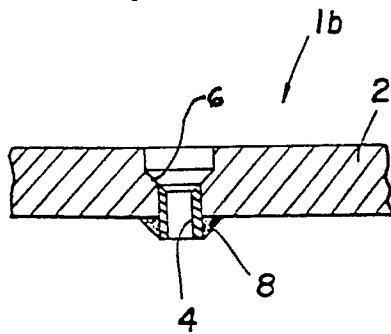


FIG. 4a

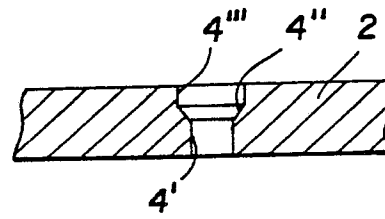


FIG. 4b

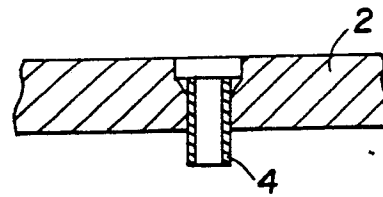


FIG. 4c

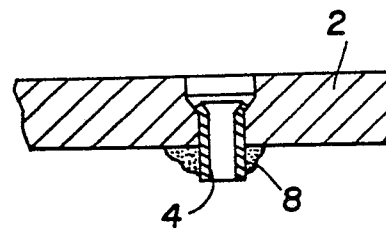


FIG. 4d

