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M. CHARPENTIER ET AL

3,304,164

APPARATUS FOR PRODUCING FINE GLASS FIBERS

Filed Dec. 16, 1963

2 Sheets-Sheet 1

Fig. 1.

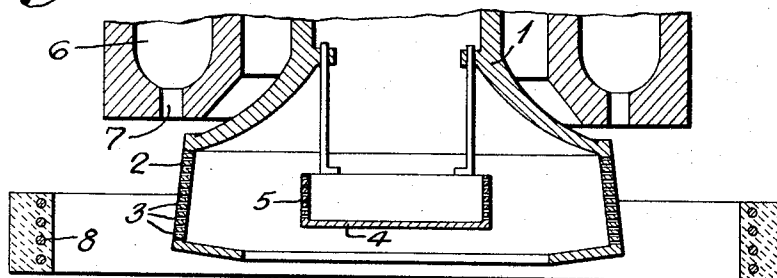


Fig. 2.

PRIOR ART

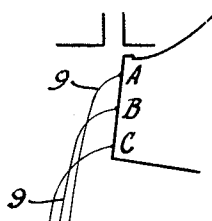


Fig. 3.

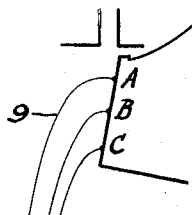
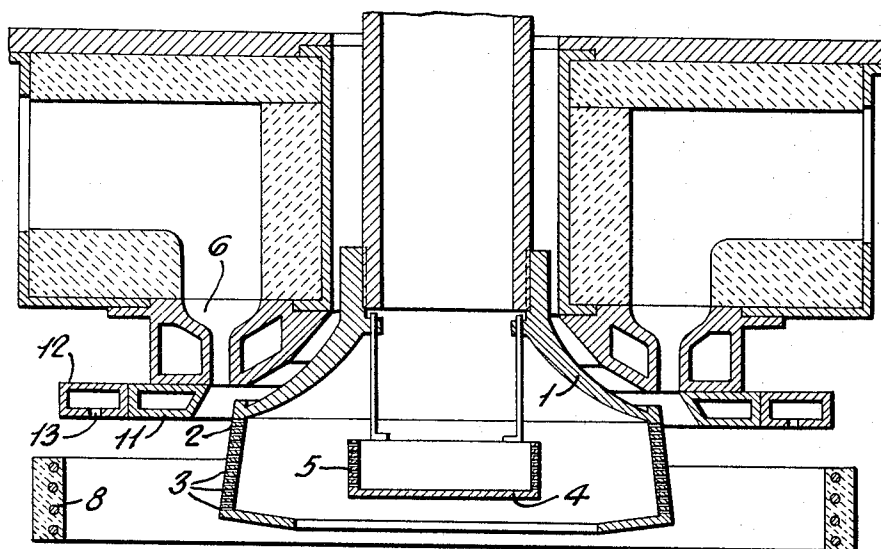


Fig. 6.



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2 Sheets-Sheet 2

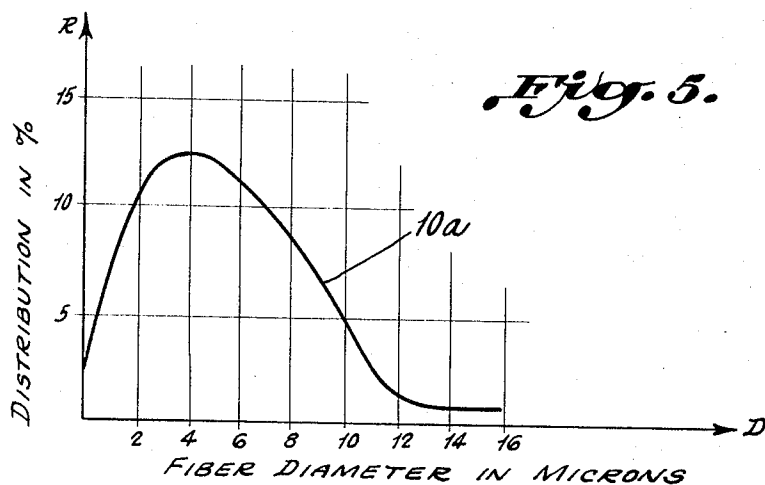
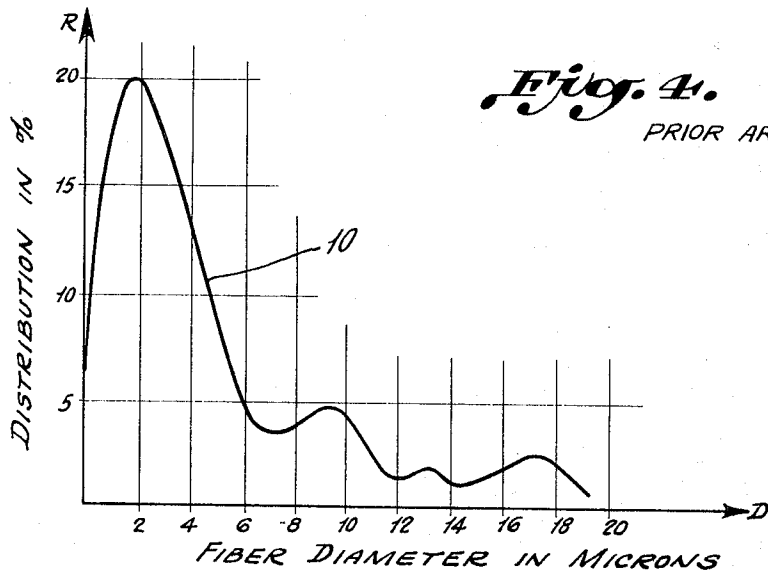


Fig. 7.
PRIOR ART

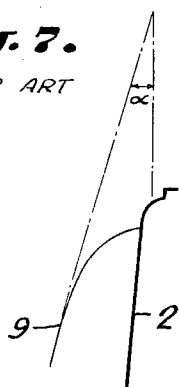
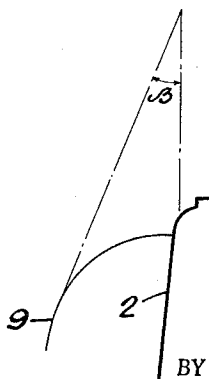


Fig. 8.



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APPARATUS FOR PRODUCING FINE
GLASS FIBERS

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926,268

13 Claims. (Cl. 65—14)

The present invention relates to a process of manufacturing fibers from thermoplastic materials, particularly glass fibers, in which the material in a molten state is supplied to a hollow rotating body provided with orifices in the peripheral wall thereof and is projected through these orifices under the action of centrifugal force.

The invention relates particularly to the process of the following type wherein the threads of viscous material which are projected from the orifices, which are arranged in a plurality of superposed rows, are acted on by gaseous currents which subject these threads to a drawing-out operation or attenuation to transform them into fibers. These gaseous currents are produced by an annular combustion chamber disposed coaxially with the rotating body from which the gaseous currents are discharged through a circular slot or expansion orifices which are situated at a level higher than the upper part of the wall of the rotating body in which the projection orifices are provided.

In order to obtain a high rate of production, hollow rotating bodies having a large number of rows of projection orifices, twenty or more rows, are utilized, which in turn make necessary peripheral walls or bands of relatively great height.

Under these circumstances it has been determined that the fibers which are obtained have diameters which vary between wide limits. In addition, a relatively large number of fibers which are produced adhere together.

These results derive from the fact that the gases which are used to draw out the threads of material which escape from the orifices of the band of the rotating body have a temperature and speed which decrease from the top of the peripheral band to the lower part of it. Thus, the threads issuing from the upper rows are subjected to a more energetic drawing-out action than the threads from the lower rows. Moreover, the fibers from the upper rows are stretched more than the fibers from the lower rows because of the greater speed of the gases at the upper part of the band. As a result, the upper fibers cross the paths of the lower fibers, giving rise to an adhering of these fibers among themselves. These effects have an injurious influence on the quality of the products obtained, particularly in respect to resistance to traction, which becomes weaker as the height of the band is increased, due to the fact that the fibers are drawn-out at different speeds and temperatures.

It is the object of the present invention to eliminate the above-mentioned disadvantages.

According to one characteristic of the invention, the peripheral band is maintained at a substantially constant temperature along its entire height, and the diameters of the orifices decrease in size from the upper part of the band to the lower part. Thus, fibers of substantially equal diameter are obtained, in spite of the decrease in temperature and speed of the gaseous currents which draw them out, since the smaller the diameters of the threads, the easier it is to draw them out, it being understood that the viscosity of the material is constant for all the threads, this condition being fulfilled by imparting a constant temperature to the peripheral band over its entire height.

Furthermore, the threads of material issuing from the upper part of the band being thicker than those below,

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their speed of projection from the orifices of the band is greater, and the drawing-out gaseous currents deflect or pull them down to a lesser degree than those below. The result is that there is no more clipping or intersecting between the drawn-out fibers, and consequently adherence between the fibers is suppressed.

The process according to the invention also makes possible the production of a large preponderance of fine fibers in comparison to those of larger diameters. These fibers, being no longer stuck together, result in products particularly pliable to the touch, very homogeneous, and with improved resistance to traction or greater tensile strengths.

It should be noted that the tensile strength of fibers is increased as a result of the process of the invention. In fact, during drawing-out, they no longer traverse sluggish flames or smoke at low temperature, but, on the contrary, they are maintained in an active field at a temperature and speed higher than that of the gaseous currents which draw them out.

According to one embodiment of the invention, the band of the rotating body is maintained at a substantially constant temperature by heating its lower part through induction by means of high frequency current.

According to another characteristic of the invention, in order to assure homogeneity of temperature of the band of the rotating body, one may associate a screen below the combustion chamber beyond the expansion orifices for the combustion gases and coaxially with the rotating body, the lower part of this screen being substantially at the level of the upper row of orifices of the band.

According to another characteristic of the invention, the melted glass feeding the orifices of the peripheral band of the rotating body is given a viscosity of the order of at least 2500 poises, and particularly 3000 poises. The diameter of the orifices of the band is then increased, this diameter being generally not less than 0.9 mm.

The glass thus undergoing fiberizing being at lower temperature, the result is that the life of the centrifuge bodies is increased. Moreover, the glass being projected through orifices of relatively greater diameter, the fibers obtained are longer, hence more elastic, and consequently the products manufactured from these fibers have a greater capability of regaining the initial volume after compression. They can then be stocked or shipped while being maintained under a reduced volume.

The fiberizing of glass at a higher viscosity also permits the use of cheap glass compositions.

The annexed drawings illustrate different modes of executing the invention, which are to be construed as non-limiting examples thereof, wherein:

FIG. 1 is a vertical sectional view of an assembly to which the invention is directed;

FIG. 2 is a schematic illustration of the trajectories of the fibers when the orifices in the peripheral wall of the centrifuge shown in FIG. 1 are of uniform diameter;

FIG. 3 is a schematic illustration of the trajectories of the fibers when the orifices in the peripheral wall of the centrifuge shown in FIG. 1 are of decreasing diameter from the upper part to the lower part of the wall;

FIG. 4 is a graph illustrating the distribution of the fibers of different diameters resulting from the mode of operation illustrated in FIG. 2;

FIG. 5 is a graph illustrating the distribution of the fibers of different diameters resulting from the mode of operation illustrated in FIG. 3;

FIG. 6 is a vertical sectional view of another embodiment of the invention which includes a deflecting screen for controlling the trajectory of the fibers produced by the assembly;

FIG. 7 illustrates the trajectory of the fibers by the use of the arrangement shown in FIG. 1; and

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FIG. 8 illustrates the trajectory of the fibers by the use of the arrangement shown in FIG. 6.

In the embodiment shown in FIG. 1, the centrifuge body 1 rotating at high speed about its vertical axis is provided with a peripheral band or wall 2 in which are provided rows of orifices 3 through which the melted material fed to the interior of hollow body 1 is projected in the form of threads. In order to obtain a uniform distribution of the melted material over the inner wall of band 2, and consequently an identical supply for all the orifices 3, whatever their level, there is also provided on the inside of the rotating body and integral therewith, a distributor member or organ 4 in the shape of a basket into which the melted material is fed. Orifices 5 are provided on the vertical lateral wall of the basket through which the material is projected so as to form a layer of substantially uniform thickness over the entire inner surface of band 2.

An annular combustion chamber 6 is arranged coaxially with the rotating body and is provided with a slot 7 or a plurality of expansion orifices through which the combustion gases escape at high speed and high temperature and come in contact with the threads of material projected from the orifices 3 and which give rise to their drawing-out into fine fibers.

A winding 8 is also provided which is traversed by a high-frequency current for induction heating of peripheral band 2. This induction heating of the lower part of the band 2 has the effect of maintaining the latter at a substantially uniform temperature over its entire height.

The diameters of orifices 3 are variable, according to the rows to which they belong, these diameters decreasing from the top of the band toward its lower part. This decrease in diameter may be progressive. However, practically, for reasons of machining, this decrease may be arranged in steps. In this way, for a peripheral band with twenty rows of orifices, the distribution of diameters according to rows may be as follows: the first two rows of orifices at the upper part of the band may have a diameter of 1.1 mm.; the next fourteen rows of orifices at the central part of the band may have a diameter of 1.0 mm.; and the last four rows of orifices at the lower part of the band may have a diameter of 0.9 mm.

FIG. 2 illustrates schematically the path of fibers 9 arising from threads projected by the rotating body provided with projection orifices of the same diameter. It is seen that the fibers derived from the threads issuing from the upper row A collide with the fibers derived from threads of an intermediate row B, the latter, in turn, intersecting the fibers derived from threads of lower row C.

In contradistinction to FIG. 2, FIG. 3 portrays schematically the functioning of the device according to the invention with decreasing orifice diameters. This drawing shows the path of fibers from levels A, B, C identical to the preceding FIG. 2. It is seen that there is no longer any intersection of the fibers.

Curve 10 of FIG. 4 shows the distribution R of the fibers of different diameters D in microns, resulting from the mode of operation indicated in FIG. 2. The corresponding curve 10a of FIG. 5 shows the distribution of the fibers of different diameters resulting from the mode of operation in accordance with the invention as illustrated in FIG. 3. It is seen that the fibers obtained by the latter procedure have a much more regular diameter and that the fine fibers are in greater number.

In the embodiment shown in FIG. 6, the device according to the invention comprises, in addition, an annular screen 11 disposed coaxially with the rotating body and located under the annular combustion chamber 6, with the lower part of this screen being substantially at the level of the first row of orifices of the rotating body. This screen is hollow and is traversed by a cooling fluid.

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An annular blower 12 is disposed concentrically with the screen 11, and the blower crown 12 is provided with exit orifices 13 which are adapted to direct a fluid current in surrounding relation to the produced fibers.

A blower crown may also be provided in the device of FIG. 1 overlying the interior of the induction heater 8.

The presence of screen 11 has the effect, on one hand, of contributing to the homogenization of temperature of the peripheral band 2 and, on the other hand, of increasing the speed of the gaseous current acting on the threads or streamlets of material. It also has the effect, due to the expansion of combustion gases between the band 2 and the lower part of the screen, of spreading out the trajectories of the streamlets and ultimate fibers in a horizontal direction.

FIG. 7 illustrates the angle α formed by the tangent to the trajectory of a fiber 9 issuing from band 2, with respect to the vertical, when the device does not include a screen 11, and in comparison thereto, FIG. 8 shows the angle β formed by the tangent to the trajectory of a fiber at a corresponding point, in the case where the assembly includes a screen 11 as illustrated in FIG. 6.

We claim:

1. Apparatus for producing fine fibers from viscous thermoplastic material comprising a hollow centrifuge body having a peripheral wall provided with a plurality of superposed rows of orifices therein and adapted to receive at its interior portion a supply of the thermoplastic material in the viscous state, said body being rotatable at a speed sufficient to project the viscous material outwardly through said orifices in the form of streamlets, a combustion chamber surrounding said body and provided with discharge means to direct gases from said chamber at high temperature and high velocity in a ring-like blast across said rows of orifices, said gases travelling transversely to the planes of projection of said streamlets whereby said streamlets of viscous material issuing from the orifices of the rotating body are turned, entrained and drawn out into an annular curtain of fine fibers by said gases, means for maintaining the peripheral wall at a substantially uniform temperature along the entire height thereof, and said orifices in said plurality of rows adjacent to the edge of said wall remote from said combustion chamber being of reduced diameter relative to those in the rows adjacent to the edge of said wall proximate to said combustion chamber, to compensate for the reduction in temperature and velocity of the gaseous blast adjacent to the former, and thereby to attain fibers of substantially uniformly fine diameter.

2. Apparatus for producing fine fibers from viscous thermoplastic material comprising a hollow vertically rotatable centrifuge body having a peripheral wall provided with a plurality of superposed rows of orifices therein and adapted to receive at its interior portion a supply of the thermoplastic material in the viscous state, said body being rotatable at a speed sufficient to project the viscous material outwardly through said orifices in the form of streamlets, a combustion chamber surrounding said body and provided with discharge means to direct gases from said chamber at high temperature and high velocity in a ring-like blast across said rows of orifices close to and in light contact with the peripheral wall of said body, said gases travelling transversely to the planes of projection of said streamlets whereby said streamlets of viscous material issuing from the orifices of the rotating body are turned, entrained and drawn out into an annular curtain of fine fibers by said gases, heating means for maintaining the peripheral wall at a substantially uniform temperature along the entire height thereof, and said orifices in the lower rows of said peripheral wall being of reduced diameter relative to those in the upper rows to compensate for the reduction in temperature and velocity of the gaseous blast adjacent to the former and thereby to attain fibers of substantially uniformly fine diameter.

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3. An apparatus as set forth in claim 2 wherein the diameters of the orifices diminish progressively from the upper rows to the lower rows.

4. An apparatus as set forth in claim 2 wherein the diameters of the orifices vary in groups of rows from the upper rows to the lower rows.

5. An apparatus as set forth in claim 2 wherein the diameters of the orifices range from approximately 1.1 mm. in the upper rows to 0.9 mm. in the lower rows.

6. An apparatus as set forth in claim 2 wherein the heating means for maintaining the peripheral wall at a substantially uniform temperature along the entire height thereof comprises a high frequency inductive heating coil surrounding the lower portion of said peripheral wall.

7. Apparatus for producing fine glass fibers from thermoplastic vitreous material comprising a hollow vertically rotatable centrifuge body having a peripheral wall provided with a plurality of superposed rows of orifices therein and adapted to receive at its interior portion a supply of the thermoplastic material in the viscous state, said body being rotatable at a speed sufficient to project the viscous material outwardly through said orifices in the form of streamlets, a combustion chamber surrounding said body and provided with annularly disposed discharge means to direct gases from said chamber at high temperature and high velocity in a ring-like blast across said rows of orifices, an annular screen beyond said combustion chamber discharge means provided with an outwardly inclined wall to induce the spreading of said ring-like blast of gases issuing from said combustion chamber, said gases travelling transversely to the planes of projection of said streamlets whereby said streamlets of viscous material issuing from the orifices of the rotating body are turned, entrained and drawn out into an annular curtain of fine fibers by said gases, heating means for maintaining the peripheral wall at a substantially uniform temperature along the entire height thereof, and said orifices in the lower rows of said peripheral wall being of reduced diameter relative to those in the upper rows to compensate for the reduction in temperature and velocity of the gaseous blast adjacent to the former and thereby to attain fibers of substantially uniformly fine diameter.

8. An apparatus as set forth in claim 7 wherein the inclined wall of said annular screen extends from said combustion chamber discharge means to approximately the level of the uppermost row of orifices in said peripheral wall.

9. An apparatus as set forth in claim 8 including an annular blower crown surrounding said screen and provided with downwardly extending openings for discharging an annular current of gas in surrounding relation to said annular curtain of fine fibers.

10. An apparatus as set forth in claim 7 wherein the thermoplastic vitreous material adapted to be deposited on the inner face of said peripheral wall for centrifugal projection through the orifices therein has a viscosity in the range of 2500 to 3000 poises.

11. An apparatus as set forth in claim 7 wherein the orifices in the lowermost rows of the centrifuge have a diameter of at least 0.9 mm.

12. Apparatus for producing fine fibers from viscous thermoplastic material comprising a hollow centrifuge body having a peripheral wall provided with a plurality of superposed rows of orifices therein and adapted to receive at its interior portion a supply of the thermoplastic material in the viscous state, said body being rotatable at a speed sufficient to project the viscous material out-

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wardly through said orifices in the form of streamlets, a combustion chamber surrounding said body and provided with discharge means to direct gases from said chamber at high temperature and high velocity in a ring-like blast across said rows of orifices, said gases travelling transversely to the planes of projection of said streamlets whereby said streamlets of viscous material issuing from the orifices of the rotating body are turned, entrained and drawn out into an annular curtain of fine fibers by said gases, means for maintaining the peripheral wall at a substantially uniform temperature along the entire height thereof, means located inside the rotating body for projecting the molten material in a divided state from a plurality of levels so as to obtain a uniform layer of molten material along the entire height of the internal part of the peripheral wall, and said orifices in said plurality of rows adjacent to the edge of said wall remote from said combustion chamber being of reduced diameter relative to those in the rows adjacent to the edge of said wall proximate to said combustion chamber, to compensate for the reduction in temperature and velocity of the gaseous blast adjacent to the former, and thereby to attain fibers of substantially uniformly fine diameter.

13. Apparatus for producing fine fibers from viscous thermoplastic material comprising a hollow centrifuge body having a peripheral wall provided with a plurality of superposed rows of orifices therein and adapted to receive at its interior portion a supply of the thermoplastic material in the viscous state, said body being rotatable at a speed sufficient to project the viscous material outwardly through said orifices in the form of streamlets, a combustion chamber surrounding said body and provided with discharge means to direct gases from said chamber at high temperature and high velocity in a ring-like blast across said rows of orifices, said gases travelling transversely to the planes of projection of said streamlets whereby said streamlets of viscous material issuing from the orifices of the rotating body are turned, entrained and drawn out into an annular curtain of fine fibers by said gases, means for maintaining the peripheral wall at a substantially uniform temperature along the entire height thereof, said peripheral wall having a frusto-conical shape so as to control the direction of discharge of said ring-like blast of gases to divert said annular curtain of fine fibers subsequent to their formation and initial attenuation from below said centrifugal body, and said orifices in said plurality of rows adjacent to the edge of said wall remote from said combustion chamber being of reduced diameter relative to those in the rows adjacent to the edge of said wall proximate to said combustion chamber, to compensate for the reduction in temperature and velocity of the gaseous blast adjacent to the former, and thereby to attain fibers of substantially uniformly fine diameter.

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