Method and Means for Centrifuging Curly Fibers

Filed June 9, 1958

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METHOD AND MEANS FOR CENTRIFUGING CURLY FIBERS

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Filed June 9, 1958, Ser. No. 740,922
7 Claims. (Cl. 18—2.6)

This invention relates to a method and means for producing fibers of curly character, and more particularly to a centrifugal method and means for producing permanently curly fibers of heat-softenable mineral materials.

Fibers of heat-softenable mineral materials such as glass, although having many admirable qualities such as high tensile strength, inertness to deterioration, and high flex strength, are somewhat limited in adaptability for many uses in that they in general lack an inherent curliness which would contribute to the fluffiness and utilization of the high flexible properties of such fibers in the form of springiness in accumulations thereof. Individual fibers of mineral material such as glass have heretofore in general been so light and so short-curtled as to be difficult to curl because in many instances a requirement that curling be accomplished by reheatting of the fibers following formation to effect setting of a deformation therein. The production of fibers of curled character, in this way, additionally present problems in economics.

In view of the foregoing, it is a principal object of the present invention to provide an economical method and means for producing inherently curly fibers of heat-softenable mineral material such as glass.

It is another object of the present invention to provide a centrifuge method and means for producing inherently curly fibers of heat-softenable mineral material.

A still further object of the present invention is to provide a centrifuging method and means for producing inherently curly fibers of heat-softenable material such as glass wherein a composite of two materials are incorporated in the individual fibers to impart the desired curl.

The present invention is intended to preserve the invention of the present disclosure by combining into individual fibers, heat-softenable materials having different degrees of thermal expansivity, the materials being combined in a fiber-forming zone, whereby upon cooling, as contrasted to different dimensions to accordingly impart a permanent curl to the fibers under all temperature conditions of ordinary atmosphere. In brief, the apparatus of the invention incorporates an orificed spinner or rotor into which the different materials of the fibers are introduced and controllably fed from the orifices of the rotor whereby they are brought together and extruded in aligned integral relationship, whereupon after cooling they have an inherent curl imparted thereto by reason of the different dimensions to which the materials contract during cooling.

Features of the invention lie in the economy of production of such curly mineral fibers due to the extremely high rates of production made possible by centrifuging and the controllable rates at which the materials can be introduced to provide prescribed amounts of the different materials in each fiber of the mass produced.

Another feature of the invention lies in the extreme fineness of fibers of composite form producible by the method of the invention.

A still further feature of the invention lies in the highly compressible, non-itch and light density character of the accumulation of discontinuous, composite fibers of the different materials producible by the method and apparatus of the invention.

Other objects and features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its method of operation and manner of construction, together with other objects and advantages, may best be understood by reference to the accompanying drawings in which:

FIGURE 1 shows a general layout of apparatus for producing curled mineral fibers according to the present invention;

FIGURE 2 is an enlarged cross-sectional view of one form of rotor or spinner for producing composite fibers of different mineral materials according to the present invention;

FIGURE 3 is a cross-sectional side elevation view of another spinner for producing curled mineral fibers according to the present invention;

FIGURE 4 is an enlarged cross-sectional view of the spinner of FIGURE 3 as taken on line 4—4 thereof;

FIGURE 5 is an enlarged partial cross-sectional view of still another spinner construction for producing composite fibers of different mineral materials according to this invention; and

FIGURE 6 is an illustration of a type of curly fibers produced according to this invention.

Although the invention is herein exemplified by reference to production of curly fibers of glass, it will be apparent in view of the disclosure that it has application to production of fibers of other materials as well. For example, fibers of rock wool type materials, as well as carbon and other mineral materials can be produced. Composite fibers of different natureous materials can also be produced by the centrifuging process of this invention.

Referring to the drawings in greater detail, FIGURE 1 illustrates a centrifuging process for producing glass fibers wherein a source of two molten glasses 10a and 10b, such as a dual forehearth or electrical melting unit having either an associated pair of feeders or a composite feeder 11 from which a pair of streams of molten glass 12 and 14 of different compositions are flowed to a rotor or spinner 20 through a hollow shaft 15 rotatably driven by a motor 16. The two streams of glass 12 and 14 are directed into the spinner 20 are deflected to the inner periphery of the spinner by the centrifugal force thereof and are emitted as discrete fine glass streams through orifices in the spinner periphery. Jets of gas from burners 18 are directed from above the streams generally perpendicularly to the direction of emission of glass from the spinner periphery to attenuate the streams into fine glass fibers which are acted upon by gravity, as well as being blown downwardly by the gas of the burners. A cylindrical veil of fibers 21 is thus formed about the spinner, which veil is introduced into a hood 23 for collection on a conveyor 24 disposed below the hood.

The two streams of glass 12 and 14, upon introduction into the spinner 20, are maintained as separate glasses until ready to be ejected from the orifices of the spinner wherein they combine to form bi-glass curly fibers which are then attenuated into bi-glass curly fibers by gaseous jets directed against the zone adjacent the outer periphery of the spinner. The compositions of the two glasses 12 and 14 are such that their co-efficients of expansion differ sufficiently that the composite fibers formed of the two glasses become curly due to the differential contraction of the two glasses during cooling.

FIGURE 2 illustrates an embodiment of the spinner construction wherein the spinner 20 has a pair of distributing surfaces 22 and 24 for the molten glass of the two streams 12 and 14 respectively. The distributing surface 22 is the bottom of the spinner on which the stream of molten glass 12 is deposited and from which the glass is thrown radially outwardly by the rotational forces of the spinner for ejection from the orifices 27.
in the outer periphery of the spinner. A horizontal annular collection and distributing table surface 24 is fixedly mounted a vertical distance from the bottom of the spinner and is arranged to catch the molten glass of the second stream 14 to correspondingly effect its distribution and ejection from the orifices 27. The central opening of the surface 24 is of such size that when the stream 12 is flowed in alignment with the spinner axis, it passes therethrough to the bottom of the spinner without collision during rotation of the spinner. The stream 14, on the other hand, is caused to flow off-center from the spinner axis so that it is directed constantly to the upper distributing surface 24. A generally vertical wall extending upward from the opening in the surface 38 and provided with a radially outward overhanging lip minimizes the possibility of glass from stream 12 being deposited on surface 24.

The surface 24 is mounted in the spinner interior so that its circumferential edge bisects each of the orifices 27 and so that the glass on each level is ejected by centrifugal force through only half of the orifice. The glass on the collection surface 24 flows through the bottom half of the orifices 27, while the glass in the top collection surface 24 flows through the upper half of each orifice 27. The glass on the two collection or distribution surfaces thus flow together at the orifices 27 and are emitted as bi-glass streams for attenuation by the gaseous jets of the annularly oriented burners 18. The bi-glass streams are thus attenuated into fibers which form the cylindrical veil extending downwardly from the zone of attenuation.

This construction is especially adapted to formation of bi-glass streams when but a single row of orifices is provided in the periphery of the spinner. Such spinner construction, however, are not limited to a single row arrangement in that additional horizontal platforms can be incorporated in the spinner to extend the concepts of the construction to two or more rows of bi-glass streams emitted from the spinner.

FIGURE 3 shows another embodiment of the present invention wherein the construction is adapted to provide a multiplicity of vertically spaced rows of orifices for the formation of bi-glass streams, while yet providing only two collection surfaces for the different glasses introduced into the spinner. In this construction the orifices are arranged in vertically oriented rows and each bisected by radially disposed, vertical partitioning members which extend from the top to bottom of the spinner interior.

In greater detail, it will be seen that the interior of the spinner 30 has a bottom distributing surface 35 which the glass of a central stream 32 is deposited for centrifugal distribution, while a horizontally disposed distributing surface 38 vertically spaced above the bottom surface 35 collects and distributes the glass of a second stream 34 of molten glass. The surface 38 is annular in shape with a central opening through which the stream 32 flows constantly to the bottom collection surface 35. A concentric cylindrical wall 31, slightly smaller in diameter than the largest interior diameter of the spinner 30 is arranged to extend from top to bottom of the interior, thus forming a zone behind the orifices 37 which can be sub-divided into compartments 41 and 42 for different glasses A and B of the separate streams 32 and 34 respectively. The compartments 41 and 42 are formed by radial partitioning walls 33 each of which extend outward from the outside surface of the cylindrical wall 31 to bisect orifices 37 in an immediately oppositely disposed row of orifices. Thus, the dividing walls 33, in a sense, form vertical compartments behind each adjacent vertical row of orifices 37. Every other one of the vertically oriented compartments about the inner periphery of the spinner are arranged to receive one of the glass compositions of the streams 32 and 34, while those interposed between these compartments are arranged to receive the other glass. Distribution of the glass from the streams 32 and 34 into the respective compartments is accomplished by providing streams or channels for each of the glasses to their respective compartments. The glass of the streams 32 is distributed on the bottom surface 35 of the spinner and caused to flow into the vertically oriented compartment 41 through a series of spaced openings 39 which are provided in the bottom zone of the annular wall 31 below the annularly oriented orifices 27. The glass of the stream 34, correspondingly introduced into vertically oriented compartments 42 through a series of openings 36 located in the annular wall 31 just above the surface 38.

Each of the dividing walls 33 extending from the cylindrical wall 31 in bisecting relation with the orifices 37, thus have different glasses flowing on the one side of the orifice into the orifices 37, as indicated more clearly in FIGURE 4, to form bi-glass streams which then are attenuated into the bi-glass curly fibers. Any number of orifices 37 within reasonable limits can thus be aligned without difficulty in a vertical row bisected by the edge of a dividing wall 33.

FIGURE 5 illustrates another embodiment of the present invention wherein a plurality of rows of orifices in the periphery of the spinner 50 are bisected by horizontal partitioning members as are the orifices of the construction of FIGURE 2. In this construction, the bottom surface 55 of the spinner 50 acts as a distribution surface for glass B of a stream 52, while a second surface 58, vertically spaced from the bottom of the spinner, is arranged to distribute glass A of a stream 54. The glass A, upon being thrown outwardly from the surface 58, passes through a series of channels 56 to be divided between compartments 56a and 56b, separated by a compartment 59 which accommodates glass B. The compartments 56a and 56b in other words are supplied with molten glass A through radial channels 56 spaced about the interior of the spinner. Each wall of the compartments 56a and 56b acts to partition the orifices 57 so that glass from each of these compartments flow into half of each of the orifices 57, while glass of composition B distributed by the lower surface 55 of the spinner flows about the channels 56 and into the zones not covered by the compartments 56a and 56b to supply the remaining half of the glass flowing from each of the orifices 57. Bi-glass streams are thus ejected from each of the orifices 57, and any number of rows of orifices spaced vertically from each other can be arranged to receive the two dissimilar glasses for ejection of bi-glass streams and formation of bi-glass fibers. FIGURE 6 is illustrative of the general appearance of bi-glass fiber 60 produced with the constructions of the foregoing figures. As indicated above, the glass upon attenuation and cooling acquires the curled character by reason of the dissimilar co-efficients of expansion thereof. Because of the differences in co-efficients, the opposite sides of the fibers contract to different degrees, one side of the fiber being shorter along its entire length than the other, thus resulting in a continuous helically shaped curl.

For example, in some instances it may be desirable that the bisecting partition extend into the tubular channel of the orifices, or even through, and to a position slightly beyond the exterior of the rotor periphery, depending upon the viscosities, temperatures, and quantities of the glasses to be combined at the orifices. Although the spinner constructions herein disclosed have been illustrated with orifices bisected by members extending to a position immediately behind the orifice so that the glasses introduced into the orifices are combined within the orifice channel prior to emergence, it is to be understood that various degrees of bisection are possible.

The following are examples of glass compositions which can be used to produce curly bi-glass fibers or filaments. The examples set forth are presented solely for the pur-
pose of further describing the invention, and are in no way to be construed as limitations thereon. Composition A is a commercially used standard composition for textile fibers, while streams of any of compositions B, C, and D can be combined with composition A to successfully form curly fibers.

Compositions

<table>
<thead>
<tr>
<th>Composition</th>
<th>&quot;A&quot;</th>
<th>&quot;B&quot;</th>
<th>&quot;C&quot;</th>
<th>&quot;D&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>5.2</td>
<td>6.5</td>
<td>5.4</td>
<td>4.6</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>17.3</td>
<td>15.4</td>
<td>16.7</td>
<td>14.6</td>
</tr>
<tr>
<td>Na₂O</td>
<td>6.3</td>
<td>5.3</td>
<td>5.9</td>
<td>4.8</td>
</tr>
<tr>
<td>TiO₂</td>
<td>25.6</td>
<td>23.7</td>
<td>25.6</td>
<td>24.6</td>
</tr>
<tr>
<td>ZrO₂</td>
<td>0.0</td>
<td>0.2</td>
<td>0.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Coefficient of Thermal Expansion+</td>
<td>30</td>
<td>72</td>
<td>85</td>
<td>97</td>
</tr>
</tbody>
</table>

Curvilineality of glass fibers produced by the arrangements set out above impart a bulkiness to the mass, thereby reducing the density requirements for desired dimensions in the mass. Additionally, the curvilineality provides resilient or a springing action in that they have a shape characteristic for the mass than is obtainable with masses of straight fibers. Furthermore, the irritability frequently caused by contact with numerous ends of straight fibers is practically eliminated by reason of the individual fibers being capable of bending back on themselves into the mass upon which they are incorporated. Discontinuous fibers of this character are especially adaptable to forming staple-type yarns by twisting and drafting in view of their tendencies toward inter-adherence. Such fibers are also of character which permits ready combination with other fibers, such as cotton or cellulosic fibers to produce composite blends in yarns, or mass products such as mats or paper. They can also be combined with other fibers, such as a soluble fiber, like polyvinyl or alcohol fibers which might be used as a carrier for the glass fibers to improve results in picking, carding, drawing, roving and spinning the glass fibers into yarns. The soluble fibers can thereafter be dissolved following processing of the yarns, such as after having been woven into a fabric. Bi-glass curly fibers also have proven of desirable character in the reinforcement of gypsum board and pottery or firing clay in that they have a form which may be termed a mechanical hook or holding action so that they reinforce in a different manner than straight fibers for such purposes.

It will be understood that variations of the concepts herein presented will be readily discernable to those familiar with the natural and synthetic fiber arts, and that modifications can be made in the structures and processes within the broad concepts of the invention. For example, in addition to providing dissimilar glasses into streams for forming bi-glass fibers, variations might include the introduction of a stream of powder glass in combination with a molten stream of glass, or two molten streams of similar glass might be treated for the formation of a composite glass stream, which when attempted would result in a curly glass. In this regard, a single glass might be divided into two streams, one of which having powder added for the formation of a composition with the other stream, the formation of the fiber thereby making possible the formation of a curled bi-glass fiber. Furthermore, the orifices in the spinners can be divided in different proportions to join predetermined different quantities of the softened materials into the common streams ejected by the spinners.

In view of the foregoing, it will be understood that while I have shown certain particular forms of my invention, that I do not wish to be limited thereto, since many modifications may be made within the concepts of the invention and I, therefore, contemplate the appended claims to cover all such modifications which fall within the true spirit and scope of my invention.

I claim:

1. Apparatus for producing composite fibers of heat-softenable materials comprising a circular hollow rotor, having orifices distributed in its circumferential periphery, partitioning members dividing the interior of the rotor into separate zones for centrifugal distribution of different heat softened material introduced to the rotor, each of said orifices being partitioned in bisecting relation by said members for centrifugal projection of material distributed by each of said zones in composite relation with the material of the other of said zones.

2. Apparatus for producing composite fibers of heat-softenable materials comprising a hollow spinner, a hollow shaft for driving said spinner, means for driving said shaft and rotor, orifices distributed in the circumferential periphery of said rotor, means for supplying dissimilar heat softened fiber-forming materials to said spinner, partitioning means providing separate material distributing zones on the interior of said spinner for each of said materials, each of said orifices being divided in bisected relation by a partitioning member, one side of each of said orifices being connected with a distributing zone for one of said materials while the other side of each of said partitioning members is connected with the distributing zone for the other of said materials, whereby each of the two materials introduced to said spinner is projected simultaneously with the other from each orifice in a composite stream, and means for attenuation of such composite streams projected from said orifices into composite fibers of the two materials.

3. Apparatus for producing fibers of heat-softenable materials comprising in combination a support, a hollow rotor, a hollow shaft connected to drive said rotor, means carried by the support for rotatably supporting the shaft and rotor, means for rotating the shaft and rotor, said rotor having orifices in its circumferential periphery through which the material in the rotor is projected by centrifugal forces to form discrete bodies of heat softened material introduced therein, said orifices being arranged in circumferential spaced relation about the circumferential periphery of said rotor, an annular partition extending horizontally across the interior of said rotor dividing it into upper and lower material distributing zones and being arranged to horizontally bisect each of the orifices in said periphery, the opening in said annular partition being centrally located in line with the axis of rotation of said rotor, means for delivering heat softened material through the opening in said annular member into said lower distributing zone, and means for delivering different heat softened material to the top of said partition for distribution in the upper distributing zone, whereby material distributed by both distributing zones are caused to be simultaneously projected from each of said orifices as a common discrete stream.

4. Apparatus for producing fibers of heat-softenable materials comprising in combination a support, a hollow rotor, a hollow shaft connected to drive said rotor, means carried by the support for rotatably supporting the shaft and rotor, means for rotating the shaft and rotor, said rotor having orifices in its circumferential periphery through which the material in the rotor is projected by centrifugal forces to form discrete bodies of heat softened material introduced therein, said orifices being arranged in a plurality of circumferential rows spaced from each other and with the orifices thereof being arranged in columns, a cylindrical wall internal of said rotor extending from top to bottom of the rotor interior and having a diameter slightly less than the interior diameter of said rotor, generally radially aligned dividing walls partitioning into compartments in the zone between said cylindrical wall and orifices periphery, said dividing walls each extending from a position of bisection of a column of orifices in the rotor periphery radially inward into abut-
ting relationship with the cylindrical wall, an annular partition extending generally horizontally across the interior of said rotor dividing it into upper and lower distributing zones and engaging the interior of said cylindrical wall, flow channels connecting the upper distributing zone alternate ones of the compartments formed by said dividing walls, and other flow channels connecting the remaining compartments directly to the lower distributing zone, means for delivering heat softened material through said annular partition into said lower distributing zone, and means for delivering a second heat softened material to the top of said annular partition for distribution in said upper distributing zone, whereby the heat softened materials of each of said zones is introduced into alternate compartments for projection from each orifice of the rotor in intimate relation with the heat softened material of the adjacent compartment.

5. Apparatus for producing fibers of heat-softenable materials comprising in combination a support, a hollow rotor, a hollow shaft connected to drive said rotor, means carried by the support for rotatably supporting the shaft and rotor, means for rotating the shaft and rotor, said rotor having orifices in its circumferential periphery through which the material in the rotor is projected by centrifugal forces to form discrete bodies of heat softened material introduced therein, said orifices being arranged in a plurality of rows vertically spaced from each other in the circumferential periphery of said rotor, the circumferential rows being arranged so that the orifices are oriented in vertical columns, a horizontal annular distributing surface in the interior of said rotor dividing it into an upper and lower distributing zone, members bisecting each of said orifices horizontally and forming channels for directing flow of material from each of said zones to each of said orifices, means for delivering heat softened material through said annular member into said lower distributing zone and means for delivering different heat softened material to the top of said surface for distribution in said upper distributing zone, whereby each of the two materials introduced into said rotor is directed to two different distributing zones and is projected from half of each of said orifices in intimate contact with the other of said heat softened materials.

6. The method of producing composite textile fibers of dissimilar heat softened material comprising flowing separate streams of said dissimilar materials into a common centrifuge, centrifuging said materials in separated relation, centrifugally ejecting said dissimilar materials in side-by-side opposite relation from common orifices in said centrifuge as discrete composite streams of such materials, and then subjecting said composite streams to the forces of gaseous blasts to attenuate them into small diameter composite textile fibers of such materials said blast being directed perpendicular to the path of emission of the streams from said spinner to redirect the path over which attenuation of said streams is effected.

7. The method of producing composite textile fibers of two dissimilar heat-softened glasses, comprising introducing two streams of said dissimilar glasses into a rotating spinner, introducing each stream into a separate distributing zone within said spinner, projecting said dissimilar glasses in side-by-side opposite relation as composite streams from common orifices under the influence of the centrifugal force of the rotating spinner, and attenuating said composite streams into fibers of small diameter suitable for textile purposes by subjecting them to the forces of a gaseous blast, said blast being directed perpendicular to the path of emission of the composite streams from said spinner to redirect the path of attenuation of said streams.

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