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G. SLAYTER ET AL

2,398,808

APPARATUS FOR FORMING FIBROUS STRANDS

Filed Dec. 9, 1942

2 Sheets-Sheet 1

Fig. 1.

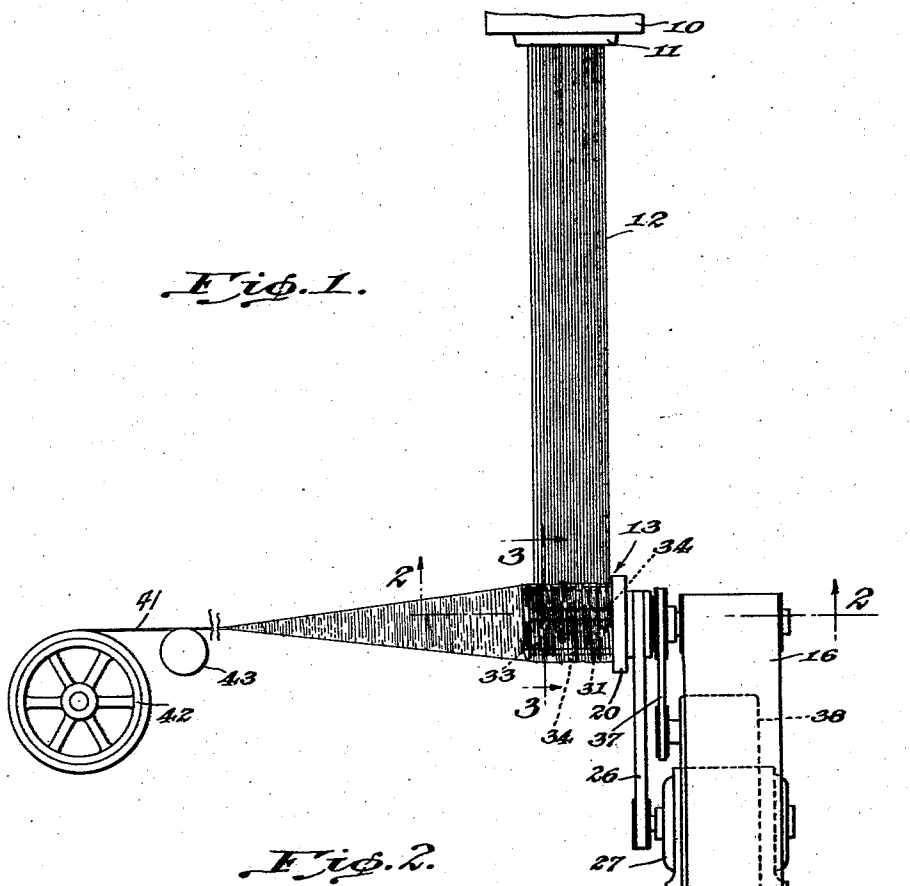
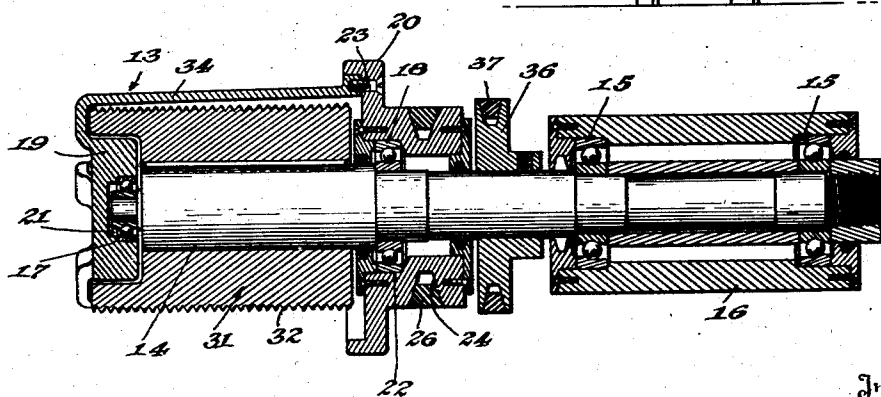


Fig. 2.



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Fig. 3.

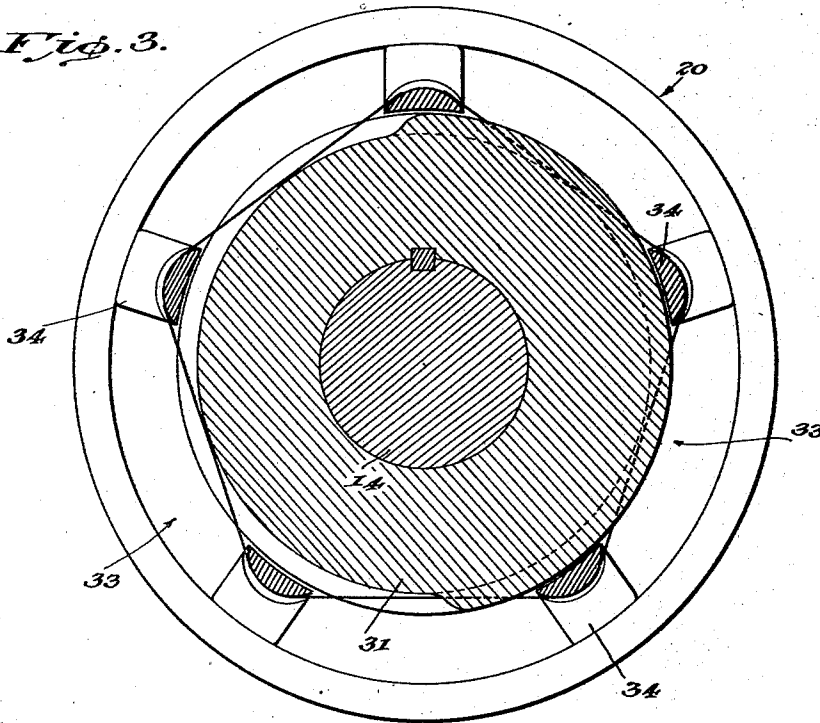
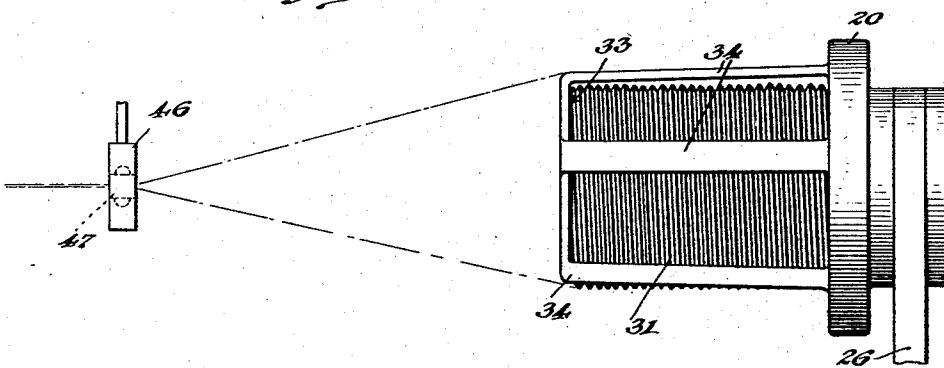


Fig. 4.



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APPARATUS FOR FORMING FIBROUS STRANDS

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9 Claims. (Cl. 49-17)

This invention relates to improved apparatus for manufacturing fibrous material. It relates particularly to the process of making strands of fibrous material from glass and other thermoplastic or hardenable substances by attenuating the material into fibers while in a plastic state and collecting the fibers in a hollow body on a rotating support and drawing the body off the support in the direction along the axis of rotation of the support. As the body of fibers moves past the end of the support it is lengthened out and drawn down into the form of a strand of intermingled fibers.

It is the principal object of this invention to provide improved means for continuously attenuating molten glass to form a continuous glass fiber and to wind the fiber about a rotatable attenuating support, and to feed the body of fibers lengthwise of the support off one end of the latter at a definite controllable rate.

A further object of this invention is to provide means for feeding the body of fibers lengthwise of the support that includes only rotating elements compactly arranged, thereby permitting high speed operation of the apparatus.

Still another object of this invention is to provide means to feed the body of fibers lengthwise of the rotatable support so arranged that the surface of the attenuating member upon which the body of fibers is collected closely approximates a true cylinder. This assures the application of a substantially uniform tension to the streams of glass being attenuated as the attenuating member rotates.

Broadly, the invention provides a rotating substantially tubular support for a body of fibers having spaced openings in its cylindrical wall, and a member within the tubular support having a helical groove in its outer surface exposed through the openings in the support to enable portions of the body of fibers on the support to be engaged by the helical groove. The construction is such that relative rotation between the support and member feeds the fibers off one end of the support.

A still further feature of this invention is to control the rate of feeding of the fibers off one end of the support by imparting a rotative movement at selected speed to the helically grooved member in the direction of rotation of the outer member. In this way the rate of feeding of the fibers off one end of the support may be accomplished at a relatively slow rate without restricting the speed of rotation of the support. As a result, the support may be rotated at very high

speeds to attenuate streams of thermoplastic materials to form the fibers.

The foregoing, as well as other objects, will be made more apparent as this description proceeds, especially when considered in connection with the accompanying drawings, wherein:

Figure 1 is a diagrammatic view of suitable apparatus for carrying out the invention;

Figure 2 is a longitudinal sectional view taken substantially on the line 2-2 of Figure 1;

Figure 3 is a cross sectional view taken on the line 3-3 of Figure 1; and

Figure 4 is a diagrammatic view of a slightly modified form of construction.

It will be understood as this description proceeds that the present invention may be advantageously used in the processing of natural fibers such as cotton, silk and wool or with the various cellulose compounds commonly known as artificial silk. For the purpose of illustration, however, the invention is shown in connection with the processing of fine filaments of thermoplastic materials such as glass.

Briefly, a body of thermoplastic material such as glass is melted and divided into a plurality of fine streams. The streams are attenuated to form filaments or fibers by the application of a traction or drawing force to the fibers and pneumatic or mechanical means may be provided for this purpose. Regardless of the specific attenuating means employed, the fibers are collected on a rotating body and are subsequently drawn off one end of the body. The Newman and Romig Reissue Patent No. 22,078, dated April 21, 1942, discloses and claims, broadly, such a process. The present invention provides an improved apparatus for carrying out this and similar processes.

Referring to the accompanying drawings, the fibers are wound on a rotatable body and successive convolutions of the fibers are fed lengthwise of the body in response to rotation of the body relative to a member within the body. The member is formed with a helical groove in the outer surface thereof and the wall of the body is slotted to enable portions of the fiber convolutions to lie in the groove. As a result, rotation of the body relative to the helically grooved member imparts a movement to the body of fibers in the general direction of the axis of rotation of the body and at a rate dependent upon the speed of relative rotation between the body and member. As the fibers move off the end of the body, they are drawn inwardly and axially away from the body to form a strand by either a blower or a rotatable packaging spool. In either case, relative rotation is

maintained between the strand and body so that the fibers are twisted. This is especially desirable when packaging the fibers on a spool because the fibers are held in a compact strand during the packaging operation, and subsequent ease in unwinding of the strand is assured.

In the present instance, the helically grooved member is rotated independently of the outer body in order to control the rate of feeding of the fibers lengthwise of the body. This arrangement also enables the body to be rotated at a high rate of speed without placing any limitations on the minimum rate of feeding of the fibers and, as a result, the body may be employed to attenuate the streams of thermoplastic material at any speed found desirable.

Referring more in detail to the drawings, the reference character 10 indicates a container or melter adapted to contain a supply of molten glass. A bushing 11 is suitably supported at the bottom of the container in communication with the supply of molten glass and comprises a plurality of nipples having relatively small orifices through which the glass flows in the form of streams 12.

The container or melter 10 and the bushing 11 diagrammatically shown in the drawings may be of any suitable construction and no claim is made to the mechanical details of these structures except in combination with the novel fiber handling mechanism to be presently described. Regardless of the specific construction of the container or melter 10 and bushing 11, the arrangement is such that molten glass flows in the form of a stream from each of the bushing orifices in response to the action of suitable attenuating means. In the present instance, the streams are mechanically attenuated to form continuous fibers by means of a cage 13 rotatably supported directly beneath the bushing 11 in a position to enable the fibers to be wrapped around the same.

Upon reference to Figure 2 of the drawings, it will be noted that the cage is rotatably supported on a spindle 14 having a portion at one end journaled at axially spaced points in bearings 15 on a suitable base 16. The base 16 is located to position the free end of the spindle 14 directly beneath the bushing 11 and the cage 13 is rotatably supported on the free end of the spindle by bearings 17 and 18.

In detail, the cage 13 is closed at one end by an integral hub portion 19 and is closed at the opposite end by a removable head 20. The hub 19 is formed with a centrally arranged inwardly opening recess 21 to receive the bearing 17 on the free end of the spindle 14 and the head 20 is formed with an axially aligned recess 22 to receive the bearing 18 on the spindle 14. The head 20 is detachably secured to the adjacent end of the cage 13 by means of fastener elements 23 and, as a result, the cage is effectively rotatably supported on the spindle 14.

The head 20 has an axial bore freely receiving the spindle 14 and is formed with an annular groove 24 intermediate its ends to receive an ordinary driving belt 25 driven by a prime mover of any suitable type such as the electric motor 27. In the present instance, the cage 13 is driven at a speed suitable for attenuating the streams 12 to form continuous fibers and the latter are wound around the outer surface of the cage to form a cylindrical body of fiber convolutions. The main features of the invention are also applicable to the case where the streams are attenuated by a

gaseous blast and the resulting fibers are collected on the cage 13.

As the fibers collect or are wound around the outer surface of the cage 13 and form a hollow fibrous body, this body is fed lengthwise of the cage toward the hub 19 and is pulled from the latter end of the cage and drawn down to form a strand. In accordance with the present invention, the body of fibers is mechanically fed lengthwise of the cage by a cylindrical member 31 keyed to the spindle 14 within the cage 13. The outside diameter of the member 31 is slightly less than the internal diameter of the cage 13 and helical grooves 32 are formed on the exterior surface of the member 31. The helical grooves 32 simulate multiple screw threads and are exposed through a plurality of circumferentially spaced axially elongated slots 33 formed in the wall of the cage. The slots 33 are so related that the bars 34 formed by the portions of the cage wall between the slots are of sufficient width to provide an ample bearing for the fibers. At the same time, the spacing between adjacent bars or, in other words, the width of the slots 33 is such that the portions of the body of fibers extending between the bars lie in the helical grooves 32 formed on the member 31 in the manner shown in Figure 3.

Rotation of the cage 13 relative to the member 31 feeds the body of fibers in the direction of the axis of rotation of the cage toward the hub 19 and finally moves the fibers off of the latter end of the cage. This action is facilitated by having the exterior surface of the cage gradually tapering inwardly from the head 20 to the hub 19 at an angle of from 3 to 10 degrees more or less depending upon the types of fibers and the particular material being processed.

Since the body of fibers on the cage moves endwise at a rate dependent upon the pitch of the grooves 32 and the speed of rotation of the cage relative to the member 31, the speed of rotation of the cage and subsequently the speed of attenuation of the fibers would be restricted by the rate at which the body of fibers is to be fed endwise. For very high speeds of rotation of the cage it would be necessary to use a very small pitch for the grooves 32, which has not been found feasible in practice. This difficulty is overcome in the present invention by imparting a rotative movement to the feeding member 31 in the same direction as the direction of rotation of the cage 13. The member 31 is rotated independently of the cage 13 by means of a driving pulley 36 secured to the spindle 14 between the head 20 and the base 16. The pulley 36 operatively connects the spindle 14 by means of a belt 37 to a suitable source of power represented by usual speed change mechanism 38. In the present instance, where the cage 13 is rotated at a very high speed in order to attenuate the streams 12 at an efficient rate, the member 31 is rotated in the same direction as the cage but at a speed sufficiently slower than the speed of rotation of the cage to obtain the desired rate of movement of the fibers off of the end of the cage.

As the fibers move past the end of the cage, they are drawn axially outwardly and inwardly to form a strand 41. As shown in Figure 1, the body of fibers from the cage is drawn out by winding the strand 41 around a packaging spool 42 supported in any suitable manner for rotation at the desired winding speed. A suitable traversing mechanism 43, for instance, a Reece-type roll, is pro-

vided between the cage 13 and spool to traverse the strand along the spool.

It is important to note in connection with the above that rotation of the cage 13 relative to the spool twists the strand of fibers and produces in effect a yarn. Although this twist is false for the continuous and unbroken fibers in the strand, it is highly advantageous because it tends to hold the fibers together in the strand during the winding operation and thereby facilitates subsequent unwinding of the strand while maintaining its integrity.

The body of fibers moving past the end of the cage may also be drawn out by a blower designated in Figure 4 by the reference character 46. The blower has a central circular passage or eye 47 through which the strand of fibers passes and is provided with an annular gas discharge orifice surrounding the passage 47 to direct an annular blast of gas lengthwise of the strand and onto the strand to draw out the body of fibers. This blower may be used independently of or in combination with a winding spool of the kind shown at 42 in Figure 1. In cases where the blower 46 is used in combination with a winding spool 42, the action of the blower relieves the tension on the strand as it is wound around the spool. This construction is advantageous because it provides a relatively loose package which lends itself more readily to the subsequent unwinding operation. Also, by use of the blower the strand may be deposited on a conveyor or in a can or other container where can-packaging is to be practiced.

In most cases, it is desirable to impregnate or treat the strand with a suitable lubricating and binding material prior to winding the same on the spool 42. This may be accomplished with the construction shown in Figure 4 by employing the blower 46 to apply the desired material to the strand. In the absence of the blower, a spray head may be located adjacent the cage 13 to direct treating material onto the fibers as they are wound on the cage or as the body of fibers is pulled off the end of the cage and drawn down into a strand. It is also possible to pass the fibers over a pad as they travel toward the cage and thereby apply the binding and lubricating material to the fibers before they are wound onto the cage.

Various modifications may be made within the spirit and scope of the appended claims.

We claim:

1. In combination, a hollow rotatable support having circumferentially spaced openings in its wall and about which fibers are adapted to be wound, means for rotating the support, and means responsive to rotation of the support to feed the fibers wound thereon lengthwise of the support including a cylindrical member received within said hollow support with its outer surface spanning the spaces in the wall of said rotatable support and having a spiralled groove in said outer surface in engagement with the fibers on said support.

2. In combination, a hollow support about which a fiber is adapted to be wound, a member located within the support in concentric relation thereto and having a cylindrical outer surface provided with a helical groove exposed through openings in the support for receiving the fiber, and means for relatively rotating the support and member to feed the fiber lengthwise of the support.

3. In combination, a rotatable cage about which a continuous fiber is adapted to be wound

and having circumferentially spaced bars extending axially of the cage, and a cylindrical member extending into the cage in concentric relation thereto and having a helical groove in the outer surface thereof for receiving the portions of the fiber convolutions extending between the bars of said cage.

4. In combination, a rotatable cage about which a continuous fiber is adapted to be wound and having circumferentially spaced bars extending axially of the cage, a cylindrical member extending into the cage in concentric relation thereto and having a helical groove in the outer surface thereof for receiving the portions of the fiber convolutions extending between the bars of said cage, and means for rotating the member independently of the cage to control the rate of feeding of the fiber by the groove in said member.

5. In glass fiber-forming apparatus including, a container for molten glass provided with a multiplicity of outlet openings through which glass flows in the form of continuous streams, means for attenuating the streams to form fibers including a rotatable cage having circumferentially spaced longitudinally extending bars about which the fibers are wound, a member extending into the cage in concentric relation thereto and having a helical groove in the outer surface thereof for receiving portions of the fibers extending between the cage bars, and means for rotating the member independently of the cage to control the rate of feeding of the fibers by the helical groove in said member.

6. In combination, a rotatable cage about which a continuous fiber is adapted to be wound and having circumferentially spaced longitudinally extending bars inclined toward the axis of the cage from one end of the latter, and a member concentrically positioned within the cage and having on its outer surface means engageable with portions of the fiber extending between the bars and responsive to rotation of the cage to feed the fiber lengthwise of the cage in the direction of inclination of the bars.

7. In combination, a rotatable hollow support about which a body of fibers is adapted to be wound and having circumferentially spaced openings in the wall thereof, and means extending concentrically into the support and having on its outer surface means engageable with portions of the body of fibers extending across the openings in the support to feed the body of fibers lengthwise of the support.

8. In combination, a rotatable cage about which a continuous fiber is adapted to be wound and having circumferentially spaced longitudinally extending bars inclined relative to the axis of rotation of the cage, a member within the cage in concentric relation thereto and having a helical groove in the outer surface thereof for receiving the portions of the fibers extending between the cage bars, said groove being arranged to feed the fibers on the cage in the direction of inclination of the bars when the cage is rotated relative to said member, and means for independently rotating the member to control the rate of movement of the fibers lengthwise of the cage.

9. In glass fiber-forming apparatus including means for flowing streams of molten glass, means for attenuating the streams to form fibers comprising a rotatable cage about which the fibers are wound, said cage being formed of circumferentially spaced bars extending substantially in parallelism with the axis of rotation of said cage but inclined thereto at a slight angle, a rotatable

cylindrical member within said cage having a spiral groove in its outer surface, said cage and member being so arranged that the spiral groove in said member engages the portions of the body of fibers extending across the spaces between said bars, whereby relative movement between said cage and said member causes endwise movement of the body of fibers on said cage, means

for rotating said cage and said member at different speeds, and means for drawing out the body of fibers as it is moved off the end of the cage by the relative rotation between said member and cage.

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