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METHOD AND APPARATUS FOR MANUFACTURING
FIBROUS PRODUCTS
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Fig. 1.

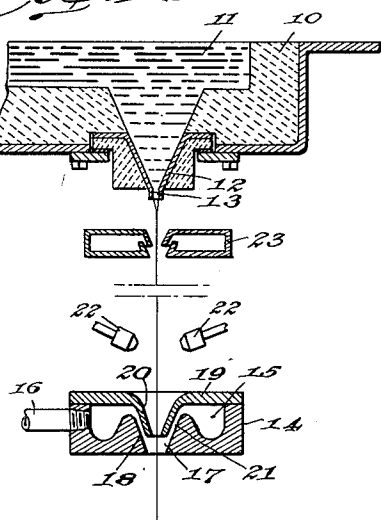


Fig. 2.

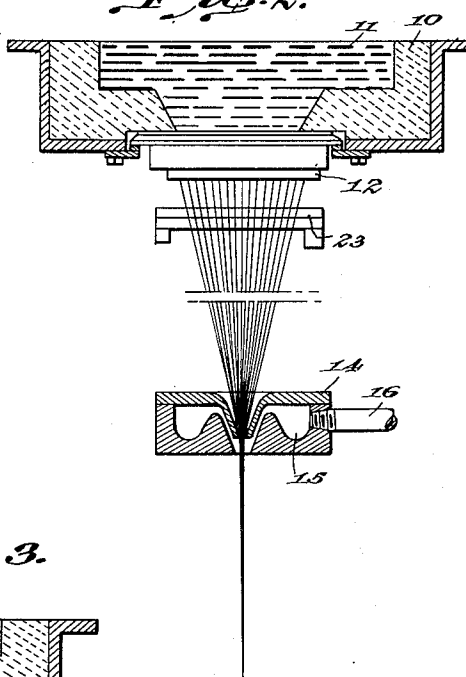


Fig. 3.

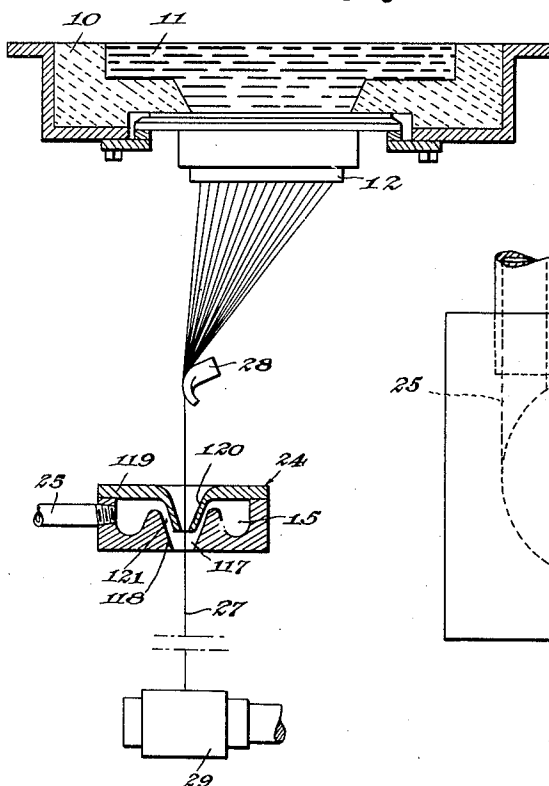
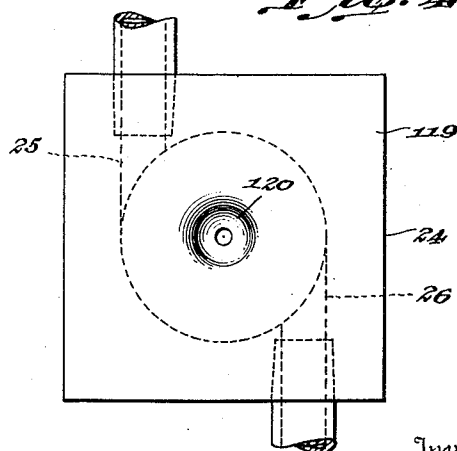


Fig. 4.



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METHOD AND APPARATUS FOR MANUFACTURING FIBROUS PRODUCTS

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6 Claims. (Cl. 49—17)

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This invention relates generally to a method and apparatus for forming fibrous products. More particularly the invention contemplates an improved method and apparatus incorporating the use of an attenuating gaseous blast for forming and attenuating fibers from a hardenable liquid capable of solidifying or hardening, such as molten glass.

It is one of the principal objects of this invention to substantially increase the rate of production of fibers relative to the volume of the gaseous attenuating agent and, at the same time, to obtain a more uniform attenuating action so that the resulting filaments or fibers are of uniform diameter.

Broadly, this is accomplished by grouping a plurality of streams of material into a strand or bundle and applying a gaseous attenuating medium to the strand. The efficiency of attenuation is thus vastly increased over the prior method of applying the gaseous agent to the individual streams. Also, since the blast of gas is much more compact, all of the filaments in the strand have equal forces applied thereto by the blast with a resulting increase in the uniformity of the finished filaments.

In the manufacture of filaments or fibers especially of glass by the mechanical attenuation method, it is customary to flow molten glass through a plurality of orifices to form a corresponding number of streams and to attenuate the streams into filaments by mechanical attenuating means, such as a drum, positioned to act on the streams after the latter have cooled or solidified. Usually the attenuated filaments are wound into a package on the drum. Although considerable success has been achieved by attenuating streams of molten glass with mechanical attenuating means, nevertheless, the latter has several objections. One objection is that the practical limit of the speed of operation of mechanical attenuating means is substantially below the rate at which it is possible to attenuate fibers or filaments and, accordingly, mechanical attenuating means restricts the rate of production of the filaments.

The use of a winding drum as the mechanical attenuating means has a further objection when employed in the manufacture of a strand of continuous glass filaments. The attenuating force places the strand under considerable tension during the winding operation and, as a result, the package obtained is wound so tightly that difficulty is oftentimes experienced in unwinding the package. The inner portion of the

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package may be put under such high compressive forces by the outer layers of strands that the filaments in these inner portions may be crushed.

In accordance with the present invention all of the above objections are eliminated by employing fluid under pressure to group and attenuate the filaments to be wound on the drum or to group the filaments and exert at least the major portion of the attenuating force on the grouped filaments prior to their being wound on the drum. Briefly, the streams are passed through the central opening of a circular blower discharging fluid under pressure toward the streams from an orifice that surrounds the path of the streams and that is arranged to direct the fluid in the general direction of movement of the streams. As a result, the streams are not only effectively attenuated but are also gathered to form a closely arranged group of fibers simultaneously with attenuation.

By employing fluid under pressure as the attenuating force, the fibers may be drawn at a rate commensurate with the velocity of the fluid discharged by the blower and the speed of attenuation may be accurately varied within wide limits by merely adjusting the pressure of the fluid discharged from the blower. Moreover due to the compact arrangement of the blast of fluid pressure, the rate of attenuation of all the filaments will be uniform at the particular speed selected. In addition, the equipment which renders the above possible is simple, inexpensive and may be operated over long periods of time without servicing.

In cases where the continuous strand issuing from the blower is wound on a spool to form a package, the attenuating speed is determined with respect to the speed of rotation of the spool so that the strand is under very little tension during the winding operation and a "soft" package results. A so-called "soft" or relatively loose package is desirable because it enables winding considerably more material without unduly compressing the material in the package which removes the danger of forming "ringers" during the subsequent unwinding operation or of otherwise interfering with ready unwinding of the strand. This is important in the manufacture of strands of glass filaments on a production basis because it permits uninterrupted operation of the equipment over a longer period of time.

Another object of the invention is to twist the strand of filaments before it is wound on the

drum or spool. In accordance with this invention a swirling motion is imparted to the fluid under pressure issuing from the circular orifice of the blower surrounding the fibers and this swirling motion is sufficient to twist the filaments of the strand together. As a result, the filaments are in effect joined in a compact strand which may be readily unwound from the package.

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

Figure 1 is a semi-diagrammatic sectional view disclosing apparatus constructed in accordance with this invention;

Figure 2 is a sectional view taken substantially at right angle to the plane of Figure 1;

Figure 3 is a semi-diagrammatic sectional view illustrating a slightly modified form of apparatus; and

Figure 4 is a plan view of the attenuating blower shown in Figure 3.

The invention concerns itself with the manufacture of fibers or continuous filaments from materials having the characteristics required to enable the same to pass through small orifices when in a liquid or flowable state and capable of being readily solidified. Many materials possess the above characteristics and a large majority of these materials may be satisfactorily used. Several examples of these materials are artificial silk, commonly known as Nylon, vinyl acetate, cellulose acetate, resin, sugar and vinylidene chloride resin. However, exhaustive experimental work and actual commercial manufacturing show that glass is particularly suitable for the formation of fine attenuated filaments and, accordingly, this material is specifically referred to hereinafter in describing the present invention.

The invention is directed more particularly to attenuating streams of molten glass into filaments by means of gaseous blasts. As will be more fully hereinafter described, a plurality of streams of glass are passed through a zone of gas under pressure which is controlled in a manner to gather the streams to form a closely arranged group of filaments in which the filaments are in actual contact to form a strand and to apply sufficient traction or pulling force to the strand to attenuate the streams into filaments. In some instances, the gas under pressure is given a swirling motion sufficient to twist the filaments together and form a twisted strand or yarn. This arrangement is especially desirable when winding a strand of the filaments on a spool because it insures grouping or placing of the filaments on the package in such close relationship in the strand that the strand may be later unwound without tangling, or without producing "ringers" by separating into two or more ends as it unwinds.

With the above in view reference is now made to the drawing wherein it will be noted that the reference character 10 in the several views indicates a container for a supply 11 of molten glass. A bushing 12 is suitably supported at the bottom of the container in communication with the supply 11 of molten glass and is provided with a plurality of relatively small outlet orifices 13. The container 10 and the bushing 12 may be of the type shown in the Slayter and Thomas Patent No. 2,234,986, dated March 18, 1941. However, the above construction is merely shown herein for the purpose of illustrating the present

invention and it is to be understood that various other specific constructions of containers and bushings may be successfully used.

Regardless of the particular construction of the container 10 and the bushing 12, the arrangement is such that molten glass flows in the form of a stream from each of the orifices 13. In each of the illustrated embodiments of the invention, attenuation of the streams of molten glass is effected by gaseous pressure means and the latter is positioned to act on the streams grouped into a strand and after the attenuated streams have solidified sufficiently to prevent fusing or sticking together.

In Figures 1 and 2 of the drawing the fluid pressure means comprises a circular blower 14 supported in any suitable manner below the bushing 12 and having an annular chamber 15 communicating with a source of fluid under pressure through the medium of a pipe 16. The blower 14 is also formed with a centrally arranged opening 17 of generally conical shape therethrough, the side walls 18 of the opening converging downwardly. The top wall 19 of the blower is formed with an inwardly tapering annular projection 20 concentric with the axis of the opening 17. The projection 20 overlaps the wall 18 of the opening 17 in spaced relation to the latter wall to form an annular passage or orifice 21. The passage or orifice 21 communicates with the annular fluid pressure chamber 15 and is substantially restricted in cross section in order to enable gas under pressure to flow at a high velocity through the passage into the opening 17.

Although various different types of gas under pressure may be employed, nevertheless, we prefer to use steam or air under pressure because these media are not only economical but also more suitable for effecting efficient attenuation of the fibers or filaments. Due to the above construction of the blower, the steam or other gas under pressure is discharged at a high velocity from the annular passage or orifice 21 in a downward direction inclined toward the axis of the opening 17 and entirely surrounding this axis. As a result, the blast of gas under pressure not only applies a sufficient pulling force on the filaments to attenuate the streams of molten glass but also gathers the filaments to form a closely arranged group or strand.

Prior to the gathering of the filaments into a strand a lubricant such as mineral oil in an aqueous emulsion is applied to the filaments by suitable means, for instance, spray guns 22 directed from opposite sides onto the filaments.

The fibers or filaments issuing from the blower 14 may be collected on a belt or other suitable conveyor to form a mat or could be packaged directly in a rotating or stationary can or could be wound directly upon a spool, depending on the particular product desired. Regardless of the disposal of the fibers or filaments issuing from the blower 14, the latter provides a highly efficient economical means for uniformly attenuating the filaments at a rate which may be readily varied within wide limits by merely altering the pressure of the fluid discharged into the blower.

The small circular blower of the present invention requires much less gas to effect the same rate of attenuation than the previously employed blowers. With the present arrangement several hundred filaments are gathered into a strand and passed through a circular opening that may

be less than one-quarter of an inch in diameter in the case of glass filaments. Previously, straight blowers had a total outlet slot length of more than ten inches to attenuate the same number of glass streams.

The use of the blower of the present invention is especially advantageous in cases where it is desired to wind a continuous strand on a suitable spool, such as that shown at 29 in Figure 3. When used for this purpose, the rate of attenuation effected by the blower 14 may be predetermined with respect to the speed of rotation of the spool 29 to relieve the filaments of substantially all or any desired degree of tension during the winding operation. As a result, the filaments are more loosely wound on the spool. This enables winding more material on the spool without unduly compressing the inner windings and thereby interfering with subsequent unwinding of the strands from the spool. The number of "shut downs" of the equipment required to interchange the spools is thus decreased and the production of the equipment is increased.

Referring again to Figures 1 and 2 of the drawing, it will be noted that a cooling blower 23 is supported between the attenuating blower 14 and the bushing 12. This blower is for the purpose of directing a draft of cooling air against the strands of glass issuing from the bushing 12 to control the attenuation and may or may not be used depending upon the particular conditions of operation.

Referring now more in detail to the embodiment of the invention shown in Figures 3 and 4, inclusive, it will be noted that this embodiment differs principally from the one previously described in that attenuating blower 24 is constructed to discharge the fluid under pressure with a swirling motion so as to twist the filaments together. In this connection it will be noted that the blower 24 is provided with two intake passages 25 and 26. These passages are arranged to cause the fluid under pressure to enter the annular chamber of the blower tangentially with respect to the periphery of the chamber so as to cause a very high speed rotation of the fluid under pressure discharged from the blower. In all other respects the blower may be identical in construction to the one previously described and, accordingly, corresponding parts are indicated by similar reference characters raised to the series 100.

Owing to the swirling action of the fluid under pressure discharged from the annular passage or orifice 121 of the blower 24, the filaments or fibers are twisted together and form a twisted strand, designated by the reference character 27. This twist is false in that the strand intermediate the bushing 12 and the spool 29 is turned about its axis but the ends of the strand both at the bushing and the spool are held against movement. Although this false twist is not, of course, of a completely permanent character, it does aid greatly in maintaining the filaments in the form of an integral strand during the winding operation. This is highly desirable because it contributes materially in eliminating tangles or "ringers" during subsequent unwinding of the package.

When using the blower 24 for aiding in attenuating the filaments, it is desirable to prevent any possibility of twisting the glass streams issuing from the bushing 12 before they are fully attenuated and have been solidified. This is accomplished by supporting a suitable guide 28 above

the blower 24 in a position to engage the filaments. The guide shown in Figure 3 also serves to gather the filaments and, if desired, may further be used to apply a suitable lubricant to the filaments. Although no means is shown in Figure 3 for artificially cooling the glass streams issuing from the bushing 12, nevertheless, it will be understood that some means may be provided for this purpose if desired. For example, a blower of the type shown by the reference character 23 in Figure 1 may be employed to direct a draft of cooling medium against the strands to chill or assist solidification of the latter.

Although the invention has been illustrated and described in connection with specific embodiments, it is to be understood that variations and modifications may be resorted to within the spirit and scope of the accompanying claims.

We claim:

1. The method which comprises flowing a plurality of streams of molten material of a type which solidifies when cooled, gathering the cooling streams together, and applying attenuating tension to the streams to form filaments therefrom and twist them into a strand by directing gas under pressure in a spiral direction about the strand.

2. In the method which comprises flowing a plurality of streams of molten glass, continuously attenuating said streams to form filaments, and winding the filaments continuously to form a package of filaments, the steps of gathering the filaments to form a strand, and engaging said strand in a region intermediate the point where the filaments are gathered and the point where the strand is wound, with a gaseous blast moving in a spiral path about said strand and in the general direction of movement of the strand in said region to attenuate the streams to fibers whereby the strand is provided with a false twist, the attenuating tension of the blast being greater than the tension applied to said strand by the winder.

3. The method which comprises flowing a plurality of streams of molten glass, gathering the streams when cooled into a strand, attenuating the streams to form filaments and twisting the strand by discharging gas under pressure in a swirling motion toward the strand and in the general direction of length of the filaments from an orifice surrounding the strand, winding the twisted strand at a tension less than the attenuating tension to form a package, and holding the filaments in advance of the region of application of said gas against twisting movement to prevent twisting of the streams of glass.

4. In a fiber forming apparatus which includes a container for molten glass having a series of orifices in said container through which the glass flows in the form of streams, an annular fluid pressure blower surrounding the streams when gathered into a strand and having an annular outlet orifice directed toward the strand in the general direction of flow of the streams for discharging fluid under sufficient pressure to attenuate the streams to form filaments, said blower arranged to impart a swirling motion centered about the strand to the fluid under pressure discharged from the outlet orifice to twist the filaments together simultaneously with the attenuation thereof.

5. Apparatus for producing strands of continuous glass filaments comprising means for flowing streams of molten glass to be attenuated to filaments, means including a winding drum to

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wind the filaments into a package, a guide over which said filaments are drawn as they are formed and by which they are gathered into a strand, and an annular swirl blower surrounding the strand and intermediate the winding drum and guide to direct a spiraling blast of gas onto said strand in the attenuating direction for attenuating said streams to form filaments and to falsely twist said strand.

6. In the method in which a plurality of spaced-apart streams of molten glass arranged in a group are flowed from a supply of molten glass, are attenuated by engaging the streams with a rotatable element, the attenuated streams are solidified to form fibers, and the fibers are wound onto the rotatable element, the steps of gathering the streams together into a strand as they are attenuated and before they are wound onto the rotatable element, and directing a gaseous blast generally lengthwise of the direction of the flow of the streams and onto the strand in a region between the location at which the streams are gathered into the strand

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and the location of the rotatable element to apply a traction force to the streams in the direction of attenuation of the streams and thereby aid in attenuating the streams.

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