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APPARATUS FOR MAKING SILICEOUS FIBERS

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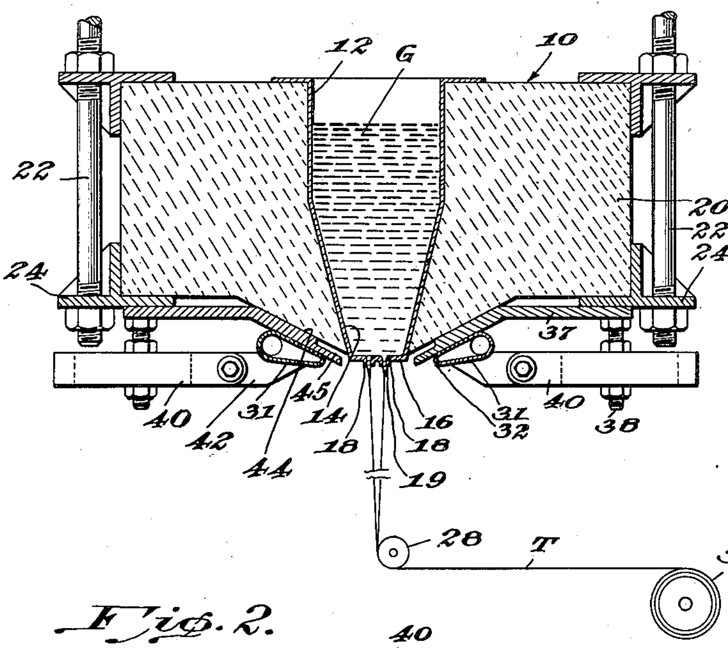
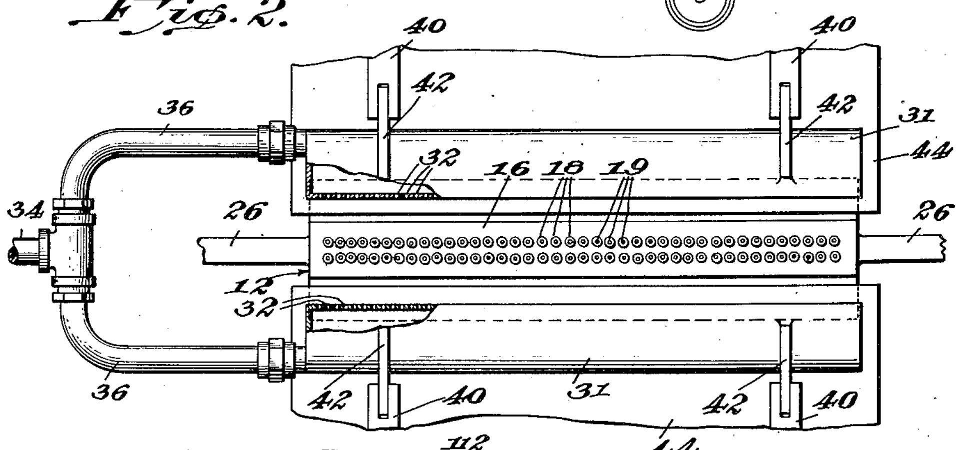


Fig. 1.

Fig. 2.



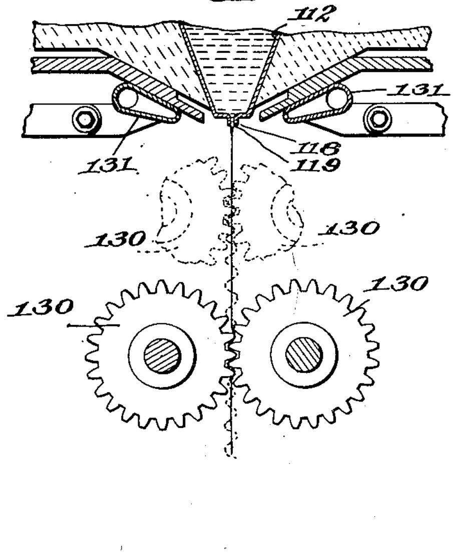


Fig. 3.

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APPARATUS FOR MAKING SILICEOUS FIBERS

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6 Claims. (Cl. 49—55)

The present invention relates to apparatus for making siliceous fibers, and more particularly to a novel method and apparatus for forming fibers by mechanical drawing of the glass or other siliceous material to form relatively continuous filaments or fibers.

This application is a continuation-in-part of our copending application Serial No. 105,405, filed October 13, 1936, which issued as Patent No. 2,234,986, March 18, 1941.

Generally, and for the most part, the objects of the present invention are substantially the same as those set forth in connection with the above identified application, insofar as actual fiberization is concerned. Likewise the character of fiber produced is similar to that produced by the method and apparatus disclosed in the said application insofar as fineness of diameter, tensile strength, flexibility and weavability, stretchability, uniformity, and fiber continuity are concerned. The present invention is primarily concerned with temperature control which is a necessity in maintaining the proper resistance for the attenuation of the fibers.

After the glass has been reduced to the proper size in the form of a fiber, it is essential that it is sufficiently cool and viscous so that it will not continue to attenuate and pull to nothing thus becoming severed. If the glass is too molten or fluid at this stage, it will not have sufficient resistance to maintain the desired diameter. This is especially true in high speed production of fibers and in such an instance the temperature control of the glass from the supply body to the finished fiber must be accurately maintained throughout.

As explained in our copending application above referred to, without adequate temperature control, the attenuation may take place simultaneously over a long portion of its length. It has been found that in such a case it is considerably more difficult to regulate the final size of the fibers inasmuch as attenuation may not be uniform throughout the length of the fiber. Thick and thin spots and other irregularities may thus be present. Moreover, attenuation over a long range produces a fiber having a multiplicity of minute strains, checks, and discontinuities, particularly at the surface.

The present invention is concerned with a novel method of temperature control which under certain conditions of manufacture may be more advantageously employed than the method disclosed in the above identified application or than other methods heretofore employed.

It is among the principal objects of the present invention, in an apparatus of the character set forth in the above cited application, to provide an improved apparatus wherein accurate control of the temperature, and consequently the fluidity, of the fibers undergoing attenuation may be attained.

It is an equally important object of the invention to provide a means whereby the temperature of the bushing nipples from which the attenuated fibers emanate may also be controlled to produce fibers of a desired character and to prevent clogging of the bushing nipples during production of the fibers.

Another object of the invention is to provide a temperature control apparatus of the character wherein the fibers undergoing attenuation are protected from the deleterious effect of dust or other suspended particles in the atmosphere and wherein such dust is excluded from the attenuating region and is thus maintained out of contact with the glass filaments undergoing fiberization.

In carrying out the above mentioned objects, the invention contemplates the provision of an electrically or otherwise heated metal bushing having a plurality of orifices therein for feeding the molten glass together with a plurality of blowers which are positioned beneath the bushing and which are so located that jets of air or steam issuing from the same are directed against the bushing nipples and against the streams of molten glass issuing from the latter in such a manner that both the nipples and the streams issuing therefrom may be maintained at the proper temperature for most efficient attenuation of the fibers.

In a temperature control apparatus of this character, the blowers above referred to may be located in close proximity to the bushing and may be so adjusted that the jets issuing therefrom are largely confined to the vicinity of the bushing nipples, thus not only rendering the space immediately below the bushing accessible to the operator but also making it possible to bring the mechanical attenuating means into close proximity to the bushing. Such an arrangement is particularly advantageous in the production of crimped fibers by means of attenuating gears, in that it permits the combined mechanical attenuating and crimping mechanism to be located well within the attenuating region wherein the fibers may be still more or less plastic and subject to the crimping operation.

Other objects and advantages of the invention, not at this time enumerated, will become apparent as the nature of the invention is better understood.

In the accompanying single sheet of drawings:

Fig. 1 is a side elevational view, partially in section and diagrammatic in its representation, of an electrically heated bushing to which the improved temperature control apparatus has been applied;

Fig. 2 is a bottom plan view of the apparatus shown in Fig. 1; and

Fig. 3 is a fragmentary side elevational view, partially in section and similar in its representation to Fig. 1, of a bushing to which the temperature control apparatus is applied, the bushing and attenuating means being designed for the production of crimped fibers.

Referring now to Figs. 1 and 2, the glass furnace or melting unit is designated in its entirety by the reference character 10 and includes a metal bushing 12 in which a supply body G of molten glass is contained. The bushing 12 preferably tapers downwardly and inwardly as at 14 and is formed with a relatively narrow bottom wall 16 provided with a plurality of nipples 18 which are preferably arranged in parallel rows as shown. The nipples 18 are formed with orifices 19 therethrough from which the molten glass issues to be attenuated into fibers. While in Figs. 1 and 2 there are illustrated two rows of nipples, it its to be distinctly understood that a greater or lesser number of such rows may be employed, depending on the character of the thread to be produced as the final product. Likewise the number of nipples contained in each row may be varied to accommodate composite threads which are composed of a varying number of individual filaments.

In order to produce exceedingly fine fibers it has been found desirable to draw from a relatively small cross-sectional area of exposed molten glass. For example, successful attenuation has been achieved from nipples which were in a range of from .02" to .08" in diameter, these figures being subject to variation in accordance with particular degrees of attenuation, etc. desired. A diameter of about .04" has been found preferable for certain types of attenuation and, as a matter of fact, nipples of this diameter may be made to yield fibers having diameters of wide variation, according to the viscosity of the glass and the rate of drawing.

The material of which the metal bushing 12 is formed is preferably composed of a platinum alloy. This material may be wetted by molten glass so as to expose definite amounts of the supply body in the vicinity of the nipples. Other high temperature refractories or alloys capable of withstanding temperature above or near the devitrification point of the particular glass contained in the bushing 12 may be used if desired.

The bushing 12 is surrounded by a refractory insulating medium 20, the entire melting unit 10 being suspended by means of hanger studs 22 and angle pieces 24.

Formed on or connected to the opposite ends of the bushing 12 adjacent the bottom thereof are a pair of terminal ears or lugs 26 to which conductors (not shown) may be connected for regulably supplying electrical current to the bushing in order that the latter may be heated in the lower regions thereof by direct resistance of the metal of the bushing.

Disposed below the melting unit 10 is a gathering eye or guide 28 in the form of a concave surface around which the multiplicity of fibers emerging from the nipples 18 are drawn. An attenuating means which may be in the form of a winding or packaging spool 30 is provided to draw the fibers and wind up the thread as it is being formed. The grouped fibers, after having passed through the guide 28, are in parallel and close relationship and form a strand T which is wound upon the packaging spool 30 at high speed.

The arrangement of parts thus far described is more or less conventional in its design and no claim is made herein to any novelty associated therewith, the novelty of the present application residing rather in the novel temperature control means now to be more fully described.

The temperature control means comprising the present invention comprises a pair of opposed blowers 31 in the form of elongated tapered hollow members which are positioned beneath the unit 10 on opposite sides of the rows of nipples 18 and are substantially coextensive with or slightly longer than the latter. A plurality of inwardly directed jet openings 32 are preferably provided at the inner sides of the blowers and air, steam, or other cooling fluid admitted to the blowers 31 from a manifold conduit 34 and branch conduits 36 is expelled through the jet openings 32 and directed inwardly toward the nipples 18. Generally only a relatively small amount of pressure such as ½ to 5 pounds is sufficient in said blowers.

The jet openings 32 are preferably located relatively close to each other and preferably exceed in number the number of nipples 18 in each row thereof in order that the streams of cooling fluid issuing therefrom may become intermingled and lose their identity prior to contact with the nipples 18 or streams of glass issuing therefrom. In other words, by closely spacing the jet openings 32, no pin point blasts of air or other fluid impinges upon the streams and a smooth blast of air which is substantially coextensive with the rows of nipples 18 is produced. If desired, the jet openings may be sufficiently wide to merge into a single slot although generally greater economy of air may be effected with smaller openings.

The jet openings 32 are preferably directed at an angle to the nipples 18 in such a manner that the streams impinge not only against the nipples but also against the glass issuing therefrom in the direction of movement thereof and thus fiberization is facilitated.

Disposed between the blowers 31 and the refractory medium 20 are a pair of baffle plates 37 which are secured to the angle pieces 24 by means of studs 38. The plates 37 also serve as an additional support for the refractory medium 20. Adjustably mounted on the studs 38 are a plurality of blower clamps 40, each having an adjustable inner section 42 which bears against its respective blower 31 and clamps the same firmly against one of the baffle plates 37.

The baffle plates 37 are provided with downwardly and inwardly inclined surfaces 44 against which the blowers 31 bear and which terminate in close proximity to the lower end 16 of the bushing 12. The inner ends of the plates 37 are cut away as at 45 to provide a clearance space in order that these inner ends will not be excessively heated by direct contact with the insulating medium near the casting. Air or other cooling fluid issuing from the jet openings 32 passes over the inner edges of the plates 37 and impinges on the fibers at the base thereof in the vicinity of the orifices 19 from which the streams of molten glass emanate. The fluid issuing from the jet openings 32 may if desired be caused to impinge directly upon the lower extremities of the nipples 18 as well as upon the fibers at the base thereof where the same are plastic. In this manner the air or other cooling medium cools the lower extremities of the nipples and also passes along a portion of the exposed surface of the glass. During attenuation of the fibers when the attenuating means 30 is in operation the air or other fluid issuing from the jet openings 32 may assist attenuation to a certain extent. If for any reason whatsoever the attenuating operation is ceased, the blasts of air will keep the glass moving slowly and the orifices 19 clean and prevent clogging of the orifices 19 by virtue of the glass wetting the outside surfaces of the nipples 18.

In actual operation it is most desirable to attain relatively high temperatures within the bushing 12 in order to result in complete solution of the ingredients of the glass and also in order that the glass may become sufficiently fluid to flow freely through the small orifices 19 of the nipples 18. By the present temperature control system in which the cooling fluid is caused to impinge either directly upon the lower ends of the nipples or upon the streams of glass immediately below the orifices, or both, the relatively hot glass which at this high temperature would ordinarily not be susceptible to the attenuating operation because of its high liquid state is rendered sufficiently viscous in the vicinity of the nipples to permit attenuation thereof. The object sought is to pull or attenuate the glass at as low a viscosity as will permit the same to be attenuated into a fiber.

In Fig. 3 the bushing 112 is shown as being formed with a row of nipples 118 having orifices 119. Attenuating gears 130 are employed for drawing the fibers from the orifices 119. The attenuating gears 130 are slightly longer than the row of nipples 118 provided in the bushing and the fibers are each drawn directly downwardly between the gears 130 which are rotated in opposite directions at high speed. Where fibers of a straight character are desired, the gears 130 may be located well below the bushing 112 in a region removed from the region of plasticity of the fibers being attenuated. If however crimped fibers are desired, the gears 130 may be located as shown in dotted lines in the vicinity of the nipples 118 and within the region of plasticity of the fibers. In this manner the fibers upon entering between the teeth provided on the gears 130 become distorted and crimped as shown in dotted lines.

Because of the fact that the blowers 131 are positioned on opposite sides of the bushing 112 and substantially on a level with the lower end of the latter, ample room is available beneath the bushing for positioning of the attenuating means. The blowers serve to impinge air upon the glass at the orifices while it is still in a molten, unfiberized state and increases its viscosity so that filaments may be drawn at extremely high speeds with a minimum length of attenuation.

Modifications may be resorted to within the spirit and scope of the appended claims.

We claim:

1. Apparatus for forming a substantially continuous fine glass fiber comprising a glass melting unit including a metal bushing having an orifice at the bottom thereof, an insulating member surrounding the bushing at the sides thereof and extending downwardly to a region adjacent the bottom of the bushing, said member having outer surfaces sloping upwardly and away from the bottom of the bushing, a pair of baffle plates in contact with said surfaces on opposite sides of the bushing and terminating adjacent said orifice, a blower in contact with each baffle plate, and means for clamping each blower against its respective baffle plate, said blowers having jet openings therein arranged to direct blasts of cooling fluid under pressure over the ends of said baffle plates and against the glass issuing from the orifice to rapidly cool the glass issuing from the orifice.

2. Apparatus for forming a substantially continuous fine glass fiber comprising a bushing for containing molten glass and having an orifice in its bottom wall for exposing the molten glass, cooling blowers arranged in proximity to said orifice on opposite sides thereof and located substantially wholly above the level of the orifices and having jet openings directed toward the orifice for directing substantially horizontal blasts of cooling gases under pressure over said orifice and the glass issuing from the latter to rapidly cool the glass.

3. Apparatus for forming a substantially continuous fine glass fiber comprising a bushing for containing molten glass and having an orifice in its bottom wall for exposing the glass, a blower positioned in proximity to said orifice and having a jet opening therein directed toward the orifice and arranged to direct a blast of cooling fluid under pressure over said orifice and the glass issuing from the latter to rapidly cool the glass to solidification, said blower being substantially flat and elongated in cross-section and occupying a position substantially wholly above the level of the orifice and arranged to direct said blast in a direction having a component parallel to the movement of said fiber.

4. Glass fiber forming apparatus comprising a glass melting unit including a metal bushing for containing molten glass and having an orifice in its bottom wall, an insulating and supporting member surrounding the bushing at the sides thereof and extending downwardly to a region adjacent the bottom of the bushing, blowers respectively at opposite sides of said bushing provided with jet openings directed toward said orifice, said blowers being substantially flat in cross-section and located closely adjacent the bottom of the insulating and supporting member and at a level at least as high as the level of the orifice, and means for clamping said blowers to said insulating and supporting member in such position.

5. Glass fiber forming apparatus comprising a glass melting unit including a narrow elongated metal bushing for containing molten glass and having plural rows of orifices in its bottom wall, said rows extending in the direction of length of said bushing, an insulating and supporting member surrounding said bushing and extending downwardly to a region adjacent the bottom of the bushing, and blowers arranged respectively at opposite sides of said bushing and located closely adjacent the bottom of said insulating and supporting member, said blowers being substantially flat in cross-section and being located at a level at least as high as the level of the orifices, and each of said blowers being provided with a series of jet openings extending the full

length of the rows of orifices and directed toward said orifices.

6. Glass fiber forming apparatus comprising a metal bushing for containing molten glass and having plural rows of hollow nipples on its bottom wall through which said molten glass flows, an insulating and supporting member surrounding said bushing and extending downwardly to a region adjacent the bottom of the bushing, the bottom wall of said insulating member sloping upwardly away from the bottom of said bushing, blowers respectively at opposite sides of said bushing in contact with said inclined bottom wall and each provided with a series of jet openings extending the full length of said rows of nipples and directed toward said nipples, said blowers being substantially wholly positioned above the level of said nipples, and means for clamping said blowers to said insulating and supporting member in such position.

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