Sept. 13, 1949. C. J. STALEGO 2,481,543

METHOD AND APPARATUS FOR PRODUCING GLASS FIBERS

Filed April 30, 1947 2 Sheets-Sheet 1

FIG. 1

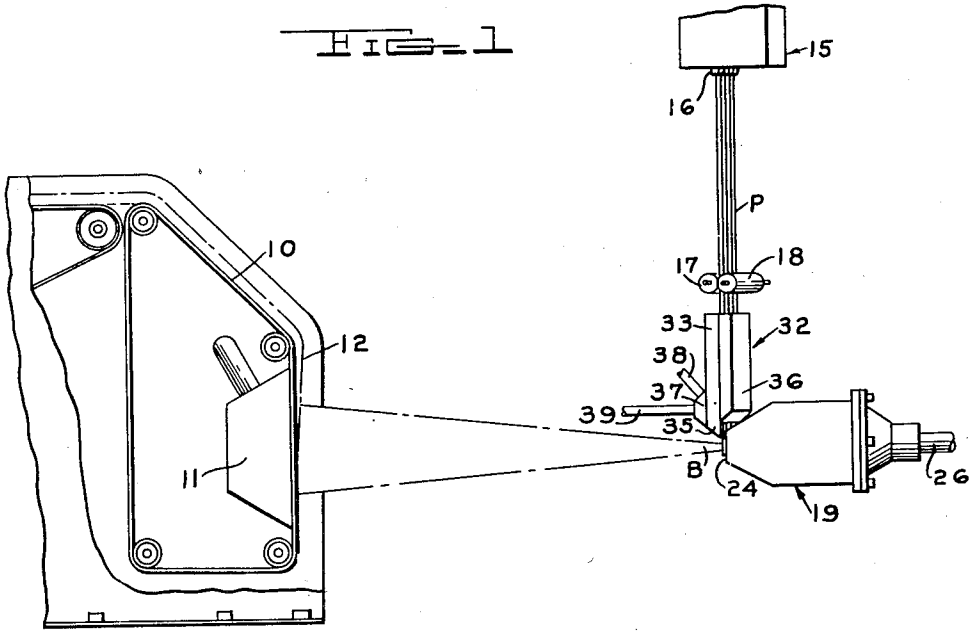
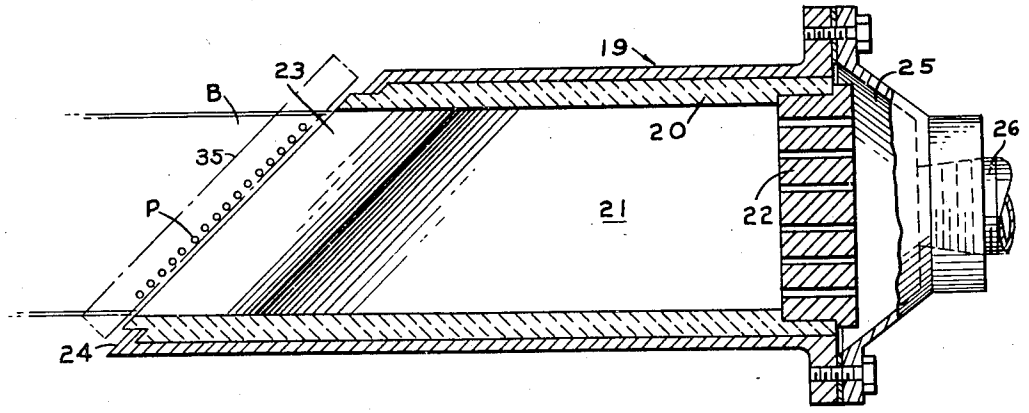


FIG. 2



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FIG. 3

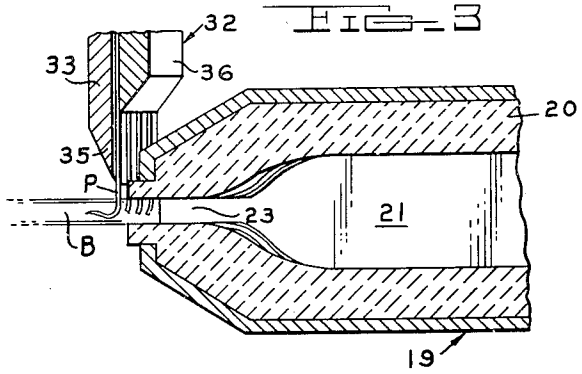


FIG. 4

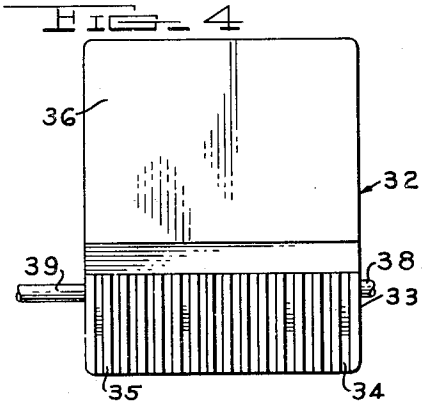
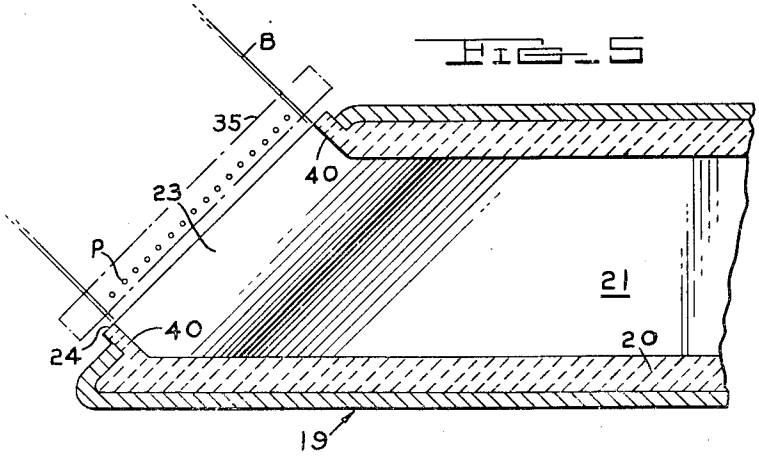


FIG. 5



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METHOD AND APPARATUS FOR PRODUCING GLASS FIBERS

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Application April 30, 1947, Serial No. 744,989

15 Claims. (Cl. 49—1)

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This invention relates generally to a method and apparatus for producing fibers from a heat softenable material, such for example, as glass.

Fine fibers of glass and like materials are made by feeding elongated glass rods or filaments into a gaseous medium having a temperature in excess of the melting temperature of the glass and having a velocity sufficiently high to draw out or attenuate the molten glass into fibers ranging from one micron or less to two and one-half or more microns in diameter.

The blast may be produced by a burner having a chamber within which a combustible gaseous medium is ignited and having an elongated relatively narrow opening through one wall of the chamber through which the products of combustion are discharged in the form of a blast of substantial width. The area of the opening is restricted in relation to the cross sectional area of the chamber to provide a blast having a temperature sufficient to melt the advancing ends of the glass rods and having a velocity sufficiently high to attenuate the molten glass into fibers.

The glass filaments or rods may be fed endwise into the blast from one side thereof at a point immediately adjacent the burner outlet opening in order to take full advantage of the effective attenuating length of the blast and at the rate of feed of the filaments is predetermined in dependence upon the size of the filaments to assure melting the advancing ends of the filaments in the blast.

It follows from the above that the quantity of fibers produced by the blast from primary glass filaments of a given size and fed at a given rate into the blast depends largely upon the number of primary filaments capable of being simultaneously fed into the blast. The number of glass rods or filaments capable of being fed into the blast issuing from the burner outlet opening is limited by the width of the blast, and by the lateral spacing required between adjacent filaments. The width of the blast is determined by the length of the outlet opening, and for a burner of given size, the length of the outlet opening is limited by the width of the burner combustion chamber. The length of the outlet opening is also limited by the necessity of producing a high velocity blast of sufficient depth or thickness to assure melting the advancing ends of the filaments before the latter are projected through the blast. There is also a practical limit on the minimum lateral spacing between adjacent filaments. In practice this spacing must be sufficient to enable expediently handling the filaments during lacing of the latter into the usual primary filament guide and to permit forming the guide without resorting to complicated machining operations.

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With the above in view, it is an object of this invention to substantially increase the quantity of fibers produced from a burner of given size by feeding a greater number of primary filaments or rods into the blast issuing from the burner outlet opening. In accordance with this invetion the above result is accomplished without reducing the lateral spacing between adjacent filaments to an extent which interferes with the ease of handling of the filaments or which complicates the construction of the guide and other parts of the apparatus.

A more detailed object of this invention is to increase the effective width of the gaseous blast issuing from the burner outlet opening without correspondingly increasing the width of the combustion chamber. As a result a greater number of primary glass filaments may be fed into the blast in side by side relation along a path extending normal or substantially normal to the blast. In accordance with the invention, the effective length of the outlet opening is increased by extending the wall of the combustion chamber through which the outlet opening is formed diagonally of the burner so that the length of the outlet opening may be greater than the effective width of the combustion chamber by an amount depending upon the angle of inclination of said wall.

A further object of this invention is to feed the primary glass filaments endwise into the blast from one side thereof with the filaments lying in a common plane extending substantially normal to the blast and located in close proximity to the outlet opening in order to take full advantage of the maximum available attenuating length of the blast.

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 illustrating one type of apparatus for carrying out the various steps of the process;

Figure 2 is a horizontal sectional view through the burner and guide means for the primary filaments;

Figure 3 is a vertical sectional view through the burner and guide means;

Figure 4 is an elevational view of the guide means; and

Figure 5 is a horizontal sectional view through a modified form of burner construction.

In accordance with this invention glass fibers as small as one micron or less and as large as two and one-half microns or more in diameter may be produced in large quantities on an economical production basis from primary glass filaments or rods of substantially greater diameter. The glass filaments or rods are indicated in the several figures of the drawings by the reference character P and may be readily produced in continuous lengths by the apparatus diagrammatically shown in Figrue 1 of the drawings. In detail the reference character 15 indicates a glass feeder or bushing which may be in the form of a long, relatively narrow trough, having a plurality of feeding orifices 16 in its bottom wall. Glass cullet or glass batch is fed to the bushing in any suitable manner and is heated while in the bushing to a molten condition. The molten glass flows from the orifices 16 in small streams which are attenuated to form the primary filaments P by means of coacting feed rolls 17 and 18 located a distance from the bushing 15 sufficient to assure cooling of the filaments to solidification before engagement by the rolls. One or both of the feed rolls may be driven by any suitable type of prime mover not shown herein.

The feed rolls also serve to proect the primary filaments P into an intensely hot, high velocity gaseous blast B. The blast B is produced by a burner 19 having a body 20 of refractory material and having a combustion chamber 21 therein. One end of the combustion chamber terminates at a perforated wall 22 having a plurality of small orifices extending therethrough and the other end of the chamber is provided with a wall 24 having a restricted outlet or discharge passage 23 therein. The refractory body may be surrounded by a sheet metal shell which extends past one end of the body to form an inlet chamber 25 between the end of the shell and the perforated wall 22. A suitable conduit 26 connects with the shell to feed the combustible gaseous mixture into the inlet chamber 25. The gaseous mixture enters the inlet chamber 25 and passes through the orifices in the wall 22 where it ignites and burns with a resulting high degree of expansion. During operation the walls of the chamber 21 are heated by the burning gas and the hot walls tend to increase the rate at which the gas entering the chamber burns. The resulting high rate of combustion causes a great expansion of the products of combustion which, as they pass through the outlet passage 23, are accelerated into a very high velocity blast of intense heat. The aim is to feed as much gaseous mixture into the chamber 21 as possible without causing the combustion to become unstable or to take place at the outside of the chamber or to cease altogether.

The outlet passage 23 is elongated and is substantially less in cross sectional area than the chamber 21, so that the products of the combustion taking place within the chamber are accelerated as they pass through the opening or passage 23 to provide a blast B of the gases moving at a very high velocity. In this connection it may be pointed out that the cross sectional area of the passage 23 may be varied to some extent relative to the cross sectional area of the chamber 21, depending upon the heat required in the blast leaving the outlet passage. Passages of greater cross sectional area relative to the cross sectional area of the chamber 21 permit burning a greater amount of gas and result in greater heat of the blast, but also cause a decrease in the velocity of the blast. Preferably, however, the cross sectional area of the outlet passage 23 is not greater than necessary to obtain in the blast the heat required to raise the glass to the attenuating temperature. The best relation of the cross sectional area of the passage 23 to the cross sectional area of the chamber 21 may be determined by simple trial, but will be found to be within the range of 1:8 to 1:4. This arrangement provides for obtaining the high velocity of the blast coupled with sufficient heat of the blast to quickly melt the glass to be attenuated.

The type of combustible gas used may be of any suitable kind, but for reasons of economy, it is preferably an ordinary fuel gas, such as natural or manufactured fuel gas. This gas is mixed with the proper amount of air by means of the orthodox air and gas mixers. The gas and air mixture is taken from the mixer at moderate pressure of approximately one to five pounds per square inch, but may be considerably higher if desired, and is led through an ordinary conduit to an enclosed ignition chamber where ignition of the gaseous mixture takes place.

It has been found that the velocity and temperature of the blast is highest immediately adjacent the outlet opening 23 and decreases in both temperature and velocity as the distance from the orifice increases. Thus in order to take full advantage of the maximum temperature and velocity of the blast, the primary filaments P are fed into the blast as near the discharge opening 23 as practical. In accordance with this invention the primary filaments P are guided into the blast by a guide 32 supported below the coacting feed rolls 17 and 18. The guide 32 comprises a plate 33 elongated in the direction of the path of travel of the primary fibers leaving the feed rolls and having a plurality of laterally spaced grooves 34 corresponding in number to the number of primary fibers. The lateral spacing of the grooves 34 is such that these grooves respectively receive the primary fibers leaving the feed rolls and the grooves extend for the full length of the plate 33. The lower end portion 35 of the plate 33 extends downwardly in juxtaposition to the front burner wall and terminates substantially flush with the top wall of the passage 23. It is pointed out in this connection that the width of the plate 33 corresponds to the length of the passage 23 or, in other words, to the width of the blast, so that all of the primary fibers leaving the delivery end of the plate or guide are projected into the gaseous blast issuing from the passage 23.

The guide 32 is provided with a cover 36, which is secured to the rear face of the plate 33 over the grooves 34 to enclose the primary fibers. The lower end of the cover 36 terminates short of the portion 35 of the plate 33 to expose the primary fibers directly to the heat radiating from the front burner wall. Due to the fact that the portion 35 of the guide or plate 33 extends in such close proximity to the wall 24 on the burner 19, this plate is subjected to extremely high temperatures, and if desired, may be cooled by providing a jacket 37 at the front side of the plate 33. A cooling medium from a suitable source may be conveyed to the jacket 37 through an inlet conduit 38 and discharged from the jacket through an outlet conduit 39.

It follows from the above that the guide 32 is

so positioned relative to the burner 19 that the primary glass filaments P are fed endwise into the blast in side by side relationship along a plane extending substantially normal to the blast B issuing from the outlet opening 23 in the burner chamber. The temperature of the blast exceeds the melting temperature of the glass filaments and the rate of feed of the primary filaments into the blast is controlled in dependence upon the diameter of the filaments to assure melting the advancing ends of the filaments in the blast, or in other words, before the filaments are projected through the blast. The molten glass at the advancing ends of the filaments is carried away in the form of streams and the force of the blast is sufficiently great to draw out or attenuate the molten glass streams while the latter remain anchored to the filaments P to form fine fibers. The fibers thus formed are carried through the asmosphere by the blast and are deposited on a suitable foraminous conveyor 10 that is moved across the path of the blast-borne fibers. A suction chamber 11 may be disposed at the rear side of the conveyor 10, and is arranged to extend over the deposition zone of the fibers to enable building up a mat 12.

The quantity of glass fibers produced by the blast B from primary glass filaments P of a given size and fed into the blast at a given rate depends upon the number of filaments capable of being simultaneously fed into the blast. The number of glass filaments fed into the blast is in turn dependent upon the lateral spacing required between adjacent filaments and by the width of the blast B. The lateral space between adjacent glass filaments P must be sufficient to enable readily handling the filaments during lacing the latter with the fiber guide 32 and the width of the blast for a burner of given size is limited by the length of the outlet opening 23 in the burner combustion chamber 20.

In accordance with this invention provision is made for substantially increasing the width of the blast B without correspondingly increasing the width of the burner combusion chamber 20, so that a greater number of primary filaments P may be introduced into the blast while maintaining sufficient lateral spacing between the filaments P to assure ease of handling of the filaments. This feature is accomplished in the embodiment of the invention shown in Figures 1 to 4 inclusive by extending the front wall 24 of the burner 19 diagonally of the combusion chamber 20, and since the outlet opening 23 is formed in the wall 24, it follows that the opening 23 is correspondingly inclined. As a result, the length of the opening 23 may actually be extended to increase the width of the blast without correspondingly increasing the width of the combusion chamber 20.

The extent to which the width of the blast B may be extended depends upon the angle of inclination of the outlet opening 23 or wall 24 and, in the present instance, this angle is shown to be approximately 45° to the center line of the burner. Thus it will be noted that if the length of the outlet opening in a standard burner having a straight front wall is limited to one inch by the width of the combustion chamber, the effective length of the outlet opening, and accordingly, the width of the blast, may be increased to 1.414 inches by inclining the front wall of the burner at an angle of 45°. It will, of course, be understood that this length may be increased or

decreased as desired by altering the angle of inclination of the front wall 24 of the burner 19. Generally speaking, where the front wall 24 is inclined at an acute angle to the center line of the burner combustion chamber, it is possible to increase the width of the blast by an amount equal to the trigonometric function of the angle.

In order to take full advantage of the increased width of the blast B, the guide 32 is positioned in a plane parallel to the plane of the front wall 24 of the burner, and the number of primary filaments P is increased by an amount depending upon the additional width of the blast available. This increase in the number of primary filaments is effected without disturbing the minimum lateral spacing required for ease of handling the filaments during lacing of the guide and without complicating the construction of the guide. In actual practice, it has been found that a lateral spacing between adjacent primary filaments P of .080 of an inch enables handling the filaments with ease and does not introduce any special problems in machining the guide 32. The above arrangement of increasing the capacity of the blast issuing from a burner of given size is accomplished without disturbing the desirable lateral spacing between adjacent filaments noted above.

In the foregoing embodiment of the invention, the primary filaments P are fed into the blast in a plane substantially normal to the blast B and extending diagonally of the path of the blast. In some instances it may be desirable to feed the primary filaments into the blast with the filaments lying in a plane extending substantially at right angles to opposite sides of the blast B as well as generally perpendicular to the path of travel of the filaments. With this in view, reference is made to Figure 5 of the drawings, wherein a burner similar to the burner 19 is shown, except that the end walls 40 of the elongated outlet opening 23 are shaped to direct the products of combustion or blast B from the opening at substantially right angles to diagonally arranged front burner wall 24 of the burner combustion chamber.

The guide 32 is supported in any suitable manner to introduce the primary filaments P to the blast immediately adjacent the delivery side of the outlet opening along a plane substantially parallel to the wall 24. Inasmuch as the blast B is projected from the burner 19 along a path extending substantially perpendicular to the wall 24, it follows that the plane along which the primary filaments are fed into the blast is substantially perpendicular to the opposite sides as well as the top of the blast. However, the effective length of the outlet opening in the burner shown in Figure 5 may be the same as the length of the outlet opening in the burner shown in Figure 2 where the angle of inclination of the walls 24 of both burners is the same.

I claim:

1. The process of making fibers from a heat softenable material which comprises producing an intensely hot high velocity blast of substantial width, feeding a plurality of rods of heat softenable material into one side of the blast with the rods disposed in a common plane extending diagonally of the blast, and attenuating the advancing ends of the rods within the blast to form fibers by the heat and force of the blast.

2. The process of making glass fibers which comprises burning a combustible gaseous medium and producing a blast of the products of com-

bustion having a temperature exceeding the softening temperature of the glass and having a velocity sufficiently high to attenuate the softened glass into fibers, and feeding rods of glass endwise into the blast from one side of the latter with the rods lying in a common plane extending diagonally of the blast.

3. The process of making glass fibers which comprises burning a combustible gaseous medium in a chamber of restricted width, discharging the products of combustion from the chamber in the form of an intensely hot high velocity blast having a width greater than the width of the chamber, feeding glass rods endwise into the blast from one side thereof with the rods arranged in side by side relationship across the blast, and attenuating the rods by the heat and force of the blast.

4. Apparatus for producing fibers from a heat softenable material, comprising means for burning a combustible gaseous medium and for directing the products of combustion into a fiber attenuating zone in the form of blast having a temperature in excess of the melting temperature of the material and having a velocity sufficiently high to attenuate the molten material into fibers, and means for feeding elongated bodies of the material endwise into the blast along a plane extending diagonally of the blast.

5. Apparatus for producing glass fibers, comprising a burner having a chamber in which a combustible gaseous mixture is burned and having an opening in one wall of the chamber elongated in the direction of the width of the chamber to discharge the products of combustion from the chamber in the form of an intensely hot high velocity blast, said wall being inclined in the direction of length of the opening to provide a blast of substantial width in comparison to the width of the combustion chamber, and means for feeding rods of glass endwise into the blast with the rods arranged in side by side relationship across the blast.

6. Apparatus for producing glass fibers, comprising a burner having a chamber in which a combustible gaseous medium is burned and having one end wall extending diagonally between opposite side walls of the chamber, an outlet opening in said end wall elongated in the direction of the width of the chamber and restricted to discharge the products of combustion from the chamber in the form of an intensely hot high velocity blast of substantial width, and means for feeding glass rods endwise into the blast with the rods arranged in side by side relation in a plane extending substantially parallel to the end wall aforesaid of the chamber.

7. Apparatus for producing glass fibers, comprising a burner having a chamber in which a combustible gaseous mixture is burned and having one end wall extending diagonally from one side wall to the opposite side wall of the chamber, an outlet opening in the end wall elongated in the direction of width of the chamber and having a length greater than the width of the chamber, said outlet opening having a relatively narrow depth predetermined to provide for the discharge of the products of combustion in the form of a relatively wide intensely hot high velocity blast, means for feeding a plurality of glass rods endwise into the blast, and means for guiding the rods into the blast with the rods positioned in side by side relationship in a plane extending substantially parallel to the said end wall of the chamber.

8. Apparatus for producing glass fibers, comprising a burner having a chamber in which a combustible gaseous medium is burned and having a restricted outlet opening in one wall shaped to discharge the products of combustion from the chamber in the form of a relatively wide intensity hot high velocity blast, means for feeding glass rods endwise into the blast from one side of the latter, and means for guiding the glass rods into the blast with the rods positioned in side by side relationship in a plane extending diagonally of the blast.

9. Apparatus for producing glass fibers, comprising a burner having a chamber in which a combustible gaseous medium is burned and having one end wall extending diagonally between opposite side walls of the chamber, an outlet opening in said end wall elongated in the direction of the width of the chamber and restricted to discharge the products of combustion from the chamber in the form of an intensly hot high velocity blast of substantial width, said outlet opening having end walls shaped to direct the blast along a path extending in a direction generally perpendicular to the said end wall, means for feeding glass rods endwise into the blast from one side of the latter, and means for guiding the rods into the blast with the rods positioned in side by side relationship across the blast in a plane extending substantially parallel to the said end wall.

10. Apparatus for producing glass fibers, comprising a burner having a chamber in which a combustible gaseous mixture is burned and having a restricted outlet opening in one end wall of the chamber through which the products of combustion are discharged in the form of an intensely hot high velocity blast, said outlet opening being elongated in the direction of the width of the chamber and having a length exceeding the chamber width to provide a relatively wide blast, and means for feeding glass rods endwise into the blast from one side of the latter with the rods arranged in side by side relationship across the blast.

11. Apparatus for producing glass fibers, comprising a burner having a chamber in which a combustible gaseous mixture is burned and having a restricted outlet opening in the end wall of the chamber through which the products of combustion are discharged in the form of an intensely hot high velocity blast, said outlet opening being elongated in the direction of the width of the chamber and having a length exceeding the chamber width to provide a relatively wide blast, means for feeding glass rods endwise into the blast from one side of the latter, and means for guiding the rods into the blast with the rods arranged in side by side relationship in a common plane extending substantially perpendicular to the blast.

12. The process of making fibers from heat softenable material which comprises burning a combustible mixture of gases within a space so confined with respect to the gas burned as to produce a rate of expansion of the gases within said space high enough to force the burned gases from the space and through a zone beyond said space in the form of an intensely hot high velocity blast of greater width than thickness, feeding a plurality of elongated bodies of heat softenable material into the blast in said zone along a path extending transversely to the direction of flow of the blast and with said bodies in side by side relationship in a row extending diagonally across

the blast, and attenuating the material at the advancing ends of the bodies into fibers by the heat and force of the blast.

13. The process of making fibers from a heat softenable material which comprises directing products of combustion through a zone in the form of a blast having a temperature exceeding the softening temperature of the material and having a velocity high enough to attenuate the softened material into fine fibers, and feeding elongated bodies of the material into the blast in said zone along a path extending transversely to the direction of movement of the blast and with said bodies arranged in side by side relationship in a row extending diagonally across the blast.

14. The process of making fibers from a heat softenable material which comprises burning a combustible mixture of gases within a confined combustion chamber, discharging the products of combustion from the chamber through an outlet opening in the form of a blast having a width adjacent the outlet opening greater than the corresponding dimension of the chamber, feeding elongated bodies of the material endwise into the blast in said zone along a path extending trasversely to the direction of flow of the blast and with said bodies arranged in side by side relationship in a row extending across the blast, and attenuating advancing ends of the bodies into fibers by the heat and force of the blast.

15. The process of making glass fibers which comprises introducing a combustible mixture of gases into a confined combustion chamber having in one wall an outlet opening of substantially greater length than width, burning the combustible gaseous mixture within the chamber in sufficient quantity to produce an expansion therein high enough to forcibly discharge the burned gases through the outlet opening in the form of a blast of substantially greater width than thickness and having a temperature in a zone exteriorly of the chamber exceeding the softening temperature of the glass and a velocity in said zone high enough to attenuate the softened glass into fibers, and feeding a plurality of rods of glass into the blast in said zone along a path of travel extending transversely to the direction of movement of the blast and with the rods in side by side relationship in a row extending diagonally across the width of the blast.

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