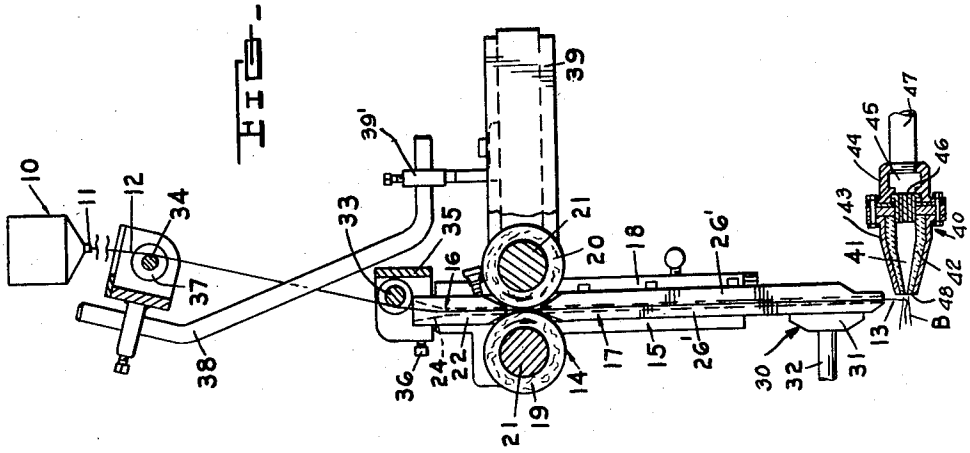
Oct. 9, 1951 E. FLETCHER 2,571,025

APPARATUS FOR PRODUCING FIBERS

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FIG. 1



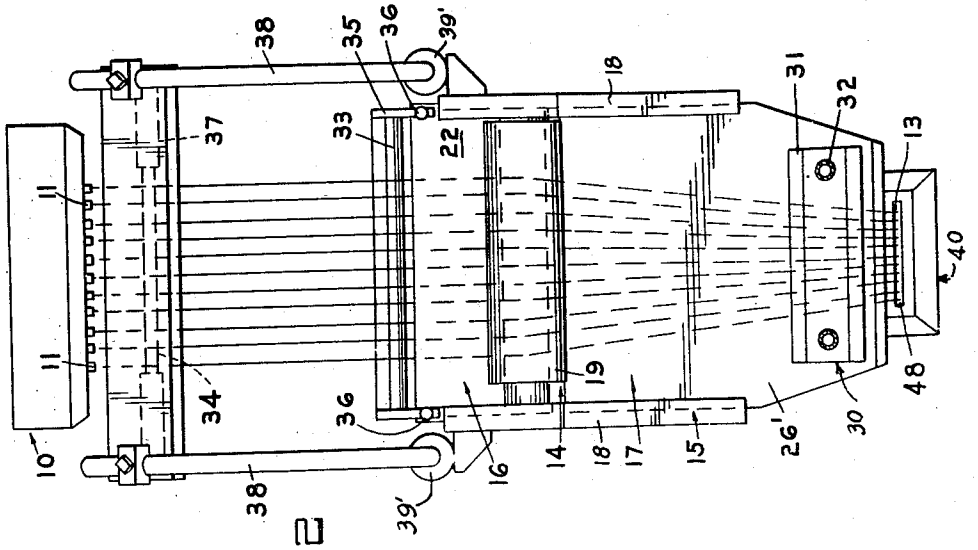


FIG. 2

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APPARATUS FOR PRODUCING FIBERS

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FIG. 3

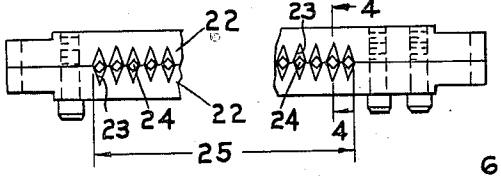


FIG. 5

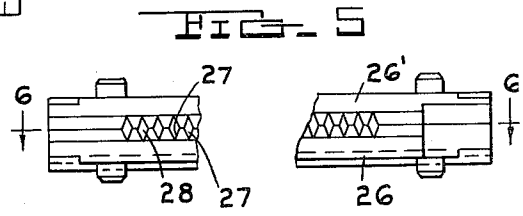


FIG. 6

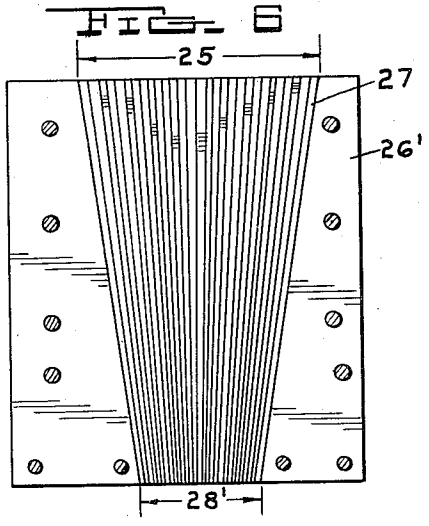


FIG. 7

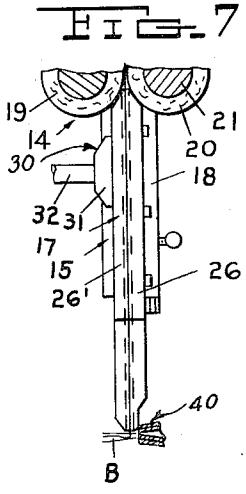
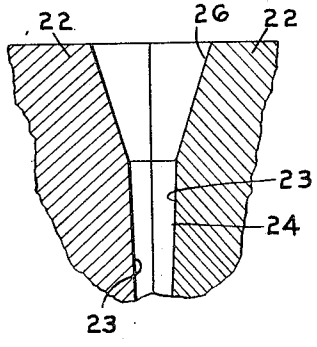


FIG. 4



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2,571,025

UNITED STATES PATENT OFFICE

2,571,025

APPARATUS FOR PRODUCING FIBERS

Ed Fletcher, Newark, Ohio, assignor to Owens-Corning Fiberglas Corporation, a corporation of Delaware

Application December 30, 1948, Serial No. 68,162

4 Claims. (Cl. 18—2.5)

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This invention relates to apparatus for producing fibers from glass or materials having characteristics similar to glass.

One highly satisfactory process for commercially manufacturing fine fibers from glass or materials which may be drawn out when in a softened or molten condition is to flow a multiplicity of individual streams of the material in a downward direction from a suitable feeder or bushing containing a body of the molten or heat softened material. As the streams pass from the feeder, the material is solidified sufficiently to enable engaging the same by power driven feed rolls, and these rolls impart sufficient force to the material in the direction of flow of the streams to attenuate the streams into rods or filaments. The filaments are also advanced by the feed rolls into a wide relatively thin blast of gas having a temperature exceeding the softening temperature of the material, and having a velocity sufficient to attenuate the heat softened material into fine fibers. It is also common practice to guide the primary filaments endwise into the blast by a guide designed to space the filaments laterally with respect to one another in a row extending across the width of the blast.

The general aim is to feed as many primary filaments into the blast as possible without disrupting the flow of the blast, so that the maximum production of fibers can be obtained from a single burner. However, there are practical reasons why it is desired to provide as much space as possible between the adjacent streams flowing from the feeder to the guide. In this connection there is a tendency for the streams to vibrate or shift laterally with respect to one another as they are discharged into the atmosphere from the feeder, and there is the danger that one or more of the streams will contact adjacent streams. This would result in the streams adhering to each other, and would cause a disruption in the operation of the equipment. In addition the primary filaments are usually manually threaded into the guide following breakage or disruption of the process for any reason, and ample spacing between the adjacent filaments must be provided to facilitate handling of the filaments.

With the above in view, it is one of the objects of this invention to provide apparatus rendering it possible to feed a greater number of primary filaments into a blast of given width, and at the same time, provide ample spacing between the individual glass streams flowing from the feeder to the guide. Thus the production of fine glass

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fibers with a burner of given size is substantially increased without the necessity of grouping the individual streams in such close proximity that disruptive operation may result.

It is another object of this invention to maintain a sufficient tension on the streams flowing from the burner to the guide to minimize any tendency for adjacent streams to contact one another and thereby disrupt the fiber forming operation.

It is a further object of this invention to provide a guide for the individual filaments having means rendering it possible to facilitate threading the individual filaments into the guide.

A still further object of this invention is to provide a guide which, in addition to directing the primary filaments endwise into the blast of gas issuing from the burner or other source of supply, also serves to heat the filaments prior to feeding the same into the blast. Thus the time required to heat primary filaments of given diameter to the attenuating temperature is materially reduced and the depth or thickness of the blast may also be reduced. This is important especially where the temperature and velocity of the blast are determined to a great extent by the size of the outlet opening in the burner combustion chamber. In this connection it will be understod that the velocity or extent of reduction of the area of the burner outlet is limited by the temperature required in the blast, so that by reducing this temperature it is possible to proportionately increase the velocity of the blast or reduce the width of the outlet opening.

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, in which:

Figure 1 is a semi-diagrammatic sectional view showing apparatus embodying the features of this invention;

Figure 2 is an elevational view of the apparatus shown in Figure 1;

Figure 3 is a plan view of the guide shown in Figure 1;

Figure 4 is a sectional view taken substantially on the line 4—4 of Figure 3;

Figure 5 is a plan view of the bottom guide section shown in Figure 1;

Figure 6 is a sectional view taken on the line 6—6 of Figure 5; and

Figure 7 is a fragmentary elevational view of a modified form of guide.

The apparatus forming the subject matter of this invention may be successfully employed in

the manufacture of fine fibers from many different types of materials which are reduced to a molten or softened state when subjected to heat, and are capable of being drawn out to form fibers when in a molten or softened condition. However, the apparatus is particularly adapted for use in the manufacture of glass fibers, and accordingly, is described below for this purpose.

With the above in view, reference is made to Figure 1 of the drawings, wherein the numeral 10 designates a feeder in the form of a bushing adapted to contain a body of molten glass, and having a plurality of restricted openings or orifices 11 in the bottom wall through which molten glass flows into the atmosphere in the form of streams 12. This general type of bushing or feeder has been extensively used in the past in the manufacture of fine fibers from heat softenable material, such as glass, and therefore, need not be described in detail. It will suffice to point out that the bushing is preferably heated in a manner not shown herein to maintain the molten glass therein at such a viscosity that the glass flows relatively freely through the orifices 11. These orifices are spaced laterally from each other in a row in order to position the individual streams 12 in a common substantially vertical plane.

As the individual streams 12 of glass are admitted to the atmosphere, they are cooled to the point of solidification after being drawn out to form primary filaments 13 by suitable feeding means designated generally by the numeral 14. The feeding means 14 also acts to project the primary filaments 13 into one side of an intensely hot high velocity blast B of gas. The portion of the blast B extending for an appreciable distance from the point of entry of the filaments into the blast is at a temperature which exceeds the softening point of the glass and moves at a velocity sufficiently high to attenuate the softened glass to form fibers. As will be more fully hereinafter described, the blast B is of substantial width, and the primary filaments 13 are introduced into one side of the blast along paths of travel which extend substantially normal to the direction of movement of the blast B.

In the present instance a guide 15 is interposed between the feeding means 14 and the blast B for guiding the individual primary filaments 13 into the blast. The guide 15 is designed to arrange the primary filaments in lateral spaced relation to each other in a row extending across the width of the blast, and the general aim is to feed as many primary filaments 13 into the blast as is possible without disrupting the flow of the gases forming the blast. The problem of feeding a large number of primary filaments 13 into a blast B of given width is aggravated by the necessity of maintaining sufficient distance between adjacent streams 12 issuing from the feeder 10 to prevent contact of the streams as they are projected into the atmosphere. In this connection it will be understood that as the streams of glass pass into the atmosphere, they are subjected to the action of air currents and other forces which have a tendency to move adjacent streams into contact, and disrupt the operation of the equipment. In addition it is customary to manually feed or thread the filaments into the upper end of the guide 15 following an interruption of the process, and adjacent filaments must be spaced laterally from each other a sufficient distance to enable handling of the filaments during the threading operation. Owing to the above conditions full advantage has not been taken in the past of the attenuating capacity of the blast B, and as a consequence, production of fibers from apparatus of a given size has been somewhat curtailed.

The apparatus forming the subject matter of this invention renders it possible to feed the maximum number of primary filaments into a blast B of given width without disrupting the blast, and at the same time, provides the desired lateral spacing between the adjacent streams 12 issuing from the feeder 10. In general the above result is obtained by designing the guide 15 so that the primary filaments at the entrant end of the guide are spaced laterally from each other throughout a distance which substantially exceeds the width of the blast B, and converge to such an extent as they pass along the guide as to occupy a space at the delivery end of the guide which approximates in length the width of the blast B.

In detail the guide 15 comprises two sections 16 and 17 supported in vertical alignment by a bracket 18. The bracket 18 also forms a support for the feeding means, which in the present instance, comprises a pair of rolls 19 and 20 rotatably supported at opposite sides of the path of travel of the primary filaments 13. The feed rolls are respectively secured to shafts 21, and one or both of the latter may be driven by suitable power means. The power means is not shown herein, but is such that the rolls are rotated in the direction of the arrows indicated on Figure 1 of the drawings. The peripheral surfaces of the rolls are preferably formed of a resilient material, such for example, as a rubber composition, and the rolls are supported in positions such that the peripheral surfaces have a rolling contact with opposite sides of the filaments 13 as the latter pass between the two sections of the guide 15.

The guide section 16 is located between the feed rolls and the bushing 10. This section comprises two plates 22 secured in side by side relationship and formed with a plurality of laterally spaced vertical recesses 23 in the adjacent surfaces thereof. The recesses 23 in one plate cooperate with the corresponding recesses in the other plate to form vertical grooves 24. The grooves 24 are of sufficient dimension to respectively freely receive the primary filaments 13 and are spaced laterally from each other throughout a distance 25 which substantially exceeds the width of the blast B. The lateral spacing between adjacent grooves corresponds to the desired lateral spacing between adjacent glass streams at the bushing 10, and the distance 25 may be as great or greater than twice the width of the blast B. In any case this distance is sufficient to enable spacing adjacent streams from each other to the extent required for convenient handling of the filaments during threading of the latter into the grooves 24. In order to facilitate threading the filaments 13 into the grooves 24, the latter are preferably flared outwardly at the upper ends in the manner indicated by the numeral 26 in Figure 4 of the drawings. This is an important feature as it reduces considerably the time required for threading the individual filaments into the upper end of the guide.

The section 17 of the guide 15 is located between the feed rolls and the blast B. This section also comprises a pair of plates 26' secured to the bracket 18 in face to face relationship. The inner surface of each plate 26' is formed with a plurality of laterally spaced vertically extending recesses 27, and these recesses cooperate to form grooves 28. The grooves 28 corre-

spond in number to the number of grooves 24 in the guide section 16, and are respectively aligned with the grooves 24 in order to receive the primary filaments 13 from the guide section 16.

The grooves in both guide sections are substantially greater in diameter than the diameter of the primary filaments so that the latter may shift laterally within the grooves and this is important because it reduces friction which is one of the factors responsible for breaking of the filaments passing from the bushing 10 to the feed rolls. It is also pointed out at this time that the provision of grooves of substantial diameter makes it unnecessary to employ precision methods for aligning the two guide sections. It is also pointed out that since the primary filaments 13 entering the blast are advanced in the direction of movement of the blast, the adjacent plate 26' of the bottom guide section is subjected to considerable wear, and accordingly, may be hardened or formed of a high wear resisting material, if desired.

It follows from the foregoing that the receiving ends of the grooves 27 are spaced laterally from each other throughout a distance identical to the distance 25 previously described in connection with the section 16 of the guide. The grooves 27, however, converge toward the bottom of the guide section 17, and are spaced from each other at the bottom of the guide section throughout a distance 28' which approximates the width of the blast B. Actually the distance 28' is somewhat less than the width of the blast B in order to assure positioning the end filaments within the blast. Thus it will be apparent that full advantage of the blast B is taken without interfering with the desired lateral spacing between the streams of glass issuing from the bushing 10. This is important as it enables substantially increasing the quantity of fibers produced from a blast of given width, and results in a reduction in cost of manufacture of fibers.

In view of the fact that the lower end of the guide is located in close proximity to the blast B, it may be desirable to cool the lower portion of the guide 15. This may be accomplished by circulating a coolant such as water through a jacket 30 formed in a part 31 which is secured to one of the plates 26' by suitable fastener elements 32.

Reference has been made above to the fact that contact of adjacent streams 12 of glass disrupts the operation of the apparatus and requires manually restarting the same. In order to minimize accidental disruption of the process, provision is made herein for applying a slight tension to the streams 12. Referring again to Figure 1 of the drawings, it will be noted that a pair of rolls 33 and 34 are supported in vertical spaced relationship between the guide 15 and the bushing 10. The bottom roll 33 is suitably rotatably supported on a bracket 35 which is removably clamped to the top guide section 16 adjacent opposite sides thereof by suitable screws 36. The roll 33 is supported on the bracket 35 in a position to engage one side of the primary filaments and guide the same into the upper end of the guide section 16. The top roller 34 is mounted on a bracket 37 in a position to engage the opposite side of the primary filaments 13 at a point substantially above the roller 33. It will also be noted that the roller 34 is offset laterally with respect to the roller 33 to cooperate with the latter in applying a slight tension to the primary filaments. This tension is

sufficient to counteract any tendency for the filaments or streams to contact as the latter pass from the bushing 10 to the guide 15.

The bracket 37 is adjustably supported on the upper end of a rod 38 having the lower end adjustably secured to a support 39 by a bracket 39'. The adjustable connection between the bottom of the rod 38 and the support 39 is such as to permit varying the offset relationship between the tension rolls and thereby adjust the tension applied by the latter on the primary filaments. This tension may also be varied by adjusting the position of the bracket 37 on the upper end of the rod 38, if desired.

The blast B is produced by a burner 40 having a combustion chamber 41 formed in a block 42 of refractory, which is enclosed in a suitable metal casing 43. The casing 43 has a part 44 at the rear end shaped to form a gas inlet chamber 45, and the latter communicates with the interior of the combustion chamber through a perforated wall 46. A combustible mixture of gases is introduced into the chamber 45 through the medium of a supply conduit 47. 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 gas. This gas is mixed with the proper amount of air by means of the orthodox air and gas mixers not shown herein. The gas and air mixture is taken from the mixer at moderate pressure of approximately 1 to 5 p. s. i., but may be considerably higher if desired.

The combustible mixture of gases introduced into the chamber 45 flows through the perforated wall 46 into the combustion chamber 41, and is ignited within the latter. As the gases burn within the chamber 41 the walls of the latter become extremely hot, and the rate of burning of the gases is exhilarated to provide a very high rate of expansion of the products of combustion within the chamber 41. The burned gases or products of combustion are discharged from the chamber 41 through an outlet opening 48 formed in the front wall of the burner and having a length substantially greater than the width thereof. The size of the outlet opening is so proportioned with respect to the volume of the combustion chamber 41 or the amount of fuel mixture burned within this chamber that the products of combustion are discharged from the outlet opening 48 at a temperature in excess of the softening temperature of the glass and at a velocity sufficiently high to draw out or attenuate the softened glass to form fibers. The effective area of the outlet opening may be so proportioned with respect to the volume of the combustion chamber 41 to enable obtaining a blast of gas having a temperature as high or higher than 3000° F. and having a velocity as high or higher than 1200 feet per second. It will, of course, be understood that the cross-sectional area of the outlet opening 48 may be varied to some extent relative to the volume of the combustion chamber, depending upon the heat required in the blast B. Outlet openings of greater area relative to the volume of the combustion chamber 41 enable burning a greater amount of fuel mixture and result in generating higher heat in the blast, but also cause a decrease in the velocity of the blast. It is generally preferred to form the outlet opening of a size no greater than necessary to obtain in the blast the heat required to raise the glass to the desired attenuating temperature.

Owing to the shape of the outlet opening 48, a blast B is obtained which has a much greater width than depth. However, the depth of the blast is sufficient to assure softening the ends of the primary filaments within the blast to the attenuating temperature before the primary filaments are projected entirely through the blast. The velocity and temperature of the blast is greater immediately adjacent the outlet opening 48. Therefore, it is desirable to locate the burner in such a position with respect to the lower end of the guide 15 that the primary filaments are fed into the blast immediately adjacent the outlet opening 48. As the ends of the primary filaments 13 are projected into the blast B, the glass is heated to the attenuating temperature by the heat of the blast, and is drawn out to form fine fibers by the force of the blast. The size of the fibers produced depends to a great extent on the velocity of the blast, size of the primary filaments, and the heat of the blast. With a blast B having the characteristics noted above, it is possible to form fibers as fine as one micron or less in diameter from filaments of substantial size. However, regardless of the size of the fibers produced, and regardless of the diameter of the primary filaments employed, the guide 15 previously described enables feeding a greater number of primary filaments into a blast of given width so that maximum production is obtained with equipment of a given size.

The embodiment of the invention shown in Figure 7 of the drawings differs from the above construction in that the cooling jacket 30 is located adjacent the top of the bottom guide section 17, and the plates 26' of the bottom guide section 17 are formed of a high heat resistant material, such for example, as platinum or chrome metal alloys. In use the lower end portion of the guide section 17 is heated by the blast B of gas issuing from the burner, and this heat is transmitted to the primary filaments 13 passing through the grooves 28 in the bottom guide section. Thus the primary filaments 13 are heated prior to being introduced into the blast B, and this has the effect of producing finer fibers on a greater production basis. With the above arrangement, the time required for the blast to soften or heat the primary filaments to the desired attenuating temperature is substantially reduced, and accordingly, the depth or thickness of the blast need not be as great. Consequently, the width of the burner outlet slot may be proportionately reduced to increase the velocity of the blast and provide a correspondingly greater force for attenuating the heat softened glass into fibers. The purpose of the cooling jacket 30 in the modified form of guide construction is to more or less limit heating of the primary filaments to the lower portion of the guide, and thereby avoid interference with proper feeding of the primary filaments through the guide by the feed rolls.

I claim:

1. Apparatus for making glass fibers comprising means for flowing a plurality of streams of glass from a supply body of molten glass with adjacent streams individually accessibly spaced laterally from each other in a row, means for attenuating the streams to form rods of glass including a pair of rolls spaced from the supply means in the general direction of flow of the streams and engageable with opposite sides of the rods, a guide having a section supported at the side of the rolls facing the supply means and having a second section supported at the opposite side of the rolls, said sections having aligned grooves for respectively receiving the glass rods and the grooves in the second section converging from the rolls to substantially reduce the lateral spacing between adjacent rods and render said rods individually inaccessible, and a tensioning means for the rods between said supply means and said guide.

2. Apparatus for making glass fibers comprising means for flowing a plurality of streams of glass from a supply body of molten glass with adjacent streams individually accessibly spaced laterally from each other in a row, means for attenuating the streams to form rods of glass including a pair of rolls spaced from the supply means in the general direction of flow of the streams and engageable with opposite sides of the rods, an upper guide member supported at the side of the rolls facing the supply means, a lower guide member supported at the opposite side of the rolls, said guide member having aligned grooves for respectively receiving the glass rods, the receiving ends of the grooves in the upper guide member being flared outwardly to facilitate threading the individual rods into the guide and the grooves in the lower member converging from the rolls to substantially reduce the lateral spacing between adjacent rods and render said rods individually inaccessible, and means between said upper guide and said supply means for applying tension to the rods.

3. Apparatus for making glass fibers comprising means for producing a relatively wide blast of gas having a temperature exceeding the softening temperature of glass and having a velocity high enough to attenuate heat softened glass to form fibers, a feeder supported above the blast and adapted to contain a supply of molten glass, said feeder having a plurality of restricted orifices spaced laterally from each other in a row extending transversely of the blast and through which the molten glass flows in the form of individually accessible streams, means for attenuating the streams to filaments, a guide supported between the feeder and the attenuating means and having a plurality of parallelly arranged grooves for respectively receiving the filaments resulting from said streams, the grooves being spaced from each other distances corresponding to the spacing between adjacent orifices in the bottom wall of the feeder, a second guide supported between the attenuating means and the blast, said second guide having grooves corresponding in number and spacing at the entrant end to the grooves in said first guide, and said grooves converging from the entrant end to the delivery end to occupy a distance approximating the width of the blast and render said filaments individually inaccessible.

4. Apparatus for making glass fibers comprising means for producing a relatively wide blast of gas having a temperature exceeding the softening temperature of glass and having a velocity high enough to attenuate softened glass to form fibers, a feeder supported above the blast of gas and adapted to contain a supply body of heat softened glass, said feeder having in the bottom wall a plurality of orifices spaced laterally from each other in a row extending across the width of the blast and occupying a distance substantially greater than the width of the blast, means for attenuating the streams of

glass issuing from the orifices to form individually accessible rods of glass, an upper guide member supported between the feeder and the attenuating means and having a plurality of grooves for respectively receiving the glass rods, said grooves spaced from each other distances which correspond to the spacing between adjacent orifices in the bottom wall of the feeder to maintain a parallel relation between said rods, and a lower guide member supported between the attenuating means and the blast and having a corresponding number of grooves, said grooves having the entrant ends spaced in alignment with the grooves in said upper guide member and having the delivery ends occupying a space approximating in length the width of the blast and render said rods individually inaccessible.

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