

July 21, 1953

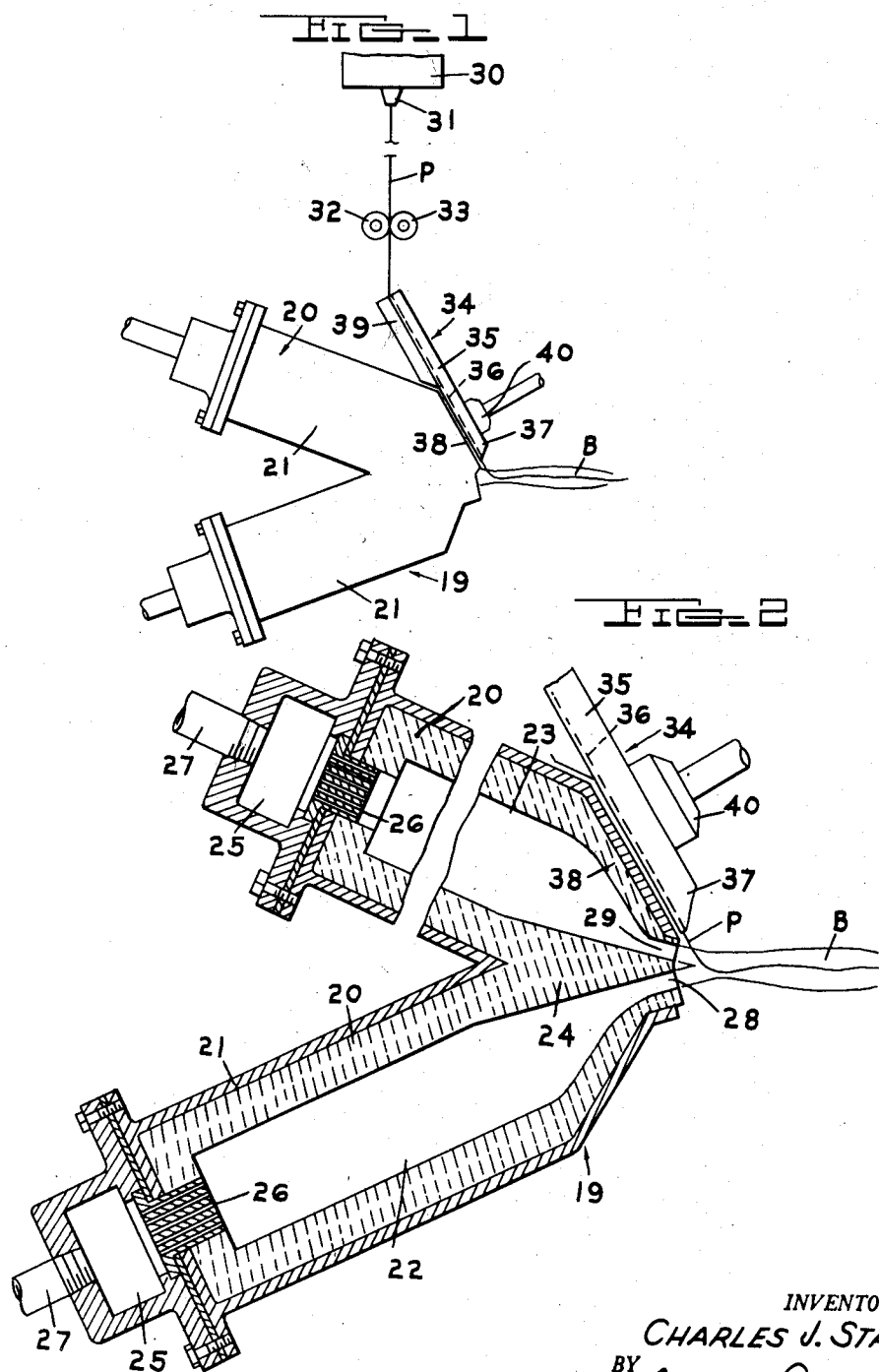
C. J. STALEGO

2,645,814

METHOD AND APPARATUS FOR PRODUCING FIBERS FROM
GLASS AND OTHER HEAT-SOFTENABLE MATERIALS

Filed Nov. 2, 1948

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

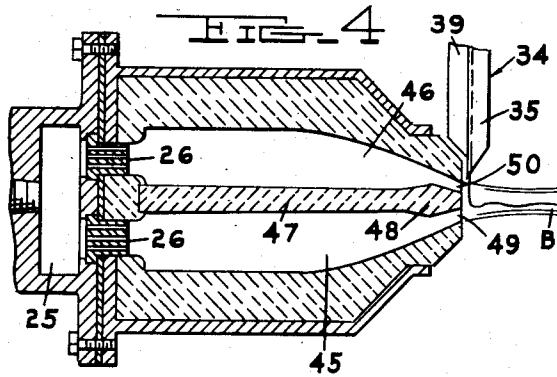
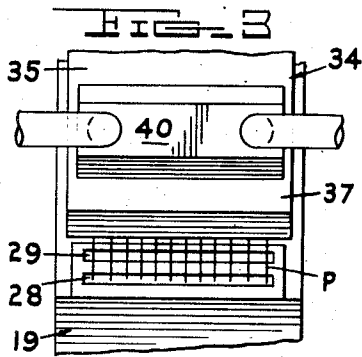


FIG. 5

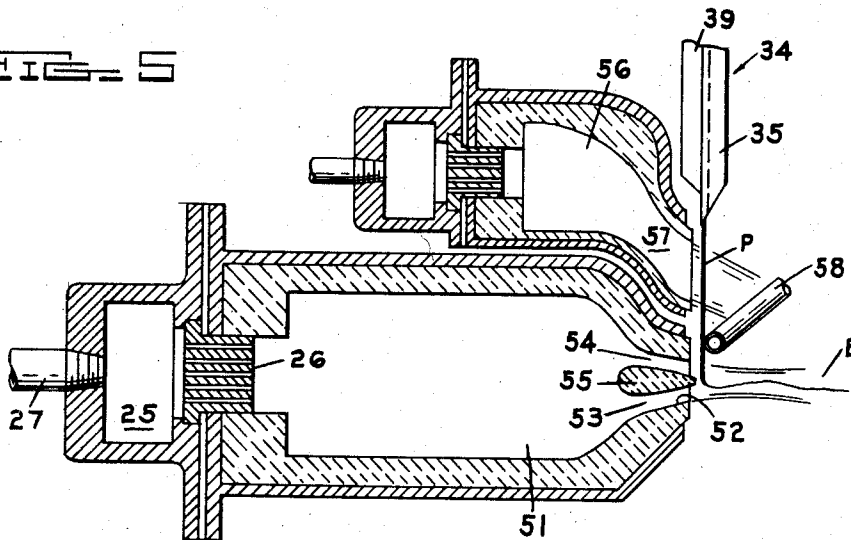
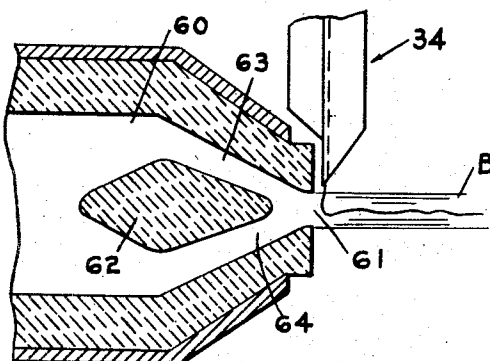


FIG. 6



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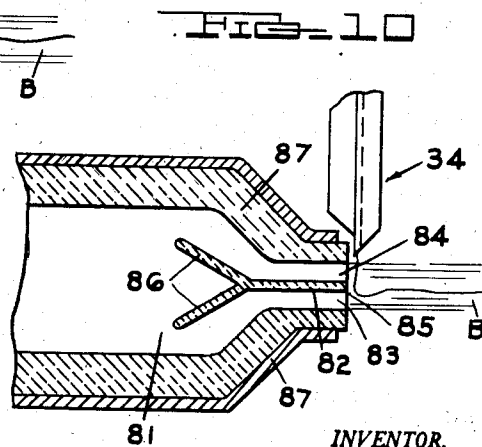
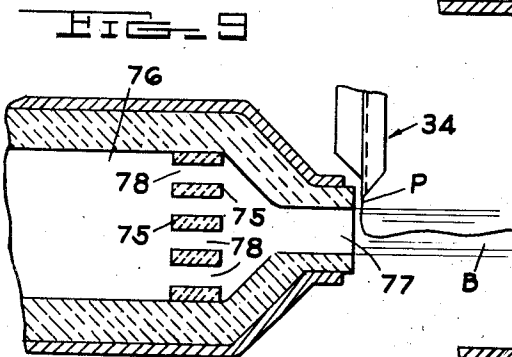
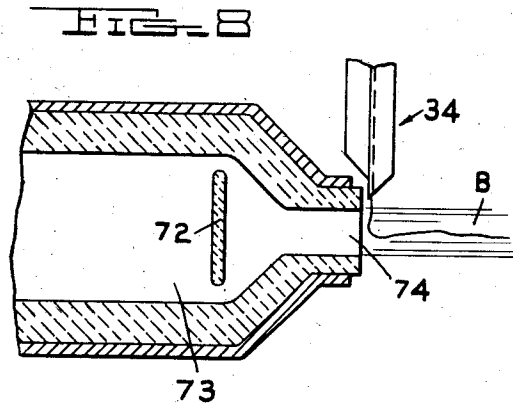
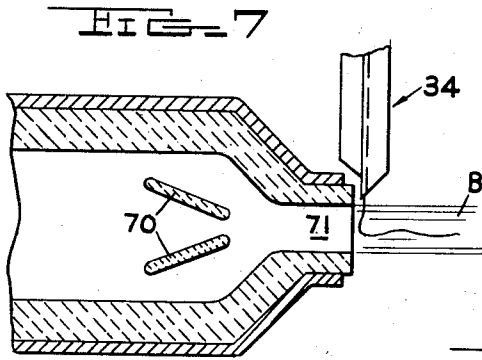
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2,645,814

METHOD AND APPARATUS FOR PRODUCING
FIBERS FROM GLASS AND OTHER HEAT-
SOFTENABLE MATERIALSCharles J. Stalego, Newark, Ohio, assignor to
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Application November 2, 1948, Serial No. 57,902

17 Claims. (Cl. 18—2.5)

1

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

Fibers varying in size from less than one micron in diameter to four or more microns in diameter have been produced from glass or materials having characteristics similar to glass by subjecting the material in one form or another to a blast of gas having a temperature throughout a substantial portion of its length exceeding the softening temperature of the material and having a velocity sufficient to attenuate the softened material into fibers of the specified size.

One satisfactory method of producing a blast having the required characteristics is to burn a combustible gaseous mixture in a chamber having an outlet opening in one wall through which the products of combustion may escape from the chamber. The opening is ordinarily elongated in a direction extending transversely of the combustion chamber, and is so proportioned with respect to the cross sectional area of the combustion chamber, that the gases passing through the opening form a ribbon-like blast having a temperature exceeding the softening temperature of the glass and having a velocity sufficiently high to attenuate the softened glass into fibers.

The glass is ordinarily in the form of rods or primary filaments and the latter are usually fed into the blast from one side thereof with the filaments arranged in side by side relationship crosswise of the blast. The characteristics of the blast, the size of the primary filaments and the rate of feed of these filaments into the blast are such that the glass at the advancing ends of the filaments is melted or softened sufficiently in the blast to enable the force of the blast to attenuate the softened glass into secondary fibers of the specified diameter.

The depth of the blast adjacent the burner outlet opening, or in other words, at the zone in which the primary filaments are introduced, depends on the width of the opening, and since the opening is elongated to accommodate a plurality of primary filaments, it follows that the outlet opening must be relatively narrow in order to provide a blast having the velocity required to attenuate the softened primary filaments into secondary fibers of the desired size. Due to this limited depth of the blast, care must be taken to control the rate of feed of primary filaments of given diameter into the blast so that the advancing ends of the primary filaments are heated while in the blast to the proper attenuating

2

temperature. Otherwise the primary filaments would be projected through the blast before reaching the required temperature, and improper fiber formation would result.

One of the objects of the present invention is to substantially increase the depth of the blast without reducing the velocity of the blast. In fact the present invention renders it possible to obtain a blast having a high depth and a greater velocity in the attenuating zone as compared with that obtainable with orthodox types of internal combustion burners.

A more detailed object of this invention is to provide a burner assembly having provision for burning a combustibly gaseous mixture and having restricted outlet openings through which the products of combustion are discharged in the form of high velocity streams of gas. In accordance with this invention, the outlet openings are directed toward one another at such an angle that the gas streams combine to form a single blast having a depth greater than the depth of the gas in either stream and having a velocity apparently in excess of the gas velocity in either stream. Owing to the fact that the depth of the blast in the attenuating zone is increased, it is possible to feed primary filaments of a given size at a greater rate into the blast, or larger primary filaments may be introduced into the blast without the danger of projecting the filaments through the opposite side of the blast before heating the filaments to the proper attenuating temperature. Thus the volume of glass capable of being fed into the blast per unit of time is increased, and as a result, the capacity of a single burner assembly to produce secondary fibers is correspondingly increased.

Another object of this invention is to provide a burner assembly having at least two independent combustion chambers and having outlet openings in each chamber directed toward one another to enable the streams of the products of combustion issuing from the openings to combine into a single blast immediately adjacent the front wall of the burner. With this construction the outlet openings may be reduced to provide gas streams of considerably higher velocity, and at the same time, provide a blast having sufficient depth to insure heating the filaments to the proper attenuating temperature.

Still another object of this invention is to provide a burner of the type set forth above, wherein the combustion chambers are provided with a common wall portion at the front end of the burner, and wherein the restricted outlet open-

3

ings are positioned at opposite sides of the wall portion. In operation this wall portion is heated to a high temperature by the combustion which takes place in the chambers, and the products of combustion are required to pass over this wall portion as they flow through the restricted outlet openings. This construction greatly assists in heating products of combustion to the proper attenuating temperature, and thereby increases the efficiency of the apparatus.

A further object of this invention is to heat the primary filaments just prior to feeding the filaments into the blast. This may be accomplished by passing the primary filaments in heat conducting relationship to one wall of the burner, or an additional burner may be positioned to direct heat on the primary filaments just prior to introducing the filaments to the blast. Such an arrangement is especially advantageous in cases where relatively large diameter primary filaments are employed, since it enables softening the filaments to some extent before introducing the same to the blast.

Still another object of this invention is to feed the primary filaments into the blast along a path inclined with respect to the direction of movement of the blast. Thus the time interval available for heating the primary filaments in the blast is increased for a given rate of feed of the filaments, and this arrangement is also highly advantageous in instances where primary filaments of substantial size are employed.

A still further object of this invention is to provide a burner assembly wherein the length of the throat at the outlet opening for the burner combustion chamber is substantially reduced to correspondingly reduce the resistance offered by the walls of the throat to the flow of gases there-through.

Under certain conditions of operation the arrangement set forth in the preceding paragraph may result in a phenomenon commonly known as fluttering, and may also permit unburned gases to escape from the chamber. In order to overcome such a condition, the present invention contemplates providing a baffle in the burner combustion chamber located within or directly opposite the burner outlet opening. The baffle is heated by combustion taking place in the chamber and is shaped to divide the products of combustion into individual streams. The gases in these streams are directed by the baffle into more intimate heat conducting relation to the extremely hot surfaces of the burner walls, and as a result, considerable heat is transmitted to the gases. This has the effect of increasing the rate of combustion to such an extent that a larger volume of fuel mixture may be completely burned in a combustion chamber of given size. Moreover, the baffle tends to produce a turbulence in the combustion chamber which also greatly assists in obtaining more efficient combustion.

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 semi-diagrammatic side elevational view of one type of apparatus that may be provided for carrying out the various steps of the process about to be described;

Figure 2 is a longitudinal sectional view through the burner assembly shown in Figure 1;

Figure 3 is a front elevational view of the apparatus shown in Figure 1;

4

Figure 4 is a longitudinal sectional view through a modified burner assembly;

Figure 5 is a longitudinal sectional view through still another embodiment of this invention;

Figure 6 is a longitudinal sectional view through a burner showing a further modification of the present invention; and

Figures 7, 8, 9 and 10 are respectively longitudinal sectional views through different types of burner assemblies.

The process for producing fibers in accordance with this invention from heat-softenable or thermoplastic materials, such for example, as glass, will be more fully understood upon considering the apparatus selected herein for carrying out the various steps of the process. Referring first to the embodiment of the invention shown in Figures 1 to 3 inclusive, of the drawings, it will be noted that the reference numeral 19 designates a combustion type burner assembly having a body 20 of refractory material enclosed in a suitable sectional metal casing 21. The body 20 comprises two converging combustion chambers 22 and 23 located in juxtaposition and having a common wall portion 24 at the front or delivery end of the burner.

The entrant or rear end of each combustion chamber communicates with an intake manifold 25 through a perforated plate 26 and a supply conduit 27 is connected to each intake manifold 25 to supply a specified gaseous fuel mixture to the respective combustion chambers. The front walls of the combustion chambers are formed with outlet openings or passages 28 and 29, respectively, located on directly opposite sides of the common wall portion 24. In fact, the outer surfaces of the common wall portion 24 at the front end of the burner form the inner walls of the outlet openings or passages.

Any suitable type of combustible gas may be used in the operation of the burner assembly, but for reasons of economy, it is preferred to use an ordinary fuel gas, such for example, as natural or manufactured fuel gas. In any case the gas is mixed with the proper amount of air by means of a conventional type of air and gas mixer not shown herein. The gas and air mixture is taken from the mixer at moderate pressures of approximately 1 to 5 p. s. i. or considerably more, if desired, and is led through the conduits 27 to the inlet manifolds 25 for the respective combustion chambers 22 and 23.

In operation the selected gaseous mixture admitted to the inlet manifolds 25 passes through the orifices in the plates 26 where it ignites and burns in the two chambers with a resulting high degree of expansion. During operation the walls of the two combustion chambers are heated by the burning gas, and the hot walls tend to increase the rate at which the gas entering the combustion chambers burns. The resulting high rate of combustion causes a great expansion of the products of combustion which escape from the respective combustion chambers into the atmosphere through the outlet openings or passages 28 and 29. Upon reference to Figure 2 of the drawings, it will be noted that the dividing wall portion 24 between the two combustion chambers is exposed to the heat generated in both chambers and thereby becomes very hot. The heating radiating from the common wall 24 assures complete combustion of any unburned gases approaching the outlet openings and otherwise increases the rate of combustion in the two chambers. Thus

more efficient combustion is accomplished in the two chambers, and this is advantageous in that it allows burning a greater volume of gas in combustion chambers of a given size.

Generally speaking, it is preferred to feed as much gaseous mixture into both combustion chambers as possible without causing the combustion to become unstable or to take place exteriorly of the burner assembly, or to cease altogether. Inasmuch as combustion is effected independently in the two chambers, it is possible to alter the operating characteristics of the burner over a wide range by either varying the size of the two chambers or by burning different types of gas in the chambers. However, for ordinary operations, it is desired to provide chambers of the same size and to burn the same type of gas in both chambers.

Referring now to Figure 3 of the drawings, it will be noted that the outlet openings or passages in the respective combustion chambers are elongated in a direction extending transversely of the chambers and the cross sectional area of these openings is so proportioned with respect to the cross sectional area of the chambers that the products of combustion are greatly accelerated as they pass through the outlet openings. It will be noted particularly from Figure 2 of the drawings that the outlet openings 28 and 29 converge so that the streams of gases issuing from the outlet openings impinge against one another to form a single blast B. Although the included angle between the two outlet openings may be varied over a wide range, particularly satisfactory results have been obtained with a burner assembly wherein the outlet openings are arranged at an included angle of between 20 and 40 degrees.

Under normal operating conditions, it is desired to angularly dispose the outlet openings, so that the two streams of gas join one another in a zone immediately adjacent the front wall of the burner assembly. The space between the flames produced by the narrow dimension of the dividing wall 24 is of such small size that there is no tendency for atmospheric air to be drawn in between the flames as would occur if the space were greater. A greater angle of impingement and spacing apart of the flame orifices creates a back pressure within the angle and thus reduces the effectiveness of the combined flames. Joining the two flames provides a blast B having a depth considerably greater than the depth of the gas in either stream and having a velocity which may well be in excess of the velocity of the gas in either stream. An increase in the production rate of extremely fine fibers over that of a single flame burner of comparable size appears to warrant the assumption that the flame velocity is increased.

It will, of course, be understood that the cross sectional area of the openings or passages may be varied to some extent relative to the cross sectional area of the combustion chamber, depending upon the required characteristics of the blast B. In this connection it will be noted that as the cross sectional area of the outlet openings is increased in relation to their respective combustion chambers, the temperature of the gaseous stream issuing from the openings is increased, and the velocity of the gas is decreased. Preferably, the cross sectional area of the outlet openings is no greater than necessary to obtain in the blast B the heat required to raise the material or glass to the proper attenuating temperature. The most efficient relationship be-

tween the cross sectional area of the outlet openings and the corresponding area of the respective combustion chambers may be readily determined by simple trial and depends largely on the characteristics of the blast required to produce the particular type of fibers specified.

For example, satisfactory results may be obtained by a burner assembly wherein each combustion chamber is of a size capable of burning approximately 140 cubic feet of gas per hour and wherein the outlet openings have a width of approximately $\frac{1}{8}$ " and a length of $2\frac{1}{8}$ ". These values are merely given by way of example, and are not to be considered as limiting the scope of this invention, since they may be changed considerably depending upon the type of fibers to be produced. The important consideration is to so proportion the outlet openings that the resulting blast has a temperature high enough to soften or melt the glass introduced to the blast sufficiently to enable the glass to be attenuated into fibers of the specified size by the available velocity of the blast. With a burner of the general type noted above, it is possible to provide an attenuating zone in the blast having a temperature exceeding 3000° F. and having velocities in excess of 1250 feet per second.

The glass or other heat softenable material selected is fed into the blast B in the form of primary filaments or solid rods P. As indicated in Figure 3 of the drawings, a plurality of primary filaments are fed into the blast B along a path extending in a direction transverse to the blast, and are arranged with adjacent filaments spaced laterally from each other crosswise of the blast. Referring again to Figure 1 of the drawings, it will be noted that the reference character 30 indicates a glass feeder or bushing which may be in the form of a long, relatively narrow, trough having a plurality of orifices 31 in the bottom wall thereof. 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 31 in the form of small streams which are attenuated to produce the primary filaments P by means of coating feed rolls 32 and 33 located below the bushing 30 a sufficient distance to assure cooling of the streams to solidification before engagement between rolls. One or more of the feed rolls may be driven by any suitable type of prime mover, such for example, as an electric motor not shown herein.

The velocity and temperature of the gaseous blast B are greatest immediately adjacent the burner outlet openings and decrease in both temperature and velocity as the distance from the outlet openings 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 close to the burner outlet openings 28 and 29 as is practical. In accordance with this invention, the primary filaments are guided into the blast by a guide 34 suitably supported between the coating feed rolls and the blast B. The guide 34 comprises a plate 35 elongated in the direction of the path of travel of the primary filaments P leaving the feed rolls and having a plurality of laterally spaced grooves 36 corresponding in number to the number of primary filaments. The lateral spacing of the grooves 36 is such that these grooves respectively receive the primary filaments as the latter leave the feed rolls, and the grooves extend for the full length of the plate 33. The lower end portion 37 of the guide plate 35 extends downwardly in jux-

taposition to the front wall 38 of the burner and terminates as closely as possible to the adjacent side of the blast B issuing from the burner.

The guide 34 is provided with a cover 39 which is secured to the rear face of the plate 35 over the grooves 36 to enclose the primary filaments P. The lower end of the cover 39 terminates short of the portion 37 of the guide plate 35 to expose the primary filaments to heat radiating from the front wall 38 of the burner. Due to the fact that the guide plate 35 extends in such close proximity to the gaseous blast B, this plate is subjected to very high temperatures and may be cooled by providing a jacket 40 at the front side of the plate 35. A cooling medium from any suitable source may be circulated through the jacket 40 in accordance with orthodox practice.

Referring again to Figure 2 of the drawings, it will be noted that the front wall of the burner assembly tapers or is inclined rearwardly, and the guide 34 is correspondingly inclined. Thus the primary filaments are fed into the blast B along a path extending diagonally across the blast. The arrangement is such that the effective depth of the blast available for melting or softening the advancing ends of the primary filaments is increased by an amount depending on the angular relationship between the path of travel of the filaments and the direction of movement of the blast. When considering that the depth of the blast is also substantially increased by virtue of the two individual streams issuing from the burner, it follows that ample time is available for softening or melting primary filaments of substantial diameter before the filaments are projected through the bottom side of the blast. Thus primary filaments having greater diameter and/or moving at a faster rate may be softened in the blast to the attenuating temperature, and the capacity of the burner to form secondary fibers is greatly increased. In instances where primary filaments of smaller diameter are employed to produce fine secondary fibers, the guide 34 may be supported in a substantially vertical position with respect to the direction of movement of the blast.

Another very important advantage obtainable by joining the two streams of gas to form the single blast B is that there is a tendency to attenuate or draw out the molten or softened glass at the advancing ends of the filaments P in the region between the two layers of gas in the blast B. The turbulence in this central region of the blast is somewhat less, and as a consequence, breakage of the fibers into short lengths during attenuation is reduced. Moreover, with such an arrangement, there is less opportunity for the turbulent forces to assume such proportions that the fibers are deflected laterally into the atmosphere beyond opposite sides of the blast where they would solidify and form "slugs."

The burner assembly shown in Figure 4 of the drawings differs principally from the burner assembly previously described in that the two chambers 45 and 46 are arranged in substantially parallel relationship, and are separated throughout their length by a wall 47 common to both chambers. Thus the common wall 47 is subjected throughout its length to the heat generated in both combustion chambers, and thereby reaches a very high temperature, which greatly assists in obtaining complete combustion of the gaseous mixture admitted to the chambers. The front end of the wall 47 is formed with an enlargement 48 which cooperates with adjacent

walls of the chambers at the front end of the burner to form outlet openings or passages 49 and 50. The products of combustion in the chambers escape through the outlet openings in the form of streams and the openings are inclined to enable the streams to join one another at the front side of the burner to form a single blast of gas. The operation and the advantages obtained by the burner assembly shown in Figure 4 are similar to those previously described in connection with the first embodiment of this invention.

In Figure 5 of the drawings, a burner assembly is shown having a single combustion chamber 51 and having a relatively wide discharge opening 52 in the front wall thereof. The discharge opening 52 is divided into two passages 53 and 54 by a partition 55. The partition 55 is formed of a refractory material and extends lengthwise of the outlet opening 52.

The opposite surfaces of the partition 55 and the sides of the opening 52 adjacent these surfaces are shaped so that the streams of gas flowing through the passages are directed toward one another and join immediately adjacent the front wall of the burner to form a single blast. The partition 55 is heated by the combustion taking place in the chamber, and this heat is transferred to the streams of gases flowing through the passages 53 and 54. As in the first described form of the invention, the passages 53 and 54 are restricted to impart a high velocity to the gases flowing therethrough and these gases combine to form a single blast having a velocity apparently in excess of the velocity of the gases in either stream.

If desired, provision may be made in the burner shown in Figure 5 to heat the primary filaments P just prior to introducing the filaments to the blast. For accomplishing this result, a second combustion chamber 56 is provided similar in principle of operation to the combustion chamber 55 in that a combustible gaseous mixture may be burned therein. However, the outlet opening 57 in the front wall of the combustion chamber 56 is of sufficient cross sectional area to enable the escape of products of combustion from the chamber 56 at a relatively slow rate of speed. This outlet opening 57 is positioned immediately in rear of the path of travel of the primary filaments and the products of combustion escaping therefrom serves to heat the primary filaments as the latter are advanced along their path of travel into the attenuating blast. By preheating the primary filaments, it is possible to employ filaments having a great diameter and/or feed the filaments into the blast at a great rate of speed. This is particularly advantageous in the production of coarser secondary fibers which may be five or more microns in diameter.

In the use of the preheater feature previously described, care must be taken to avoid heating the primary filaments to such an extent that difficulty would be encountered in projecting the softened advancing ends of the filaments into the high velocity blast. In order to overcome this objection, provision may be made to support the primary filaments just prior to introducing the latter to the attenuating blast. In Figure 5 of the drawings, the supporting means is diagrammatically shown in the form of a tube 58 suitably supported in advance of the front wall of the burner in a position to engage the front sides of the primary filaments immediately above the blast. A suitable cooling medium such as

water may be circulated through the tube to protect the tube against overheating and also prevent the soft fibers from sticking thereto.

Referring now to the embodiment of the invention shown in Figure 6 of the drawings, it will be noted that a burner assembly is shown having a single combustion chamber 60 in which a combustible gaseous mixture is burned in the same manner described at some length above. The front wall of the burner is formed with an outlet opening 61 which is restricted to greatly accelerate the flow of the products of combustion from the burner into the atmosphere. In order to reduce the resistance to the flow of gases through the outlet opening 61 and thus obtain the maximum velocity from the volume of gas being burned, the length of the throat of the outlet opening is reduced to a minimum. With such a construction, however, care must be taken to minimize the escape of unburned gases from the chamber and to prevent fluttering of the blast issuing from the outlet opening.

To accomplish this result the present invention contemplates providing a baffle 62 in the combustion chamber 60 directly opposite the outlet opening. The baffle 62 is formed of a refractory material and extends transversely of the combustion chamber for the full length of the outlet opening 61. As shown in Figure 6 of the drawings, the baffle is so shaped in cross section that the opposite surfaces at the front end thereof respectively cooperate with the adjacent walls of the combustion chamber to form passages 63 and 64. The passages converge toward the entrant side of the outlet opening 61 and enable joining of the streams of gases flowing through the passages at the zone of the outlet opening 61.

It follows from the above that the products of combustion are divided into two streams by the baffle 62 and the two streams are directed toward each other as they flow through the passages 63 and 64 to combine into a single blast at the outlet opening 61. The flow of the gases through the passages 63 and 64 not only stabilizes the action of the blast issuing from the outlet opening 61, but also enables considerable heat to be transferred to the gases as they pass through the passages 63 and 64. This heat transfer to the gases together with the turbulence caused by the location of the baffle in the chamber increases the rate of combustion and allows a greater volume of gas to be burned in a chamber of a given size.

Upon reference to Figures 7 to 10 inclusive, it will be noted that baffles may also be advantageously employed in combustion chambers wherein the throat at the outlet opening is of considerable length in comparison to the illustration shown in Figure 6 of the drawings. Referring in detail to Figure 7, it will be noted that a pair of plates 70 are suitably secured in the combustion chamber directly in rear of the restricted outlet opening or passage 71. The plates may be formed of a high temperature resisting refractory material, or may be formed of a metal, such for example as platinum, inconel or nickel depending upon the temperature of the gases. The plates converge toward the outlet opening 71 and coact with one another to create a turbulence within the combustion chamber. Thus the tendency for unburned gases to escape from the combustion chamber through the outlet opening 71 with the products of combustion is reduced to a minimum, and the gases passing around the plates are heated by heat radiating from the surfaces of the plates.

Another adaptation of the above construction

is shown in Figure 8 of the drawings wherein a plate 72 is supported in the combustion chamber 73 directly opposite the outlet opening or passage 74. The plate 72 extends transversely of the combustion chamber for substantially the full length of the outlet opening 74 and is of a width somewhat less than the width of the chamber to enable gases to flow around the same to the outlet opening 74. The plate 72 may be formed of a refractory material or from any one of the materials noted above capable of withstanding the high temperatures developed in the combustion chamber.

In Figure 9 of the drawings, a baffle plate 75 is secured in the combustion chamber 76 rearwardly of the outlet opening 77. The baffle plate 75 has a width approximating the width of the chamber and extends throughout the length of the outlet opening 77. In order to provide for the passage of gases through the plate 75, the latter is formed with a plurality of openings 78 therethrough, and these openings are of sufficient size to enable relatively free flow of the gases through the plate. However, sufficient obstruction to the flow of gases is provided by the plate to create a turbulence in the chamber sufficient to assure complete combustion of the gaseous mixture in the chamber. Moreover, the plate is, of course, heated to a high temperature by the combustion which takes place in the chamber and transfers this heat to the gases flowing through the same, so that the rate of combustion in the chamber is greatly increased.

The embodiment of the invention shown in Figure 10 illustrates a baffle 80 which is substantially Y-shaped in cross section. This baffle is secured in the combustion chamber 81 with the stem portion 82 projecting into the outlet opening or passage 83 in a manner to divide the outlet opening into two passages 84 and 85. The width of the outlet opening 83 may be increased slightly to compensate for the thickness of the stem portion 82 of the baffle. The flange portions 86 of the baffle project rearwardly into the chamber and respectively cooperate with the rearwardly inclined walls 87 of the chamber to form extensions of the passages 84 and 85. Thus from the foregoing, it will be noted that the products of combustion are required to flow through the passages 84 and 85 in heat conducting relationship to the baffle 80. As the streams of gases leave the delivery ends of the passages 84 and 85, they combine to form a single blast having many of the characteristics of the blast B described at some length above.

It follows from the foregoing that regardless of the specific type of baffle selected, the latter function to not only create a turbulence in the combustion chamber to effect complete combustion of the gaseous mixture, but to also supply heat to the gases and thereby increase the rate of combustion in the chamber.

I claim:

1. The process of producing fibers from a heat-softenable material, comprising burning a combustible gaseous mixture in a burner assembly and discharging the products of combustion from the burner assembly in the form of separate streams of gas, directing the streams toward each other at such an included angle that the streams intersect each other and conflow into a single stream substantially immediately following their discharge from the burner assembly, joining the gas streams as they discharge to form a single blast of gas moving at a high

velocity, and feeding heat-softenable material into the blast and transversely of the direction of movement thereof to attenuate the heat-softenable material into fibers.

2. The process of producing glass fibers, comprising burning a combustible gaseous mixture in a burner assembly and discharging the products of combustion from the burner assembly in the form of individual streams of gas traveling at a high velocity, directing the streams toward one another at such an included angle that the streams intersect each other substantially immediately following their discharge from the burner assembly to produce a single blast of gas traveling at a high velocity, and feeding a body of glass into the blasts from one side thereof at a point adjacent the zone of intersection of the streams.

3. The process of producing fibers from heat softenable material, comprising burning a combustible gaseous mixture in a burner assembly and discharging the products of combustion from the burner assembly in the form of a plurality of streams of gas that are all of substantially equal velocity and volume, directing the blasts toward each other at such included angles as to cause the blasts to intersect each other and form a single blast of gas, and feeding heat softenable material into the blasts from one side thereof along a path extending transversely to the direction of movement of the blasts.

4. The method of producing fibers from a heat softenable fiberizable material, comprising burning a combustible fuel mixture and directing the products of combustion into the atmosphere as a plurality of high temperature blasts moving at high velocity, flowing said blasts along paths that intersect each other and joining said blasts into a single blast of gas having a temperature exceeding the attenuating temperature of the material and traveling at a rate of speed that will draw out the material heated by the blast to fibers, and feeding heat softenable material into the blasts along a path extending transversely to the direction of movement of the blasts.

5. The method of producing fibers from a heat softenable material, comprising burning a combustible fuel mixture in a chamber and discharging the products of combustion from the chamber through an outlet opening restricted to provide a high velocity blast, dividing the gases approaching the outlet opening into two streams by interrupting the direct flow of the gases from within the chamber through the outlet opening with a baffle shaped to enable the gas in the two streams to join at the exit side of the outlet opening, and introducing heat softenable material into the blast as it issues from the outlet opening.

6. The method of producing fibers from a heat softenable material, comprising burning a combustible gaseous mixture in separate chambers and discharging the products of combustion through a restricted port in each chamber in the form of a high velocity stream of gas, joining the gas streams to produce a blast having a depth exceeding the depth of gas in either stream, feeding heat softenable material into the blast along a path extending crosswise of the blast, and applying heat to the material just prior to introducing the material to the blast.

7. Apparatus for producing glass fibers, comprising at least two chambers within each of which a combustible fuel and air mixture is burned, restricted outlet openings in correspond-

ing walls of the chambers through which the products of combustion are discharged in separate streams, said outlet openings being directed toward one another at such an angle that the paths of the streams of gas intersect each other adjacent the delivery sides of the openings to provide a combined blast of gas and means for feeding glass into the blast along a path extending crosswise of the blast.

8. Apparatus for producing glass fibers, comprising a burner having at least two chambers in each of which a combustible gaseous mixture is burned and having a wall portion at the front end thereof common to said chambers, restricted outlet openings in the front wall of the burner at opposite sides of the common wall portion through which the products of combustion in the chambers are discharged in the form of separate gas streams, said outlet openings being directed toward each other at such an angle that the paths of the streams of gas intersect each other adjacent the front wall of the burner to produce a blast of hot gas moving at a great velocity, and means for feeding glass into the blast at the juncture of the streams and along a path extending crosswise of the blast.

9. Apparatus for producing glass fibers, comprising at least two adjacent chambers within each of which a combustible mixture of fuel and air is burned and having restricted outlet openings in corresponding walls of the chambers through which the products of combustion are discharged in the form of separate streams of gas, said outlet openings being elongated in a direction extending transverse to the chambers to impart a ribbon-like cross sectional area to the streams and being inclined toward one another at such an angle that the paths of the streams intersect each other adjacent the outlet openings to produce a blast, and means for feeding glass into the blast along a path of travel extending crosswise of the direction of movement of the blast.

10. Apparatus for producing glass fibers, comprising a chamber in which a combustible gaseous mixture is burned and having an opening in the front wall through which the products of combustion are discharged from the chamber in the form of a hot high velocity blast, means in the chamber opposite the outlet opening for directing the products of combustion laterally outwardly toward the adjacent chamber walls prior to movement of the products of combustion through said outlet opening, and means for feeding glass into the blast issuing from the outlet opening.

11. Apparatus for producing glass fibers, comprising a chamber in which a combustible gaseous mixture is burned and having an opening in the front wall through which the products of combustion are discharged from the chamber in the form of a hot high velocity blast, a baffle supported in the chamber opposite the entrant end of the outlet opening in a position to be heated by the heat resulting from combustion of the gaseous mixture in the chamber and cooperating with adjacent walls of the chamber to provide converging ports through which the products of combustion pass to the outlet opening, and means for feeding glass to the blast issuing from the outlet opening.

12. The process of producing fibers from a heat softenable material, comprising burning a combustible gaseous mixture in a burner assembly and discharging the products of combustion from the burner assembly in the form of separate

13

streams of gas traveling at a high velocity, the streams being of substantially greater width than thickness to have the form of a ribbon, directing the streams toward each other in the direction of their thickness and at such an included angle that the streams intersect each other and con-
 flow into a single stream substantially immediately following their discharge from the burner assembly, joining the gas streams to form a single blast of gas, and feeding a plurality of bodies of heat softenable material into the blasts trans-
 versely of the direction of movement thereof.

13. The process of producing fibers from a heat softenable material, comprising burning a combustible gaseous mixture in a burner assembly and discharging the products of combustion from the burner assembly in the form of separate streams of gas traveling at a high velocity, the streams being of substantially greater width than thickness to have the form of a ribbon, directing the streams toward each other in the direction of their thickness and at such an included angle that the streams intersect each other and con-
 flow into a single stream substantially immediately following their discharge from the burner assembly, joining the gas streams to form a single blast of gas, and feeding a plurality of bodies of heat softenable material into the blasts trans-
 versely of the direction of movement thereof with the bodies arranged in a row extending in the direction of width of the blasts.

14. The process of producing glass fibers, comprising burning a combustible gaseous mixture in a burner assembly and discharging the products of combustion from the burner assembly in the form of separate streams of gas traveling at a high velocity, the streams being of substantially greater width than thickness to have the form of a ribbon, directing the streams toward each other in the direction of their thickness and at such an included angle that the streams intersect each other and conflow into a single stream substantially immediately following their discharge from the burner assembly, joining the gas streams to form a single blast of gas, and feeding a plurality of glass rods into the blasts trans-
 versely of the direction of movement thereof with the rods arranged in a row extending in the di-
 rection of width of the blasts.

15. The process of producing fibers from a heat softenable material, comprising burning a combustible fuel mixture in a plurality of com-
 bustion chambers and discharging the products

14

of combustion from the chambers in the form of separate streams of gas traveling at a high velocity, directing the streams toward each other at such an included angle that the streams intersect each other and conflow into a single stream substantially immediately following their discharge from the burner assembly, joining the gas streams to form a single blast of gas, and feeding heat softenable material into the blasts transversely of the direction of movement thereof.

16. The process of producing glass fibers, comprising burning a combustible fuel mixture in a plurality of combustion chambers and discharging the products of combustion from the burner assembly in the form of separate streams of gas traveling at a high velocity, the volumes of fuel mixture and rate of burning being substantially equal in the different chambers so that the dis-
 charged streams are of substantially equal tem-
 perature and velocity, directing the streams toward each other at such an included angle that the streams intersect each other, joining the gas streams to form a single blast of gas, and feeding a glass rod into the blasts transversely of the direction of movement thereof.

17. The process of producing glass fibers, comprising burning a combustible fuel mixture in a plurality of combustion chambers and discharging the products of combustion from the burner assembly in the form of separate streams of gas traveling at a high velocity, the volumes of fuel mixture and rate of burning being substantially equal in the different chambers so that the dis-
 charged streams are of substantially equal tem-
 perature and velocity, directing the streams toward each other at such an included angle that the streams intersect each other, joining the gas streams to form a single blast of gas, feeding a glass rod into the blasts transversely of the direction of movement thereof, and passing said rod through a flame on its way to and as it approaches said blasts.

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