

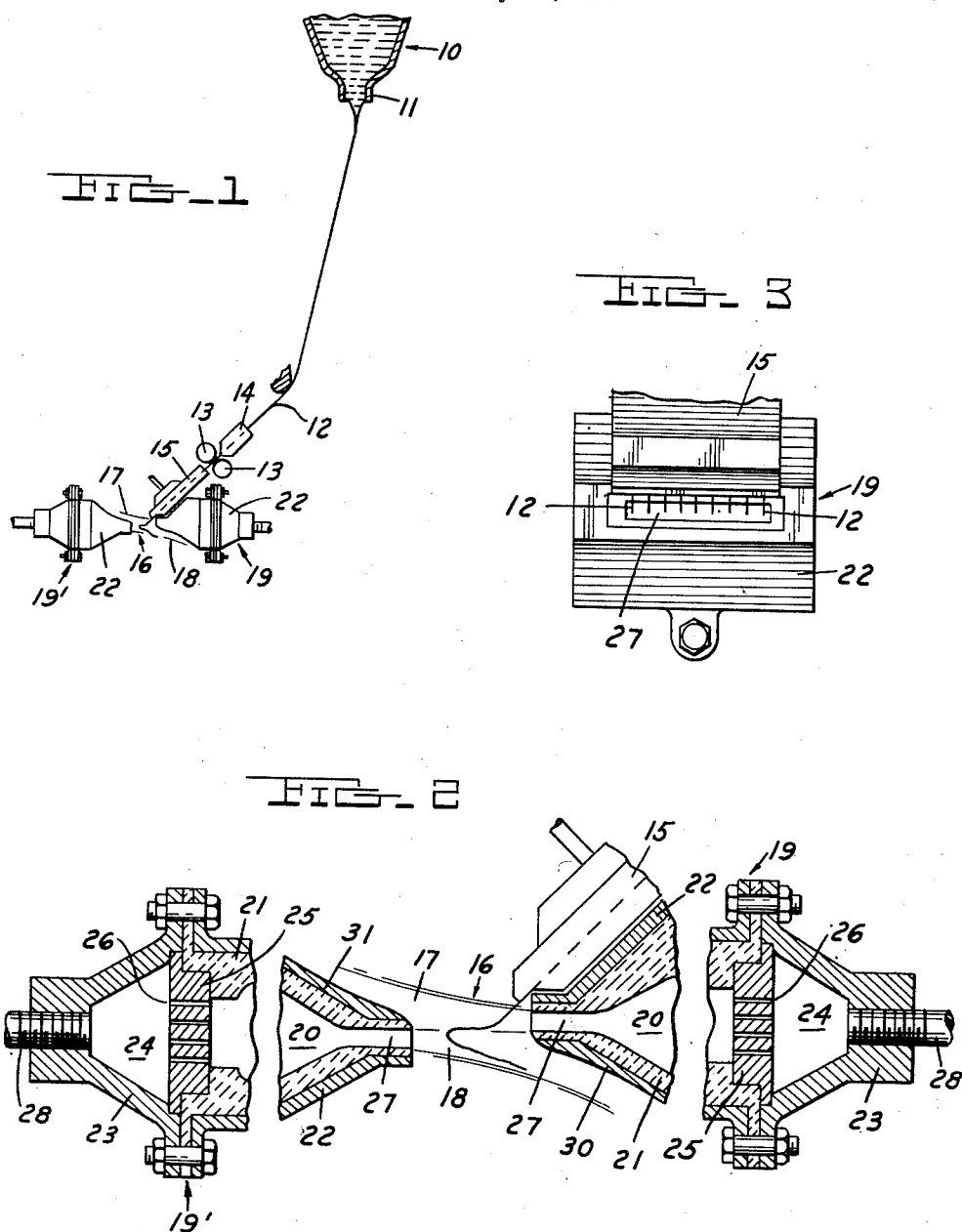
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METHOD AND APPARATUS FOR PRODUCING FIBERS

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METHOD AND APPARATUS FOR PRODUCING FIBERS

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This invention relates generally to an improved method and apparatus for producing fibers from glass or materials of the type which become soft in the presence of heat, and are capable of being drawn-out when softened to form fibers.

More particularly the present invention refers to the process for producing fibers wherein the material or glass is attenuated to form fibers by the heat and force of an extremely hot, high velocity blast of gas. In accordance with one highly satisfactory execution of the above process, a rod or primary filament of the material or glass is fed endwise into one side of a blast of gas along a path extending in a direction transverse to the direction of flow of the blast. The gas forming the blast has a temperature high enough to melt the advancing end of the rod as it is projected into one side of the blast, and has a velocity sufficient to attenuate the heat softened glass or material to form fibers.

Particularly satisfactory results are also obtained by forming the blast of products of combustion obtained by substantially completely burning a combustible mixture of gases within a chamber and discharging the burned gases from the chamber through an outlet opening so restricted with respect to the quantity of gas burned within the chamber that the burned gases are discharged from the chamber in the form of a blast having the required heat and velocity characteristics to form fibers. The outlet opening, although restricted in area, is nevertheless of sufficient width to enable simultaneously feeding a multiplicity of rods in side by side relationship into the blast. Therefore the blast is of necessity, relatively thin, and the time available for melting or softening the ends of the rods being fed into the blast is correspondingly short. In practice the diameter and the rate of feed of the rods must be controlled in relation to the thickness of the blast, so that the ends of the rods are softened or melted within the blast before being projected entirely through the blast. Thus in instances of the above type where the rod is fed endwise into one side of a thin blast, the rate of feed of a rod of given diameter must necessarily be relatively slow, and this is objectionable because it curtails the quantity of glass fibers that may be produced with a single apparatus.

It is an object of this invention to substantially increase the rate of manufacture of fine fibers from a single production unit by providing an arrangement enabling the rate of feed and/or the size of the rods fed into the blast to be substantially increased. In accordance with this inven-

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tion, the rod or rods of glass or some similar material are fed endwise into blasts moving in opposite directions in side by side relationship. The arrangement is such that the depth of the gas at the zone of penetration of the rods is at least twice the depth of a single blast, and as a result, the time available for softening the advancing ends of the rods is substantially increased enabling the size and/or rate of feed of the rods to be increased without the danger of projecting the rods entirely through the blast. In use the first blast into which the rods are projected acts to preheat or soften the advancing ends of the rods, and the next adjacent blast actually attenuates the softened glass to form fibers. Inasmuch as the blasts are moving in opposite directions, the ends of the rods moving from one blast to the adjacent blast are subjected to opposing forces, which assist in attenuating the rods to form fibers.

It is another object of this invention to support a pair of high velocity combustion burners with the restricted outlet openings facing one another in relatively close relationship, and with the opening in one burner chamber offset laterally with respect to the opening in the other burner chamber so as to locate the blasts issuing from the openings in side by side relationship.

It is a still further object of this invention to provide a burner arrangement of the type set forth in the preceding paragraph, wherein the combustion chambers are formed with walls shaped to guide the oppositely moving blasts over the respective burners.

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

Figure 1 is a diagrammatic elevational view of the apparatus;

Figure 2 is an enlarged sectional view through a part of the apparatus; and

Figure 3 is an end elevational view of a part of the apparatus.

It will be apparent as this description proceeds that the present invention may be successfully employed in the manufacture of fibers from various types of inorganic or synthetic materials which becomes soft in the presence of heat, and may be drawn out when in a softened state to form fibers. However, the invention has been developed for the particular purpose of manufacturing glass fibers, and accordingly, is described below in connection with the use of glass as the fiber forming material.

In accordance with this invention fibers

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ranging from one micron or less to two or more microns in diameter may be commercially produced in one continuous operation from a supply body of molten glass. As shown in Figure 1 of the drawings the numeral 10 designates a feeder in the form of a bushing adapted to contain molten glass and having a plurality of orifices 11 in the bottom wall through which molten glass flows in the form of individual streams. The streams are attenuated to form rods or filaments 12 by a pair of rolls 13 respectively supported at opposite sides of the filaments for rotation in opposite directions and having the peripheral portions frictionally engageable with the filaments. Any suitable means not shown herein may be provided for rotating the rolls at the speed required to draw out the streams of glass to form the filaments to the desired diameter.

The filaments 12 are directed between the rolls 13 by a guide 14 having a plurality of vertically extending passages spaced laterally from each other in a row and corresponding in number to the number of the filaments 12. The guide 14 is supported above the rolls 13 in a position to respectively receive the filaments 12 and guide the same between the rolls 13. A second elongated guide 15 is suitably supported directly below the rolls 13 and is formed with a series of passages for respectively receiving the filaments 12 leaving the delivery side of the rolls 13. Thus the rolls 13 serve the further purpose of feeding the filaments 12 downwardly through the guide 15.

The filaments leaving the lower end of the guide 15 are projected into a composite blast 16 of gas having a temperature which exceeds the softening point of the glass and having a velocity sufficient to attenuate softened glass to form fibers having the specified degree of fineness. The width of the blast at the zone of penetration of the filaments is slightly greater than the length of the row of filaments leaving the guide 15, and the latter is so positioned with respect to the blast that the filaments 12 are simultaneously fed into the top side of the blast along a path extending transversely to the blast.

The blast 16 comprises at least two separate blasts of gas 17 and 18. In the present instance the blasts are composed substantially entirely of burned gases supplied by two burners 19 and 19'. As shown in Figure 2 of the drawing, each burner comprises a combustion chamber 20 having high-temperature resistant walls 21 and having a metal casing 22 supporting the walls. The metal casing 22 has a part 23 at the inner end of the combustion chamber which is fashioned to provide a fuel mixture inlet chamber 24. The chamber 24 is separated from the combustion chamber 20 by a wall 25 having a multiplicity of passages 26 through which a combustible mixture of gases flows into the combustion chamber 20 from the inlet chamber 24. The outer end of the combustion chamber in each burner is formed with a restricted outlet opening 27 through which the products of combustion taking place within the chamber 20 escape into the atmosphere in the form of an intensely hot, high velocity blast.

Generally speaking it is preferred to feed as much fuel mixture into the combustion chambers 20 as possible without causing the combustion to become unstable or to take place outside of the burners, to to cease altogether. Any suitable type of combustible gas may be used in the operation of the burners, but for reasons of econo-

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my, 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 conventional air and gas mixers not shown herein. It is preferred to supply the gas and air mixture at moderate pressures of approximately 1 to 5 p. s. i., although higher pressures may be used if desired. The combustible mixture of gases is conducted from the mixer or mixers to the respective inlet chambers 24 by conduits 28.

In operation the selected combustible mixture of gases admitted to the inlet chambers 24 passes through the orifices 26 in the plate 25 where it ignites and burns in the combustion chambers with a very high rate of expansion. In this connection it will be noted that during operation of the burners the walls of the two combustion chambers are intensely heated by the burning gases, and these hot walls tend to increase the rate at which the combustible mixture of gases entering the chambers 20 burns. The resulting high rate of combustion causes a great expansion of the products of combustion, and the latter escape from the respective combustion chambers into the atmosphere through the outlet openings 27.

As stated above the outlet opening 27 in each combustion chamber is elongated in a direction extending transversely of the chamber, and the cross-sectional area of this opening is so proportioned with respect to the volume of the chamber that the burned gases are greatly accelerated as they pass through the opening. The cross-sectional area of the opening 27 in each chamber may be varied to some extent relative to the volume of the combustion chamber, depending upon the required characteristics of the blast.

In this connection it will be noted that as the cross-sectional area of the outlet openings in the chambers is increased in relation to the volume of the respective combustion chambers, the temperature of the blast issuing from the outlet openings is increased, and the velocity of this blast is decreased. Preferably the cross-sectional area of the outlet opening 27 in each chamber 20 is no greater than necessary to obtain in the blast the heat required to raise or maintain the glass to the proper attenuating temperature.

In practice the most efficient relationship between the cross-sectional area of the outlet openings 27 and the volume of the respective combustion chambers may be readily determined by simple trial and depend largely on the characteristics of the blast required to produce the particular type of fibers specified. The important consideration is to so proportion the outlet openings 27 in connection with the quantity of combustible fuel mixture burned in the chambers 20 that the resulting blast has a temperature high enough to soften or melt the glass sufficiently to enable attenuating the glass to form fibers of the desired size.

With burners of the general type illustrated herein, it is entirely possible to provide an attenuating zone in the blast, having a temperature exceeding 3000° F. and having velocities in excess of 1,250 feet per second.

The two burners 19 and 19' are suitably supported in fixed relationship with the outlet openings 27 facing one another, so that the blasts respectively issuing from the outlet openings actually travel in opposite directions. As shown in Figure 2 of the drawing the burner 19 is supported at an elevation somewhat higher than the

burner 19', so that the blast 17 issuing from the burner 19 passes over the top of the blast 18 issuing from the burner 19'. The two blasts are in such close proximity that they cooperate with one another to form the composite blast 16 previously referred to.

Attention is called to the fact that the bottom wall of the burner 19 has a portion 30 at the outer end of the combustion chamber which is arcuate in shape to direct the blast 18 issuing from the burner 19' over the bottom wall of the burner 19. It will also be noted that the top wall of the burner 19' has a portion 31 at the outer end corresponding in shape to the portion 30 in order to guide the blast 17 over the top wall of the burner 19'. Thus the products of combustion sweep over the portions of the respective burners and assist in maintaining the walls of the combustion chambers at a very high temperature. This is desirable in that it greatly facilitates the rate of burning of the combustible mixture of gases within the burner combustion chambers.

The velocity and temperature of the blasts issuing from the respective burners is greatest immediately adjacent the burner outlet openings, and decreases in both temperature and velocity as the distance from the outlet openings increases. In the present instance the two burners are supported with the outlet openings in relatively close proximity, and the rods or glass filaments 12 are introduced into the zone or space between the burners. Thus full advantage is taken of the maximum available temperature and velocity of the blasts issuing from the respective burners.

It has been stated above that the glass rods 12 are directed into the composite blast 16 between the burners by the guide 15. As shown particularly in Figure 2 of the drawing, the guide 15 is supported above the composite blast 16 adjacent the outer wall of the burner 19, and is inclined with respect to the vertical, so that the rods 12 are advanced diagonally into the top blast 17 toward the opposed burner 19'. As the advancing ends of the rods 12 pass into the blast 17, the glass is heated to its softening temperature by the heat of the burned gases making up the blast 17. As shown in Figure 2 of the drawing, the heat softened ends of the rods 12 are actually drawn-out to some extent in a direction toward the burner 19' by the force of the blast 17, and subsequently directed into the blast 18, which is moving at a very high velocity in a direction opposite the blast 17.

As the heat softened ends of the rods are projected into the blast 18, the glass reverses its direction of movement and is attenuated by the force of the blast 18. The fibers resulting from this attenuation are carried by the blast 18 in a general downward direction, and may be collected on a suitable conveyor not shown herein. It has been stated above that as the heat softened ends of the rods 12 pass from the top blast 17 into the bottom blast 18, the direction of movement of the glass is reversed. This is highly advantageous in that the resulting force applied to the rods assists materially in attenuating the glass to form fine fibers.

It follows from the foregoing that the above construction enables substantially increasing the depth of the blast while maintaining the restricted dimension of the outlet openings 27 required to obtain blasts having the required temperature and velocity. Increasing the depth of

the blast in the attenuating zone proportionately increases the time available for softening or melting and attenuating the rods or filaments 12 to form fibers. As a result of this increased time period, the size and/or rate of feed of the rods or filaments 12 into the composite blast 16 may be substantially increased. This is highly advantageous in that it enables correspondingly increasing the quantity of fine fibers produced from a single unit or apparatus.

It will also be noted from the above that since the primary function of the top blast 17 is to pre-heat or soften the advancing ends of the rods 12, this blast may have different characteristics than the blast 18. In other words the size of the opening 27 in the burner 19 may be somewhat greater than the size of the corresponding opening in the burner 19' in order to provide the blast 17 having a greater temperature and less velocity than the blast 18. Also the particular type of combustible mixture burned in the chambers may be varied, if desired.

I claim:

1. In a process of producing fibers from a material which becomes soft in the presence of heat and is capable of being drawn out to form fibers when in a softened state including the steps of establishing two streams of gas each having a temperature exceeding the softening point of the material, directing the gas streams to form a blast in which gases of the blast move in different directions, feeding material to be formed into fibers into the blast, and attenuating the material to form fibers by the heat and force of the blast.

2. In a process of producing fibers from a material which becomes soft in the presence of heat and is capable of being drawn out to form fibers when in a softened state, the steps which comprise flowing in one direction a first blast of gas having a temperature exceeding the softening point of the material, flowing a second blast of gas along one side of the first blast in a direction opposite the first blast and at a velocity sufficient to attenuate the heat softened material to form fibers, and feeding an elongated body of the material through the first blast and into the second blast.

3. The process of producing glass fibers which comprises producing oppositely moving generally parallel blasts of hot high velocity gas, feeding an elongated body of glass endwise into the blasts along a path extending transversely to the blasts, and attenuating the glass to form fibers by the heat and force of the blasts.

4. The process of producing glass fibers which comprises flowing hot high velocity blasts in opposite directions and in side by side relationship, feeding an elongated body of glass endwise into the blasts along a path extending transversely to the blasts, heating the advancing end of the body in one blast to a temperature exceeding the softening temperature of the glass, and attenuating the heat softened glass to form fibers by the heat and force of the adjacent blast.

5. The process of producing glass fibers which comprises flowing in one direction a first blast of gas having a temperature exceeding the softening point of the glass, flowing a second blast of gas in side by side relation to the first blast in a direction opposite the direction of flow of the first blast and at a velocity sufficient to draw out the glass softened by the first blast, feeding an elongated body of glass through the first blast and into the second blast along a path extend-

ing transversely to the blasts, heating the advancing end of the body to a temperature approximating the softening temperature of the glass in the first blast, and attenuating the glass to form fibers by the force of the second blast.

6. The process of making glass fibers which comprises producing relatively wide blasts of hot gases moving at substantial velocity, directing the blasts toward one another and offsetting one blast with respect to the other sufficiently to cause one blast to pass over the other, feeding a plurality of elongated bodies of glass endwise into the blasts with the bodies spaced from each other in a row extending across the width of the blasts, heating the advancing ends of the bodies to a temperature exceeding the softening point of the glass by the heat of the blast and attenuating the heat softened ends of the rods to form fibers by the force of the blasts.

7. The process of making glass fibers which comprises producing relatively wide blasts of gas having a temperature exceeding the softening temperature of the glass and having a velocity high enough to draw-out the softened glass, directing the blasts toward one another and offsetting one blast relative to the other a distance sufficient to cause one blast to pass over one side of the other blast, feeding a plurality of elongated bodies of glass along a path extending transversely to the blast with the bodies spaced from each other in a row extending crosswise of the blasts, directing the bodies endwise through one blast and into the next adjacent blast, and attenuating the bodies to form fibers by the heat and force of the blasts.

8. The process of making glass fibers which comprises burning a combustible mixture of gases in opposed spaced apart chambers, discharging the products of combustion from the chambers in directions toward each other to form blasts offset so that one blast passes over the other, feeding an elongated body of glass endwise through one blast and into the other, and attenuating the advancing ends of the body by the heat and force of the blasts.

9. Apparatus for producing glass fibers comprising a pair of burners, each having a combustion chamber within which a combustible mixture of gases is burned and each having an outlet opening in one wall thereof, said chambers being so proportioned with respect to the cross-sectional area of the outlet openings that the burned gases are forced from the chambers in the form of blasts, means for supporting the

burners in spaced opposed relationship with the outlet openings facing one another and offset to permit one blast to pass over the other, and means for feeding an elongated body of glass through one blast and into the next adjacent blast.

10. Apparatus for producing fibers comprising a pair of burners, each having a combustion chamber within which a combustible mixture of gases are burned and each having an outlet opening of substantially greater width than depth, said chambers being so proportioned with respect to the areas of the outlet openings that the burned gases are forced from the chambers in the form of hot high velocity blasts of greater width than thickness, means supporting the burners in spaced opposed relationship, with the outlet opening facing one another and offset to cause one blast to pass along the adjacent side of the other blast in contact with the latter, and means for feeding a plurality of glass rods arranged in a row extending across the width of the blasts through one blast and into the other blast.

11. Apparatus for producing glass fibers comprising a pair of burners each having a combustion chamber within which a combustible mixture of gases are burned and each having an outlet opening in one wall thereof, said chambers being so proportioned with respect to the cross-sectional area of the outlet openings that the burned gases are forced from the chambers in the form of blasts having a temperature exceeding the softening temperature of the glass and having a velocity high enough to attenuate the softened glass, means supporting the burners in spaced opposed relationship with the outlet openings facing one another and offset to cause one blast to pass along the adjacent side of the other blast, said burners having the walls facing the respective blasts shaped to guide the blasts laterally outwardly in opposite directions from their normal path of travel, and means for feeding a rod of glass endwise through one blast and into the other blast.

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