June 27, 1967 D. LABINO 3,327,503

METHOD AND APPARATUS FOR GENERATING A HIGH VELOCITY BLAST

Filed Nov. 6, 1963 2 Sheets-Sheet 1

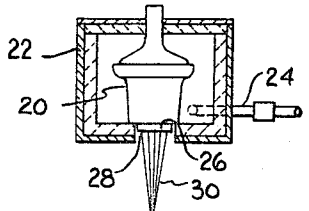


Fig. 1.

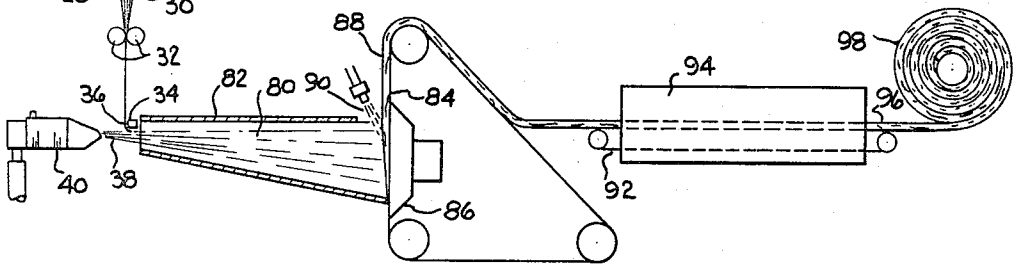
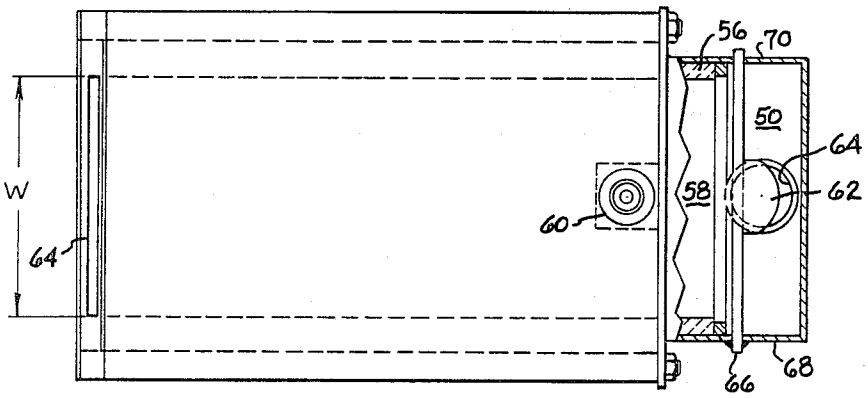


Fig. 2.



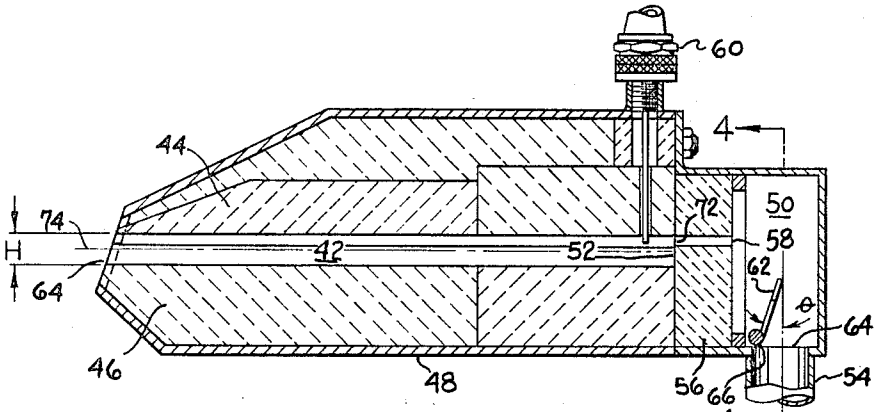


Fig. 3.

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Filed Nov. 6, 1963 2 Sheets-Sheet 2

Fig. 4.

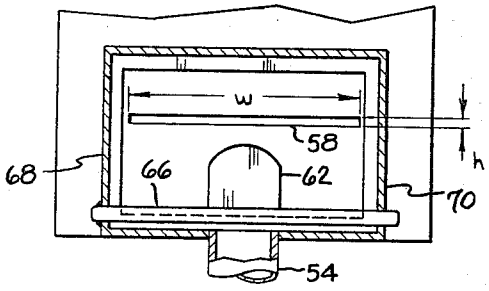
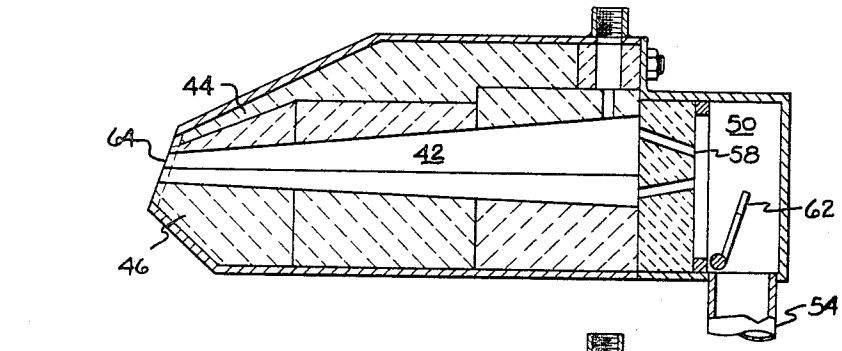


Fig. 6.



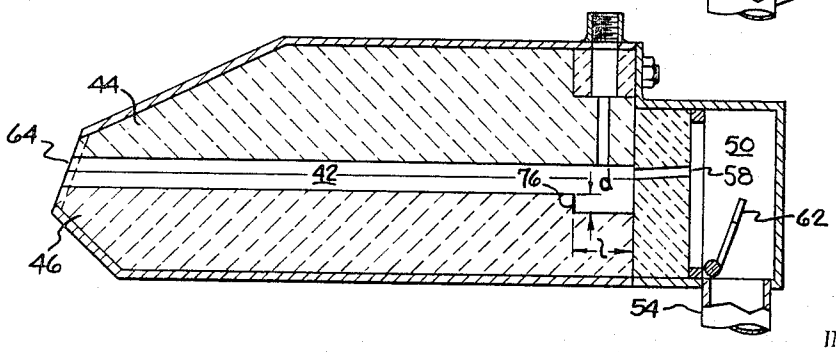


Fig. 5.

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METHOD AND APPARATUS FOR GENERATING A HIGH VELOCITY BLAST

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12 Claims. (Cl. 65—7)

This invention relates generally to method and apparatus for generating a high velocity stream of hot products of combustion. More particularly, this invention relates to a refractory tunnel burner for generating a relatively wide and flat hot gaseous blast of high temperature and high velocity for use in attenuating glass fibers.

One of the problems that has plagued the industry in the use of high velocity gas flow is the stabilization of the flame. It has been heretofore suggested to provide auxiliary pilot flames to envelope and stabilize the main flame. It has also been suggested to use metal bluff bodies in burners to create an area of turbulence and low velocity to stabilize burning. However, certain disadvantages are attendant with these arrangements, such as more complex construction, use of additional fuel in operating the pilot flames, and substantial reduction in velocity of the moving stream, which reduction in velocity materially reduces the attenuating force.

One object of this invention is to provide an improved refractory tunnel burner in which combustion of a premixed combustible admixture and the operational efficiency are enhanced.

It is another object of this invention to provide means for stabilizing the flame in the refractory tunnel of a burner having relatively low height without the need of separate pilot flames or bluff bodies.

It is a further object of this invention to provide a burner adapted to discharge the products of combustion in a generally flat wide stream with preferred velocity and temperature distribution patterns within the stream.

To accomplish the stated objects, the novel burner apparatus of this invention is designed to deliver an admixture of combustible gases to a plenum chamber wherein the admixture is uniformly distributed across the width thereof. The admixture is delivered to the inlet of a refractory tunnel through an orifice of a wall, preferably refractory, separating the plenum chamber and tunnel. The orifice is of a configuration corresponding to the cross-sectional configuration of the tunnel inlet but of reduced size. Also, the orifice is vertically displaced from the central longitudinal axis of the tunnel to present an increased area of continuous wall on one side, the bottom side, of the orifice to the tunnel. The orifice is preferably positioned closer to the top side of the tunnel than to the bottom side so that the upper portion of the gaseous stream being burned will become somewhat hotter than the lower portion. The true explanation of why this occurs is not accurately known, however it is believed to occur because of the increased impingement of the gases with the upper surface of the tunnel which causes said upper surface to become more incandescent and radiate heat back to the gaseous stream. The portion of the gaseous stream contiguous to the wall will "pick up" more heat, both by radiation and by convection, than the lower portion. However, it is believed that the lower portion of the gaseous stream will not be influenced by the frictional resistance of the refractory to the extent that the upper portion of the gaseous stream will be. Hence, the velocity of the lower stream portion will not be influenced to the extent that the upper portion of the stream is and will be greater than that of the upper portion. The burning mixture is discharged from the refractory tunnel as a stream through a discharge outlet having a configuration corresponding to the desired generally wide flat pattern. The work to be heated is then originally introduced to the upper portion of the stream and in the case where filaments are being attenuated, the filaments are projected forwardly from the burner by the velocity of the lower portion of the stream.

The invention will be more fully understood, and further objects and advantages thereof will become apparent by reference to the following detailed description in conjunction with the accompanying drawing in which like reference characters designate like parts, and in which:

FIG. 1 is a schematic elevational view of apparatus for making a bonded mat of glass fiber utilizing a burner of the present invention;

FIG. 2 is a plan view, with a portion broken away, of one form of the burner of this invention;

FIG. 3 is a cross-sectional elevational view of the burner shown in FIG. 2;

FIG. 4 is an elevational view taken along line 4—4 of FIG. 3;

FIG. 5 is a cross-sectional elevational view, similar to FIG. 3, of an alternate embodiment; and

FIG. 6 is a view, similar to FIG. 3, of a further embodiment.

As shown in FIG. 1, the apparatus adapted to the production of glass fibers utilizing the burner structure of the present invention includes a glass melting crucible 20 supported within an insulated chamber 22 and heated by suitable means such as gaseous products of combustion introduced through one or more conduits 24. The base 26 of the crucible 20 is provided with a plurality of apertures 28 through which molten glass may flow in the form of primary filaments 30. The filaments 30 are gathered and directed between a pair of power driven rolls 32 and subsequently in contact with guide block 34. The guide block 34 is provided on its rear face 36 with a plurality of vertically disposed and parallel aligned guide grooves (not shown) into which the primary filaments 30 are threaded and thereby retained in proper alignment for presentation to the hot gaseous blast 38 emitted from burner 40.

The blast 38 from the burner 40 softens and reduces the primary filaments 30 into fine fibers 80. The force of the blast 38 projects the fibers 80 through a hood 82 to deposition on an endless foraminous conveyor 84. A suction box 86 disposed behind the collection conveyor 84 imposes suction on the fibers 80 and assists in their deposition into mat form 88. A binder 90 may be sprayed upon the fibers as they approach the collection area.

From the collection conveyor 84 the mat 88 is transferred onto a second conveyor 92 which carries the mat through an oven 94 wherein the binder 90 is cured to produce a bonded mat 96 which may be rolled into a package 98.

The burner 40, as shown in FIGS. 2, 3 and 4, preferably and generally comprises a tunnel 42 defined by refractory walls 44 and 46 encased by a metal housing 48. A plenum chamber 50 is provided adjacent the inlet opening 52 of tunnel 42 for directing a combustible admixture of gases in a preferred pattern into the tunnel 42 supplied from a suitable source (not shown) through conduit 54. A wall 56, preferably of refractory, separates the tunnel 42 and the plenum chamber 50 and defines an elongated orifice 58 for emitting the combustible admixture to the tunnel 42. In order to facilitate ignition of the combustible admixture, ignition means shown to be in the form of a spark plug 60, may be optionally provided.

The preferred cross-sectional configuration of the tunnel 42, taken in any plane transverse to the longitudinal axis of the tunnel, is generally an elongated rectangle in

order to facilitate the issuance of a generally flat and wide blast of burning gases. The configuration of the orifice **58** is also preferably rectangular to facilitate the uniform distribution of the gaseous admixture across the width of the tunnel **42** which defines a combustion chamber.

It is to be noted that the plenum chamber **50** is relatively short in axial extent and consequently the overall length of the burner is reduced. The reduced burner length permits the operator easier access to the guide **34** for threading the primary filaments **30**. However, in view of the right angle transition of the flow path from conduit **54** to the orifice **58** and because of the change in cross-sectional configuration, means must be provided to facilitate uniform distribution of the gaseous admixture across the plenum chamber **50** and hence across the orifice **58**. A diffuser plate **62**, positioned adjacent the outlet **64** of conduit **54**, is provided for such purposes.

The diffuser plate **62** is suitably supported, such as by rod **66** extending through the side walls **68** and **70** of the plenum chamber **50**. The rod **66** is free to turn, at least initially, so that the position of the diffuser plate **62** may be suitably adjusted to obtain the proper distribution of the gaseous admixture across the lateral extent of orifice **58**. The most desirable position of the diffuser plate **62** may be ascertained by trial. A favorable angular range, angle θ (the angle from a normal extending through the central axis of conduit **54**) has been found to be in the order of 20–30° and in some cases the most preferred angle θ has been 24°. It has also been found desirable to provide a diffuser plate **62** which covers substantially half the open end **64** of conduit **54** when viewed from a horizontal plane. After the favorable angle θ has been established, the rod **66** may be permanently secured in place, such as by welding to one of the side walls **68** and **70**.

Now referring to the details of the wall **56**, and particularly to the orifice **58** and its relation to the tunnel **42**, which details are considered to form some of the important aspects of this invention, the wall **56** separating the plenum chamber **50** and the combustion tunnel **42** is preferably of a thickness at least four times that of the height of the orifice **58** in order to deter backfiring of the burning gases into the plenum chamber **50**.

The orifice **58** is preferably arranged with at least a major portion of the cross-sectional area of its outlet **72** vertically displaced from a line **74** extending through the longitudinal axis of the tunnel **42** when the burner **40** is in a horizontal position, to place the orifice **58** closer to the top side or wall **44** of the tunnel than to the bottom side or wall **46** of the tunnel.

While the exact reasons are not known, in an arrangement, such as described above, wherein the gas emitting orifice to a refractory combustion chamber is positioned closer to the top wall **44** than to the bottom wall **46**, a flame blast **38** discharged through the relatively flat wide outlet **64** possesses greater heat intensity at the top of the flame **38** than at the bottom. Concomitantly, the velocity is greater at the bottom of the flame than at the top. Such a flame pattern is highly desirable in the attenuation of fibers because it provides, in effect, a preheat zone at the top where the fibers are introduced and are the coldest and provides the maximum velocity in the area where the velocity may be utilized most effectively for attenuating the filaments, i.e., in the zone where the filaments have already been heat softened.

In one burner of the instant invention that has been built and tried, with a ¾ inch by 7 inches outlet, **64**, the following pressure readings, measured in inches of water column, were obtained respectively:

	Lowest	Normal	Highest
Top/tunnel	2	6	8
Bottom/tunnel	3	8	10

In relatively flat combustion tunnels, those having a height of less than ⅝ inch, when attempts are made to burn gases with sufficient volume (generally in the order of 700 c.f.h.) and pressure (2–3 p.s.i. at orifice **58**) to soften and attentuate glass fibers the combustible gases tend to pass through the tunnel, without expanding or decelerating, and to blow off. Thus, in such cases, the tunnel merely functions as an extension for the gas emitting nozzle or orifice at the entrance to the tunnel. In the burner of this invention, the offsetting of the orifice **58** provides an arrangement wherein the flame **38** is stabilized or anchored within the combustion tunnel **42** and combustion is enhanced without the addition of a separate metal bluff body in the gas stream.

Burners embodying the present invention have been successfully operated, without blowoff, in attenuating glass fibers wherein the tunnel of the burner had a constant height H of ½ inch, a width W of 4⅞ inches, and a length of 15 inches, and wherein the gas-emitting orifice had a height h of ⅛ inch and a width w of 4⅞ inches.

Another burner which has also been successfully operated had a constant height H of ¼ inch, a width W of 4⅞ inches, and a length of 15 inches, and wherein the gas-emitting orifice had a height h of 1/16 inch and a width of 4⅞ inches. With the lower height tunnels, ¼ inch and less, it has been found desirable to provide an increased area of the refractory wall on which the flame may anchor. One manner in which the area may be increased is to provide a recess portion **76** extending across the width of the tunnel **42** such as in the bottom wall **46** as shown in FIG. 5. The preferred dimensions d and l of the recess are ¼ inch and 1 inch, respectively. Also shown in FIG. 5 is the manner in which the orifice **58** may be slanted when a tunnel of increased height, ⅝ inch and greater, is employed.

In FIG. 6 is illustrated an alternate embodiment of the burner of this invention wherein a tapered tunnel **42'** is defined by top wall **44'** and bottom wall **46'**. In this embodiment, the orifice **58'** is preferably directed at an angle toward the top wall **44'**.

In use, the burner structures disclosed herein produced a blast of high temperature and high velocity to attenuate fibers having a diameter of 1 micron and less with a minimum of fuel consumption. While the invention has been described in particular regard to relatively flat wide refractory tunnels and as being particularly advantageous therewith, the features may also be employed advantageously in connection with combustion tunnels of increased heights. Among the advantages obtained through the use of the lower height tunnels in the production of a mat wherein a major portion of the fibers are of the fine fiber class and these fine fibers can be produced without increasing the gas consumption from that required to produce coarse fibers.

While the invention has been described in rather full detail, it will be understood that various changes and modifications may suggest themselves to one skilled in the art, all falling within the scope of the invention as defined by the subjoined claims.

What I claim is:

1. The method for producing a high temperature, high velocity, stabilized gaseous flame blast for heating fiberizable thermoplastic material being advanced into the path of the blast, which comprises:

(a) directing a combustible homogeneous admixture of gases in a substantially uniform elongated rectangular distribution pattern into a refractory tunnel through an orifice which is vertically displaced from the central axis of said tunnel;

(b) burning said admixture in said tunnel while advancing the burning mixture in a flow distribution pattern wherein the heat intensity of the burning mixture is greater at the top of the said flow pattern than at the bottom thereof and the velocity of the

burning mixture is greater at the bottom of said flow pattern than at the top thereof;

(c) discharging the burning mixture from said tunnel as a blast in a substantially uniform elongated rectangular pattern; and

(d) continuously introducing the fiberizable thermoplastic material to be heated into an upper portion of the discharging blast and projecting the heated material by the force of the blast.

2. The method as described in claim 1, which further comprises: anchoring a portion of the burning mixture to refractory material subjacent to said orifice.

3. The method of claim 1 wherein the fiberizable thermoplastic material is a glass material that can be attenuated into fibers when softened by heat.

4. The method of heating work which comprises:

(a) directing a combustible homogeneous admixture of gases in a substantially uniform elongated rectangular distribution pattern into a refractory tunnel through an orifice which is vertically displaced from the central axis of said tunnel;

(b) burning said admixture in said tunnel while advancing the burning mixture in a flow pattern wherein the velocity pressure of the burning gases, measured in inches of water, is at least one inch greater at the bottom portion of the burning gases than at the upper portion of said burning gases;

(c) introducing the work to be heated into the upper portion of said blast.

5. Burner apparatus comprising:

(a) a refractory tunnel having a laterally elongated inlet opening and a laterally elongated outlet opening;

(b) a plenum chamber adjacent to said inlet opening;

(c) a refractory wall separating said tunnel and said plenum chamber and defining an elongated discharge orifice for emitting a combustible mixture of said plenum chamber to said tunnel;

(d) said orifice being vertically positioned closer to the upper wall of said tunnel than to the bottom wall of said tunnel.

6. The burner apparatus as described in claim 5, wherein said orifice has a vertical height substantially less than the height of said tunnel.

7. The burner apparatus as described in claim 5,

wherein said tunnel has a constant cross-sectional configuration.

8. Burner apparatus as described in claim 5, wherein said tunnel has a rectangular cross-sectional configuration throughout its length but the cross-sectional area at the inlet is greater than the cross-sectional area at the outlet.

9. The burner apparatus as described in claim 5, wherein a portion of the bottom wall of said tunnel is recessed to provide an increased area of refractory immediately subjacent to the discharge orifice of said refractory wall.

10. Burner apparatus comprising:

(a) a refractory tunnel having a central axis with a laterally elongated inlet opening at one end thereof and a laterally elongated outlet opening at the opposite end thereof;

(b) a plenum chamber adjacent to said inlet opening;

(c) an opening at the bottom of said plenum chamber for receiving combustible gases;

(d) an elongated discharge opening connecting said plenum chamber and said refractory tunnel, said discharge opening emitting combustible gases as a homogeneous admixture from said plenum chamber into said tunnel;

(e) said orifice being positioned with at least a major portion above said central axis of said tunnel.

11. Burner apparatus as described in claim 10, which further comprises a diffuser disposed transverse to said opening in said plenum chamber at an angle from the normal extending through the central axis of said opening in the range of 20–30°.

12. Burner apparatus as described in claim 11, wherein said diffuser is disposed at an angle of 24°.

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