Nov. 22, 1949 C. J. STALEGO **2,489,244**

COMBUSTION CHAMBER BURNER

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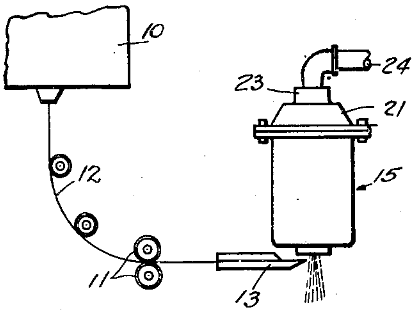


FIG. 1

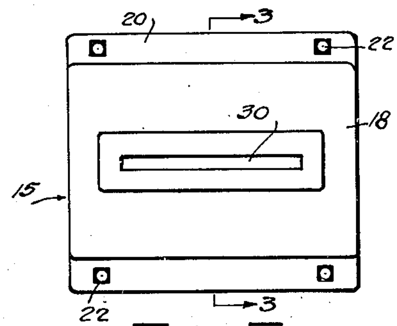


FIG. 2

FIG. 3

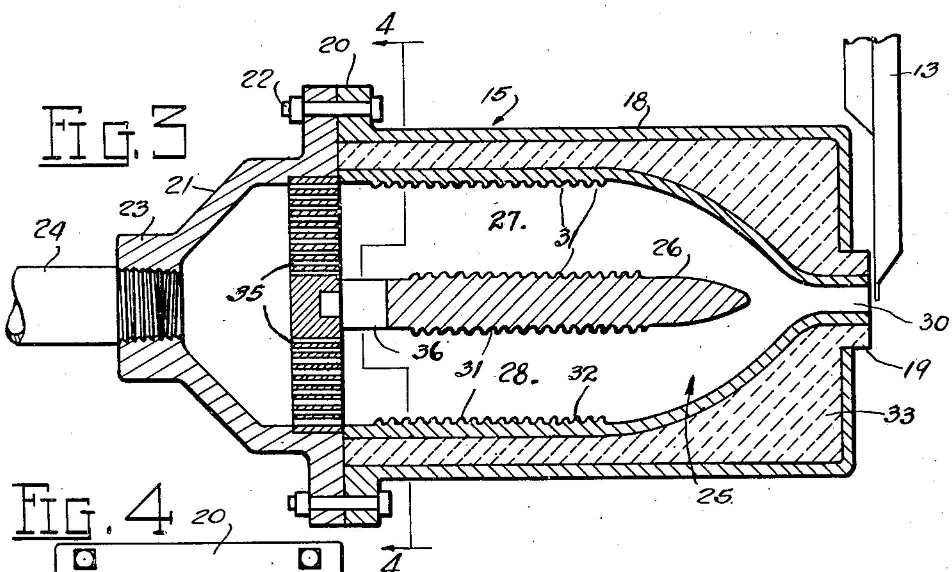
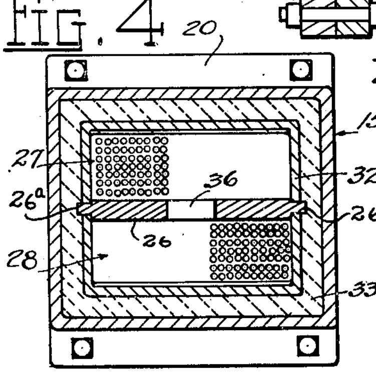


FIG. 4



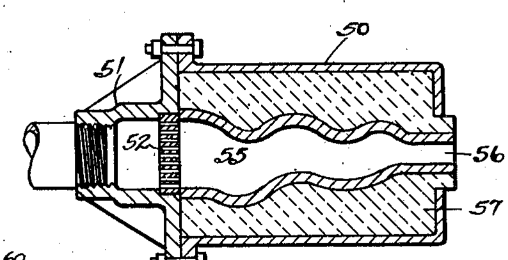


FIG. 5

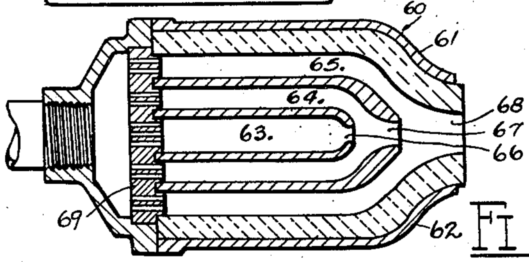


FIG. 6

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COMBUSTION CHAMBER BURNER

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11 Claims. (Cl. 18—2.5)

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The present invention relates to improvements in fuel burners and particularly burners of the type in which fuel, e. g., fuel gas or atomized oil, is burned within a combustion chamber and the products of the combustion are exhausted to the atmosphere through a restricted port for developing a high velocity blast of the products of combustion.

Such combustion chamber burners have been used in the production of fine glass fibers from streams of molten glass or from rods of solid glass. They are, of course, useful in other ways, particularly where a high velocity intensely hot blast of gas is required. For instance, burners of this type find utility in the heat treatment of metals or other materials.

It is an important object of the present invention to increase the velocity of the gaseous blast from a burner of combustion chamber type, and it is another object to increase the temperature of the gaseous blast.

In burners of this type the walls of the combustion chamber are usually formed to provide a streamlined flow of the products of combustion. Combustion within the burner takes place along the heated walls of the chamber and at this high temperature expansion of the gas creates a certain amount of turbulence within the chamber as the gas moves toward the orifice at a high rate of speed. I have found that under certain conditions there is incomplete combustion of the gas fed to the burners and a portion of it is carried unburned through the combustion chamber to the orifice.

As a consequence, it burns in the atmosphere instead of within the chamber with attendant loss of temperature and velocity of the blast, and a reduction in efficiency of the burner. Normally the unburned or incompletely burned gases leave the burner orifice along a path centrally of the blast issuing from the orifice to form a cold streak, that is, an elongated region of relatively low temperature within the center of the blast.

It is, therefore, a specific object of the present invention to provide in a fiber-forming process a combustion chamber burner of increased efficiency achieved by complete combustion within the combustion chamber of the gases fed thereto to prevent unburned gases from escaping into the atmosphere.

Burners of the present type are capable of numerous applications each of which may require a differently shaped orifice or form of burner. The burner orifice may be either oblong, oval or round depending upon the shape of the flame desired and the manner in which it is employed. The shape of the burner orifice is an important factor in the design of the burner chamber since it is desirable for obtaining the highest degree of operating efficiency to provide a combustion chamber and orifice of the same general cross-sectional shape.

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This principle of burner construction is adaptable to forming multiple combustion chamber burners having a common orifice for the discharge of the products of combustion to the atmosphere. The burner chamber may be divided into two or more combustion compartments of the desired shape which may be substantially cylindrical, frusto conical or rectangular according to the shape of the final discharge orifice. The products of combustion from each compartment combine before discharge from the burner and produce a high degree of turbulence and mixing of the gases which results in a blast of extremely high temperature issuing from the orifice.

It is still another object of the invention to provide a combustion chamber burner of a multiple chamber type having a discharge orifice common to all chambers.

It is a further object of the invention to provide a combustion chamber type burner in which the walls forming the chamber are shaped to produce a maximum turbulence and mixing of ignited gases within the chamber.

Other objects and advantages of the invention will become apparent during the course of the following description, when considered in view of the accompanying drawings, in which:

Figure 1 is a diagrammatic view of a typical fiber forming apparatus depicting the burner of the present invention used to form fine glass fibers;

Figure 2 is a front elevation of a burner;

Figure 3 is a vertical longitudinal sectional view of the burner taken on the line **3—3** of Figure 2;

Figure 4 is a vertical transverse sectional view taken on the line **4—4** of Figure 3;

Figure 5 is a sectional view through a modified form of the mixer-burner; and

Figure 6 is a sectional view through a modified form of multi-chamber burner.

Referring to Figure 1 of the drawings, the fiber forming apparatus includes generally a glass melting unit **10** adapted to discharge fine streams of molten glass which may be attenuated by continuously driven cooperating rolls **11** to the form of continuous primary filaments **12**. The rolls **11** feed the filaments into a guide member **13** by which they are supported during the final attenuating or blowing operation. Attenuation of the primary filaments 12 to fine short fibers is accomplished by means of a burner 15 or flame blower which is capable of producing an intensely hot gaseous blast of very high velocity. The ends of the filaments are projected into the flame by the feed rolls and are substantially instantaneously melted so that the molten tips of the filaments are attenuated into extremely fine fibers by the force of the flame or blast. These fibers when gathered together by suitable collecting means (not shown), form a mass having a cottony or wool-like texture which may be formed into mats, bats, or rovings, or slivers from which yarns or threads may be twisted, by any conventional process.

The combustion chamber burner of the present invention provides a substantial increase in both temperature and flame velocity so that increased production is realized as will be brought out in detail presently.

The burner 15 as illustrated in Figure 3 of the drawings comprises a shell or casing 18 preferably formed of metal and preferably of rectangular shape, and adapted to support the burner structure therein. The shell is provided in one end with a slot 19 through which the burner structure defining the burner orifice projects and is open at its other end. Flanges 20 at the upper and lower edges of the open end of the shell provide means by which a cup-shaped closure cap 21 may be secured to the shell by means of bolts 22. A pipe connection 23 is provided in the cap 21 to supply a highly combustible fuel through a pipe 24 to the burner from a suitable source. Such a fuel may be a premixed fuel gas and air, suitable fuel gases including ordinary manufactured or natural fuel gas, methane, propane, or other readily combustible gases. The gas-air mixture is supplied to the burner at a pressure less than 10 pounds per square inch and preferably at pressures of from 1 to 3 pounds per square inch.

The fuel gas-air mixture has the advantage of being readily obtainable and is more easily and safely handled than, for instance, propane or other highly compressed gases. Also, it is more economical than oxygen-acetylene when burned in sufficient volume to produce a blast having the high velocity obtainable with the gas-air mixture.

The burner includes within the shell 18 an elongated combustion chamber 25 divided by a partition wall 26 or baffle to form in effect a pair of chambers 27 and 28 or compartments communicating with a common narrow rectangular discharge orifice 30 through which the products of combustion escape. The partition wall 26 may be formed integral with the chamber or it may be supported when formed separately in grooves 26*a* provided in the side walls of the burner chamber.

The walls forming the chambers 27 and 28 may be formed of a suitable ceramic refractory material capable of withstanding high temperatures. The life of the refractory material is extended if a liner 32 of high melting point metal is employed to cover the refractory wall as illustrated herein although the use of the liner is not necessary.

In order to withstand the high temperatures created within the burner the refractory materials from which the body of the burner may be formed are, for example, the metal oxides or carbides such as tungsten carbide, boron carbide, silicon carbide or chromium, zirconium or beryllium oxide. The entire burner body may be formed of one or a suitable combination of some of the above materials.

The metallic liner 32 may be formed in any suitable way, for instance, by the powder metallurgy method of pressing finely divided metal to the proper form and then sintering the particles to consolidate them into an article of the desired shape. Tungsten and tungsten alloys are examples of high melting point metals suitable for this method of production and are adapted to withstand the temperatures approaching 4000° F. which are developed within the burner. The metal liner may be used alone to form the chamber but since it is most economically formed relatively thin it is preferable to reinforce the liner by a backing of ceramic refractory material as shown at 33, the refractory material acting also to insulate the liner from the shell 18.

Complementary orifice plates 35 mounted within the cap 21 are adapted to register with the chambers 27 and 28 and provide a uniformly distributed flow of fuel to the combustion chambers. The plates are preferably formed of a ceramic material and are held in place against the liner and wall members by the cap bolts 22.

In ordinary burners of the combustion chamber type having a cross-sectional area of the combustion chamber of approximately two square inches, chamber temperatures have been observed to reach the neighborhood of 3100° F. The blast has a flame velocity through a one-eighth inch orifice of approximately 500 to 700 feet per second. In such burners, the orifice is located equidistantly with respect to the side walls of the combustion chamber and under certain conditions incompletely burned gas from the center of the chamber may be drawn through the orifice, tending to produce a relatively cold area within the flame.

The present burner overcomes this objection to previous burners mainly by having the orifice 30 offset with respect to each chamber so that incompletely burned gas does not pass directly from the orifice plate 35 to the discharge orifice 30. Also, higher temperatures are developed within the present burner and cause combustion reaction to take place more rapidly and completely. The products of combustion from both chambers combine at a high velocity in the region adjacent the rear of the orifice 30 to produce an increased turbulence and mixing before the gases are discharged. Ridges 31 or other projections may be formed on the chamber walls to aid in mixing the gases and also for increasing the combustion surface. Thus complete combustion of the gas is obtained before it leaves the orifice.

As may be noted in Figure 4, the side walls of the chambers are vertical and substantially parallel while the upper and lower walls (Figure 3) curve or taper toward each other in the direction of the orifice. The partition wall 26 is provided with a tapering forward edge and forms with the top and bottom walls substantially restricted passages through which the gas passes before reaching the orifice. This increases the velocity of the products of combustion from each chamber before the two streams of gas are combined. The complementary converging outer walls of the passages tend to direct the flames at a substantial angle toward each other which results in the increased turbulence previously mentioned. An opening 36 may be provided in the partition wall near the orifice plates 35 to assure equalization of the pressures within the chambers.

I have found that the present burner may be operated successfully on an increased fuel consumption of about 80% above the maximum for previous burners of this type and with greatly increased results. With a fuel consumption rate for the present burner of 200 cubic feet per hour, the temperature adjacent the orifice within the burner is about 3600 to 3700° F. and the temperature of the blast immediately outside the orifice is about 3150° F. With a discharge orifice five thirty-seconds inch wide extending the full width of the burner and with a combined cross-sectional area of the two combustion chambers of about four square inches, a flame velocity of from 1700 to 1800 feet per second has been obtained, and with a three-sixteenth inch orifice a velocity of 1400 to 1500 feet results. The increased internal temperatures of the present burner are believed to be the result of complete combustion of the fuel within the burner together with increased gas consumption per unit of time, both of which in turn result in a higher degree of expansion of the combustion products with a consequent increase in velocity.

The higher temperature and blast speeds permit feeding glass rods or filaments into the flame at a higher rate so that attenuation of the filaments to fine fibers is comparably increased. The volume of fine fibers attenuated by the present burner is two to four times the volume a previous burner of this general type normally produces.

Figure 3 further illustrates specifically the manner in which the primary filaments are introduced into the flame. Since the flame velocity is highest as it issues from the orifice, it has been found expedient to introduce the fiber into the flame as close as possible to the orifice. This is accomplished by forming the fiber guide 13 with a cutout portion adjacent the tip so that it closely approximates the shape of the burner. The manner of feeding the primary filaments into the blast from the burner is described in more detail in my copending application Serial No. 533,046, filed April 27, 1944.

Figure 5 illustrates a modified form of burner that is also adapted to produce complete combustion of the gaseous fuel. The burner comprises a hollow rectangular shell 50 having a cap 51 bolted to the open end thereof and through which fuel is supplied to the burner. An orifice plate 52 of ceramic material mounted within the cap provides for a uniform flow of fuel into a combustion chamber 55 formed within the shell 50. The walls forming the chamber 55 may be in the form of a liner of high softening point metal or ceramic materials. The upper and lower walls of the chamber 55 are shaped to create an undulating or serpentine chamber gradually decreasing in cross-sectional area to a discharge orifice or port 56 in the closed end of the shell 50.

The liner is supported within the shell by a refractory insulating material 57 so that contact between the shell and liner is prevented and heat radiation held to a minimum. It is also to be understood that the combustion chamber walls may be formed entirely of ceramic material.

In the present modified type of burner the fuel mxiture is supplied at a relatively low pressure and when ignited within the chamber expands at a high velocity and escapes through the discharge orifice. The heated walls of the chamber increase the rate of ignition of the gas. As the gas flows along the undulating walls it is deflected therefrom in the direction of the opposite wall to be met in turn by counter currents of flow. This action causes a high degree of turbulence within the chamber which excites combustion of the gas and produces maximum expansion thereof so that the products of combustion are discharged from the burner at an extremely high temperature and velocity.

Figure 6 illustrates a further embodiment of the present invention in which the burner 60 comprises a casing 61 for supporting a burner body 62 therein. The burner may be generally oval or cylindrical in cross-section and the body 62 formed of refractory material or a metal in accordance with the preferred form of disclosure.

The burner body is provided with a plurality of substantially concentric combustion chambers 63, 64 and 65, each having a substantially restricted discharge orifice 66, 67 and 68 respectively arranged in longitudinal alignment for discharging the products of combustion to the atmosphere. As in the form of the invention shown in Figures 1 to 4, the ends of the chambers 63, 64 and 65 are of decreased cross-sectional area.

An orifice plate 69 at the inner ends of the chambers is arranged to introduce fuel gas and air mixture from a suitable source to the chambers.

The gas burns within the chambers and as it expands it is discharged from the respective orifices, the products of combustion from the chamber 63 combining with the discharging gases from the chamber 64 which in turn mix with gases from the chamber 65 with a high degree of turbulence. This provides for a blast of high velocity in which the gases are completely burned as they discharge from the outer orifice.

The orifices may be round, oval or oblong and preferably correspond substantially to the cross-sectional shape of the chambers. Burners of this type are useful when a flame of high temperature and velocity within a localized area are desired.

Modifications may be resorted to within the spirit of the invention and the scope of the appended claims.

I claim:

1. A combustion chamber burner of the character described comprising a hollow shell substantially rectangular in cross section and having an opening in one end defining a discharge orifice for the products of combustion escaping from the burner, a cap closing the opposite end of said shell through which a combustible fuel is supplied under low pressure, a liner defining a chamber within the shell insulated from the walls thereof and having one end open to the atmosphere through said orifice, the upper and lower opposite walls of said liner tapering toward said orifice, a longitudinally disposed dividing wall in alignment with the orifice and equally dividing said chamber into two compartments, said wall terminating short of said orifice and forming with said liner walls a restricted passage from each compartment, and orifice plates within the cap registering with each compartment through which fuel is supplied, said dividing wall provided with an aperture to equalize the pressures built up within said compartments.

2. In an apparatus for forming fine glass fibers in which glass is fed into the path of a stream of high temperature products of combustion flowing at sufficient velocity to attenuate the glass to fine fibers, a burner having a chamber within which a combustible mixture of gases is burned, said chamber having an inlet port through which the

combustible mixture of gases is introduced into the chamber and also having a discharge orifice through which the products of combustion are discharged in the form of a high temperature blast, the walls of the chamber at opposite sides of the discharge orifice converging toward the discharge orifice, and a wall extending from a point adjacent the inlet port toward but short of the discharge orifice and from side to side of the chamber to partition the chamber into two compartments, the end of said wall adjacent the discharge orifice being so related with respect to the opposite converging walls of the chamber as to form restricted outlets from the two compartments so that the turbulence of the products of combustion from the two compartments is increased prior to passage of the products of combustion through said discharge orifice.

3. In an apparatus for forming fine glass fibers in which glass is fed into the path of a stream of high temperature products of combustion flowing at sufficient velocity to attenuate the glass to fine fibers, a burner having a chamber within which a combustible mixture of gases is burned, said chamber having an inlet port through which the combustible mixture of gases is introduced into the chamber and also having a discharge orifice through which the products of combustion are discharged in the form of a high temperature blast, the walls of the chamber at opposite sides of the discharge orifice converging toward the discharge orifice, and a wall extending from a point adjacent the inlet port and toward but short of the discharge orifice and from side to side of the chamber to partition the chamber into two compartments, the end of said wall adjacent the discharge orifice being so related with respect to the opposite walls of the chamber as to form restricted outlets from the two compartments so that the turbulence of the products of combustion from the two compartments is increased prior to passage of the products of combustion through said discharge orifice.

4. In an apparatus for forming fine glass fibers in which glass is fed into the path of a stream of high temperature products of combustion flowing at sufficient velocity to attenuate the glass to fine fibers, a burner having a chamber within which a combustible mixture of gases is burned, said chamber having an inlet port through which the combustible mixture of gases is introduced into the chamber and also having a discharge orifice through which the products of combustion are discharged in the form of a high temperature blast, the walls of the chamber at opposite sides of the discharge orifice converging toward the discharge orifice, and a wall extending from a point adjacent the inlet port and toward but short of the discharge orifice and from side to side of the chamber to partition the chamber into two compartments, the wall being in substantial alignment with said discharge orifice so that the compartments are offset laterally with respect to the orifice, whereby the turbulence of the products of combustion from the two compartments is increased prior to passage of the products of combustion through said discharge orifice.

5. In an apparatus for forming fine glass fibers in which glass is fed into the path of a stream of high temperature products of combustion flowing at sufficient velocity to attenuate the glass to fine fibers, a burner having a chamber within which a combustible mixture of gases is burned, said chamber having an inlet port through which the combustible mixture of gases is introduced into the chamber and also having a discharge orifice through which the products of combustion are discharged in the form of a high temperature blast, the opposite walls of said chamber converging toward each other adjacent said discharge orifice, and a wall extending from the inlet port and toward but short of the discharge orifice and from side to side of the chamber to partition the chamber into two compartments, the wall being in substantial alignment with the discharge orifice and the end of said wall adjacent the discharge orifice being so related with respect to the opposite converging walls of the chamber as to form restricted outlets from the two compartments, whereby the turbulence of the products of combustion from the two compartments is increased prior to passage of the products of combustion through said discharge orifice.

6. In an apparatus for forming fine glass fibers in which glass rods are fed across the outlet end of an exhaust orifice to melt and attenuate the rods by the heat and force of a blast of hot products of combustion emitted from said orifice, a burner having a plurality of combustion chambers therein, said chambers provided at one end with inlet ports through which combustible gaseous fuel is fed into the chambers to be burned therein and an exhaust orifice common to and communicating with the other ends of said chambers from which orifice the stream of hot products flows, said chambers being offset laterally from said common orifice so that gases passing through said chambers must deviate from a straight path to pass through said orifice to assure uniform combustion of the gases.

7. In an apparatus for forming fine glass fibers in which glass rods are fed across the outlet end of an exhaust orifice to melt and attenuate the rods by the heat and force of a blast of hot products of combustion emitted from said orifice, a burner having a plurality of combustion chambers therein, said chambers provided at one end with inlet ports through which combustible gaseous fuel is fed into the chambers to be burned therein and an exhaust orifice common to and communicating with the other ends of said chambers from which orifice the stream of hot products flows, passages of less transverse dimensions than said chambers connecting said chambers with said common orifice, said chambers being offset laterally from said common orifice so that gases passing through said chambers must deviate from a straight path to pass through said orifice to assure uniform combustion of the gases.

8. In an apparatus for forming fine glass fibers in which glass rods are fed across the outlet end of an exhaust orifice to melt and attenuate the rods by the heat and force of a blast of intensely hot gases emitted from said orifice, a burner having a plurality of combustion chambers therein, said chambers provided at one end with inlet ports through which combustible gaseous fuel is fed into the chambers and an exhaust orifice common to and communicating with the other ends of said chambers from which orifice the stream of hot products flows, at least one of said chambers being offset laterally from said common orifice so that gases passing through said chamber must deviate from a straight path to pass through said orifice so that any straight-line flow of the gases from the chambers and through the orifice is disturbed and uniform combustion of the gases is assured.

9. In the process of forming fine glass fibers in

which an elongated body of glass is introduced endwise into an intensely hot blast of the products of combustion of a gaseous fuel adjacent the point of discharge of the blast into the atmosphere to soften and attenuate the body to fine fibers, the steps which consist in passing a gaseous fuel mixture through a highly heated zone in which it is burned, directing the products of combustion into a second zone laterally offset from said first zone, thereby creating a high turbulence in the products of combustion in the second zone, discharging said highly turbulent products of combustion into the atmosphere to form a blast of high velocity and intense heat, by which the body of glass is softened and attenuated.

10. In the process of forming fine glass fibers in which a small rod of glass is introduced endwise into an intensely hot blast of the products of combustion of a gaseous fuel adjacent the point of blast discharge to substantially simultaneously soften and attenuate the rod to fine fibers, the steps which consist in passing a gaseous fuel mixture through separate highly heated zones in which it is burned, directing the products of combustion into a common region laterally offset from said zones, thereby creating a high turbulence in said region, discharging said highly turbulent products of combustion into the atmosphere in the form of a single blast of high velocity by which the rod of glass is softened and attenuated.

11. In an apparatus for forming fine glass fibers in which glass is fed into the path of a stream of high temperature products of combustion flowing at sufficient velocity to attenuate the glass to fine fibers, a burner having a chamber within which a combustible mixture of gases is burned, said chamber having an inlet port through which the combustible mixture of gases is introduced into the chamber and also having a discharge orifice through which the products of combustion are discharged in the form of a high temperature blast, the walls of the chamber at opposite sides of the discharge orifice converging toward the discharge orifice, a wall extending from a point adjacent the inlet port toward but short of the discharge orifice and from side to side of the chamber to partition the chamber into two compartments, the end of said wall adjacent the discharge orifice being so related with respect to the opposite converging walls of the chamber as to form restricted outlets from the two compartments so that the turbulence of the products of combustion from the two compartments is increased prior to passage of the products of combustion through said discharge orifice, and a passage through said wall adjacent the inlet port establishing communication between the two compartments.

CHARLES J. STALEGO.

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