

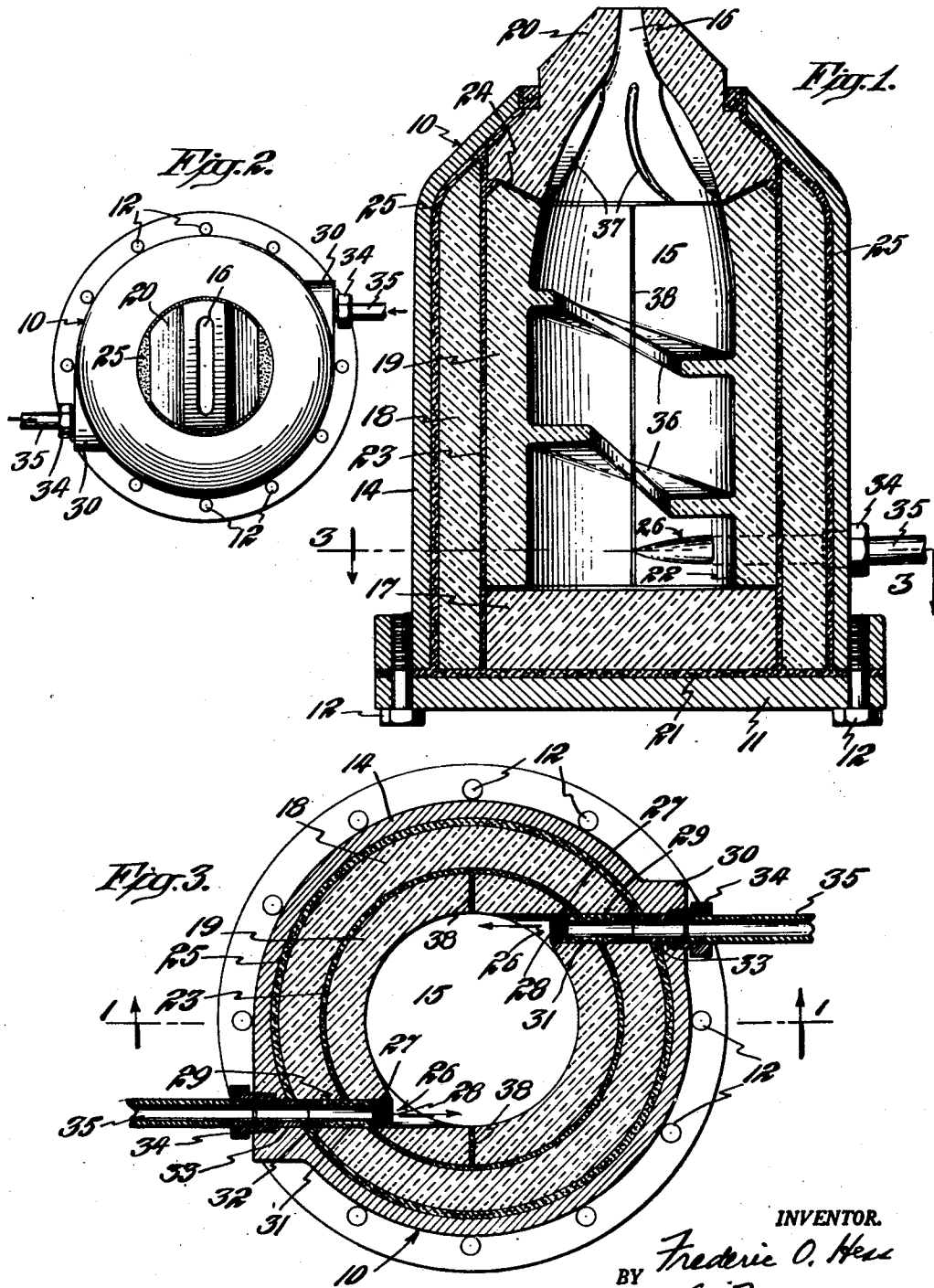
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INTERNAL GAS BURNER

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INTERNAL GAS BURNER

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My invention relates to burners, and more particularly to burners of the type having a substantially closed combustion space in which practically complete combustion of a combustible gaseous mixture is accomplished and from which heated products of combustion are discharged through a restricted outlet in the form of a high temperature gas stream.

It is an object of the invention to provide an improvement in burners of this type, particularly to increase the capacity or heat output of such burners. I accomplish this by providing an inlet through which a combustible gaseous mixture is discharged into a combustion space substantially tangentially to an inner refractory wall surface thereof and in a direction transverse to the longitudinal axis of the burner to effect a whirling movement of the gaseous mixture. Combustion of the gaseous mixture is readily effected in the combustion space to cause heating of the inner refractory wall surface to incandescence and produce a region of intense heat in the space in which substantially complete combustion is accomplished while heated products of combustion are discharged through the outlet.

In order to provide a tortuous path of flow for the gases in the combustion space, the inner refractory wall surface may be suitably ribbed. I preferably accomplish this by providing a helical rib of high temperature refractory material at the inner wall surface of the combustion space which not only provides a tortuous path of flow for the gases but also promotes the whirling movement of the gases while passing from the inlet toward the outlet. Since the helical rib is heated to incandescence by the combustion effected in the combustion space, the portion thereof adjacent to the inlet may be advantageously employed to promote combustion of the gas mixture at the inlet end of the combustion space. I accomplish this by forming the rib so that the end thereof farthest from the restricted outlet overlies the region of the combustion space into which the gaseous mixture is introduced through the inlet. In this way highly incandescent surfaces of the rib face the inlet end of the combustion space to promote combustion of the gas mixture.

In many heating applications it is desirable to employ high temperature gas streams in which the gas velocity throughout all parts of the stream is substantially the same. In order to avoid a substantial difference in velocity in different parts of the same gas stream discharged

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from the combustion space, the inner refractory wall surface adjacent to the outlet may be formed to promote straight line flow of the high temperature gases emerging from the combustion space. I accomplish this by providing a plurality of spaced apart vanes of refractory material at the inner wall surface of the combustion space adjacent to the outlet which are suitably shaped to produce straight line flow of the high temperature gases discharged through the restricted outlet from the combustion space.

The above and other objects and advantages of the invention will be more fully understood upon reference to the following description and accompanying drawing forming a part of this specification, and of which Fig. 1 is a vertical sectional view, taken at line 1—1 of Fig. 3, of a burner embodying the invention; Fig. 2 is an end view looking toward the restricted outlet or discharge orifice of the burner illustrated in Fig. 1; and Fig. 3 is a sectional view taken at line 3—3 of Fig. 1.

Referring to the drawing, the gas burner 10 embodying the invention comprises a base member 11 to which is removably secured at 12 the large open end of a cup-shaped metal shell or outer casing 14. Within the metal shell 14 is provided a hollow body having a cavity forming a combustion space 15 terminating at its upper end in a slotted discharge orifice or restricted outlet 16.

In the embodiment of the invention illustrated the hollow body comprises a number of parts or members of high temperature refractory material including an end member 17 which bears against the member 11. About the end member 17 is disposed the lower end of a hollow cylindrical member 18 which bears against the base member 11 and extends upwardly therefrom alongside of the metal shell 14 to the sloping or tapered upper end of the shell. Within the member 18 and forming therewith a part of the refractory wall of the space 15 is disposed a hollow cylindrical member 19. The lower end of the cylindrical member 19 bears against the end member 17, and the upper end thereof bears against the larger end of an annular member 20 which forms the outlet or discharge end of the combustion space 15. The annular member 20, which projects through the small open end of the shell 14, bears against the sloping or tapered part of the shell and at the extreme upper end is provided with a slot forming the restricted outlet 16 for the combustion space 15.

In order to withstand the high temperatures

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produced in the combustion space 15 during operation of the burner, the end member 17, inner cylindrical member 18 and upper annular member 20 may be formed of a suitable refractory material, such as beryllium oxide, for example, having high resistance to thermal shock and possessing rigidity and strength at the high temperatures. The outer cylindrical member 18 is preferably formed of a refractory material, such as aluminum oxide, for example, possessing good insulating properties and having adequate strength to serve as the outer portion of the refractory wall. In order to obtain a gas tight seal at the closed end of the burner, a gasket 21 of suitable material, such as asbestos, for example, is interposed between the base plate 11 and the parts which bear against the base plate.

The refractory wall parts just described may be secured to one another and snugly positioned within the outer shell 14 by a suitable high temperature air hardening cement, as indicated at 22, 23, 24, and 25, respectively. Such a high temperature cement upon hardening provides a rigid and unitary burner structure in which all of the refractory wall parts are effectively united to form the combustion space 15.

In accordance with the invention, in order to increase the capacity or heat output of burners of the type just described, the combustion space 15 is provided with one or more inlets, 26 for discharging a combustible gaseous mixture into the space substantially tangentially to the inner wall surface thereof and in a direction transverse to the longitudinal axis of the burner. As shown in Fig. 3, each inlet 26 comprises a circular burner screen 27 formed of suitable refractory material, such as beryllium oxide, having a plurality of small apertures 28 extending there-through. The screens 27 are fixed to the inner ends of hollow sleeves 29 which extend through passages formed by aligned openings in the wall members 18 and 19 and in enlarged bosses 30 of the outer metal shell 14.

The hollow sleeves 29 include inner portions 31 formed of suitable refractory material, such as silicon carbide, for example, at the inner recessed ends of which the screens 27 are fixed, as by a suitable high temperature air hardening cement. The inner refractory portions 31 of the hollow sleeve 29 are threadedly connected at 32 to outer portions 33 formed of suitable heat resisting metal. The outer metallic sleeve portions 33 are formed with enlarged outer ends 34 having threaded sections for threadedly connecting the hollow sleeves 29 in position at the bosses 30 and for threadedly connecting thereto conduits 35 adapted to be connected to a suitable source of supply of a combustible gaseous mixture.

To operate the burner 10 to produce a high velocity gas stream of heated products of combustion, a combustion fuel mixture comprising a gaseous fuel and a combustion supporting gas is supplied to the hollow sleeves 29 through the conduits 35 from a suitable source of supply. When the burner 10 is relatively cool and at a low temperature, the combustible gas mixture supplied thereto passes through the hollow sleeves 29, burner screens 27 and space 15 from which it is discharged through the restricted outlet 16. The combustible gaseous mixture is initially supplied to the burner 10 at a relatively low pressure which may be equivalent to a pressure corresponding to about 5 or 6 inches of water

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column, for example, so that the gaseous mixture discharged from the space 15 can be ignited to produce and maintain a flame at the outlet 16.

When a flame is being maintained at the outlet 16, the pressure of the gas mixture supplied to the burner 10 may be momentarily reduced sufficiently to cause the flame to backfire through the outlet 16 into the space 15 onto the burner screens 27. When this occurs a plurality of flames are produced and maintained at the discharge ends of the small apertures 28.

When the flames are being maintained within the space 15 at the discharge ends of the apertures 28 of the burner screens 27, the pressure of the gaseous mixture supplied to the burner may then be increased. After a short interval of time the flames maintained at the burner screens 27 effect such heating of the inner refractory lining of the space 15 that these surfaces are heated to a high incandescent temperature. The heating of the inner refractory lining to a highly incandescent condition promotes substantially complete combustion of the gaseous mixture in the combustion space 15 before the mixture reaches the restricted outlet 16. From the outlet 16 is discharged a high velocity jet or stream of heated gases at a temperature nearly equal to the temperature in the combustion space 15 and consisting substantially entirely of heated products of combustion.

During normal operation the burner 10 is characterized by the absence of a bright and luminous flame. It is only when the burner is first started that a flame is maintained at the elongated slot or outlet 16, as previously explained. After the gaseous mixture has once been ignited the delivery pressure of the mixture is reduced sufficiently to cause backfiring into the combustion space 15, so that burning of the gaseous mixture will take place at the burner screens 27.

By providing burner screens 27 having the small passages 28 therein to subdivide the combustible gaseous mixture at the angularly spaced apart inlets 26, the gaseous mixture issues into the combustion space or chamber 15 in a plurality of small streams. With combustion being effected in the space 15, a plurality of relatively small and short flames are produced during normal operation, whereby a substantial portion of the burning or combustion is initiated at the region of the combustion space adjacent to the inlets 26. In this way a relatively high average temperature is produced and maintained at the inlet end of the combustion space 15. Further, stability of burner operation is insured by the fact that the small flames will always be rooted to the discharge ends of the passages 28 over a wide range of gas mixture delivery pressures. This reduces the likelihood of the flames blowing off of the inlets 26 at high gas mixture delivery pressures and insures that a substantial portion of the burning of the gas mixture will be effected at the inlet end of the combustion space 15 under widely varying operating conditions.

The flames initially produced at the discharge ends of the passages 28 each consists of an inner cone of unburned gaseous mixture and an outer cone constituting the portion of the flame in which the combustion reaction is taking place. When operation of the burner 10 is first started and the inner refractory lining is relatively cool, the inner cones of the individual flames projecting into the combustion space are relatively long in length. As the inner refractory wall surface

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of the space 15 becomes heated, the inner cones of the individual flames become increasingly shorter and shorter. When the inner refractory wall surface of the space becomes heated to a high incandescent temperature, the inner cones of the individual flames become appreciably shorter from their original lengths when initially produced.

By introducing the combustible gaseous mixture through the hollow tubes 29 in a direction substantially tangentially to the inner wall surface of the cylindrical space 15, a whirling movement is imparted to the gases. To induce such whirling movement the cross-sectional area of the combustion space 15 at the region of the inlets 26, in a plane normal to the longitudinal axis of the burner, is considerably greater than the cross-sectional area of the restricted outlet 16. In order to promote the whirling movement of the gases and also provide a tortuous path of flow for the gases while passing from the inlets 26 to the outlet 16, a helical rib 36 of high temperature refractory material is provided at the inner refractory wall surface which extends lengthwise of the space 15 from the inlet end toward the outlet 16.

The end of the helical rib 36 adjacent to the end refractory member 17 is disposed immediately above both of the inlets 26. The rib 36 is of greatest width at the end thereof adjacent to the inlet end of the combustion space 15 and gradually becomes narrower along its length toward the outlet 16 and finally disappears and merges into the inner refractory wall surface at the outlet end of the refractory member 19.

Due to the combustion of the gaseous mixture effected in the space 15, the surfaces of the helical rib 36 are heated to a high incandescent temperature whereby the overall highly heated surface area of the inner refractory lining is increased for a burner of a given size. In addition, the widest portion of the helical rib 36, which overlies the region of the combustion space into which the gaseous mixture is introduced at the inlets 26, is advantageously employed to promote combustion of the gaseous mixture at the inlet end of the space. This is so because the surface of the helical rib 36 openly exposed to and facing the end member 17 becomes heated to a high incandescent temperature, thereby promoting combustion by subjecting the gases to the radiant heat of such exposed surface. Under normal operating conditions, when the inner refractory lining and helical rib 36 reach a high incandescent temperature, the inner cones of the small flames practically disappear, thereby increasing the portion of the combustion effected at the inlet end to maintain a high average temperature in the combustion space 15 adjacent to the inlets 26.

The whirling movement of the gases about the inner refractory wall surface of the helical rib 36 promotes substantially complete combustion of the gaseous mixture before the heated gases reach the restricted outlet 16. In a burner of the type just described, the heated products of combustion are discharged from the combustion space 15 through the restricted outlet 16 at an elevated temperature in the neighborhood of 3000° F. or higher when a combustible gaseous mixture of air and ordinary gas, such as city gas having a B. t. u. rating of about 550 B. t. u. per cubic foot, for example, is supplied at a pressure in the neighborhood of three pounds per square inch. Under such operating conditions

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the pressure in the combustion space 15 may be equivalent to a pressure corresponding from 55 to 70 inches of water column and appreciably above that of atmospheric pressure. The heated gases are discharged from the burner at an average velocity of about 750 feet or more per second and at a maximum velocity of about 1000 feet or more per second.

In many heating applications it is desirable to employ the high temperature gas streams produced by burners like the burner 10 for heating work in close proximity to the outlet 16 in such a manner that all regions of the work are impinged by heated gases at substantially the same velocity. In order to minimize the whirling movement of the high temperature gases emerging from the combustion space 15 and produce a gas stream for heating work in which the velocity throughout the stream is substantially uniform, a plurality of spaced apart vanes 37 of refractory material may be formed at the inner wall surface of the annular member 20 adjacent to the outlet 16.

As shown in Fig. 1, the vanes 37 are suitably curved at their lower ends to receive the whirling high temperature gases in such a manner that minimum resistance is offered to the flow of the heated gases emerging from the combustion space 15. The upper portions of the vanes 37 adjacent to the restricted outlet 16 are substantially parallel to one another and to the longitudinal axis of the burner to promote substantially straight line flow of the high temperature gases at the region the gases are about to enter the restricted outlet 16. Thus, while desirable turbulent movement of the gases is promoted in the combustion space proper, the vanes 37 serve to minimize such turbulent movement and promote straight line flow of the gases discharged through the outlet 16.

The helical rib 36 and vanes 37 are desirably formed integrally with the inner cylindrical wall member 19 and annular member 20, respectively. In order to facilitate fabrication of the burner 10, the wall member 19 in such case may be formed of two complementary parts which are joined or united by high temperature air hardening cement, for example, as indicated at 38 in Figs. 1 and 2, to form the helical rib 36 extending axially of the combustion space 15.

By introducing combustible gaseous mixture into the combustion space 15 and promoting whirling movement of the gases therein in the manner just described, the capacity or heat output of burners of the type generally like the burner 10 is increased. Conversely, for a burner of a definite maximum capacity or heat output, the length of a burner like the burner 10 is reduced compared to burners of this type heretofore provided. This is of considerable importance when a cluster or bundle of burners of the type herein described are employed in a relatively small space, as in an automatically operable heat-treating machine, for example. Moreover, by reducing the length of a burner of a given capacity, the heat losses through the refractory walls are correspondingly reduced.

While I have shown and described a particular embodiment of the invention, I do not wish to be limited to the particular arrangement set forth, and I therefore aim in the following claims to cover all modifications and changes which fall within the true spirit and scope of the invention.

What is claimed is:

1. A gas burner comprising structure including a hollow body which provides a substantially closed combustion chamber having an inlet for a combustible gas mixture and a restricted outlet, said chamber having its inner wall surface and outlet formed substantially entirely of high temperature refractory material, said inlet being formed and arranged to discharge the gaseous mixture into said chamber substantially tangentially to the inner wall surface thereof and in a direction transverse to the longitudinal axis of the burner to induce whirling movement of the gaseous mixture so that combustion of the mixture may be effected within said chamber to cause heating of said inner wall surface to incandescence and produce a region of intense heat in which substantially complete combustion is accomplished while heated products of combustion are discharged through the outlet, and high temperature refractory means at the inner wall surface of said chamber adjacent to the restricted outlet end thereof to promote straight line flow of heated gases discharged through the outlet.

2. A gas burner as set forth in claim 1, in which said means to promote straight line flow of the heated gases discharged through the outlet comprises spaced apart vanes of high temperature refractory material at said inner wall surface which extend axially of the chamber.

3. A gas burner comprising structure including a hollow body which provides a substantially closed combustion space having an inlet for a combustible gaseous mixture and a restricted outlet, said space having its inner wall surface and outlet formed substantially entirely of high temperature refractory material, said inlet being formed and arranged to discharge the gaseous mixture into said space substantially tangentially to the inner wall surface thereof and in a direction transverse to the longitudinal axis of the burner so that combustion of the mixture may be effected within said space to cause heating of said inner wall surface to incandescence and produce a region of intense heat in which substantially complete combustion is accomplished while heated products of combustion are discharged through the outlet, said space at its inner wall surface being formed with a helical rib of high temperature refractory material which extends lengthwise of the space from the inlet toward the restricted outlet.

4. A gas burner comprising structure including a hollow body which provides a substantially closed combustion space having an inlet for a combustible gaseous mixture and a restricted outlet, said space having its inner wall surface and outlet formed substantially entirely of high temperature refractory material, said inlet being formed and arranged to discharge the gaseous mixture into said space substantially tangentially to the inner wall surface thereof and in a direction transverse to the longitudinal axis of the burner so that combustion of the mixture may be effected within said space to cause heating of said inner wall surface to incandescence and produce a region of intense heat in which substantially complete combustion is accomplished while heated products of combustion are discharged through the outlet, first high temperature refractory means at the inner wall surface of said space to promote whirling of the gases in the space while passing from the inlet toward the outlet, and additional high tempera-

ture refractory means at the inner wall surface of said space between the first refractory means and the outlet which is formed and shaped to promote straight line flow of the heated gases discharged through the outlet.

5. A gas burner comprising structure including a hollow body which provides a substantially closed combustion space having an inlet for a combustible gaseous mixture and a restricted outlet, said space having its inner wall surface and outlet formed substantially entirely of high temperature refractory material, said inlet being formed and arranged to discharge the gaseous mixture into said space substantially tangentially to the inner wall surface thereof and in a direction transverse to the longitudinal axis of the burner so that combustion of the mixture may be effected within said space to cause heating of said inner wall surface to incandescence and produce a region of intense heat in which substantially complete combustion is accomplished while heated products of combustion are discharged through the outlet, a helical rib of high temperature refractory material at the inner wall surface which extends lengthwise of said space from the inlet toward the restricted outlet, and additional refractory means at the inner wall surface which extends axially of said space from said rib toward the restricted outlet to promote straight line flow of the heated gases discharged through the outlet.

6. A gas burner comprising structure including a hollow body which provides a substantially closed combustion space having an inlet for a combustible gaseous mixture and a restricted outlet, said space having its inner wall surface and outlet formed substantially entirely of high temperature refractory material, said inlet being formed and arranged to discharge the gaseous mixture into said space substantially tangentially to the inner wall surface thereof and in a direction transverse to the longitudinal axis of the burner so that combustion of the mixture may be effected within said space to cause heating of said inner wall surface to incandescence and produce a region of intense heat in which substantially complete combustion is accomplished while heated products of combustion are discharged through the outlet, a helical rib of high temperature refractory material at the inner wall surface which extends from the inlet toward the restricted outlet and terminates at a region spaced from the latter, and spaced apart vanes of high temperature refractory material at the inner wall surface which extend axially of said space from the helical rib to a region adjacent the restricted outlet to promote straight line flow of the heated gases discharged through the outlet.

7. A gas burner comprising structure forming a substantially cylindrical combustion chamber having a restricted outlet at one end thereof, said structure being formed with a pair of oppositely disposed inlets for a combustible gas mixture extending tangentially to the inner wall surface of said chamber and transverse to the axis thereof, said inlets being located adjacent the end of said chamber away from said outlet, a perforated screen over said inlets to divide the gas mixture into a plurality of streams, and a helically disposed flange extending perpendicularly from the inner wall of said chamber and beginning at a point above said inlets and ending at a point adjacent said outlet.

8. A gas burner comprising structure including a hollow body which provides a substantially closed combustion chamber having an inlet and a

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restricted outlet, said inlet being formed to supply a gas mixture into said chamber tangentially to the inner wall surface thereof and in a direction transverse to the longitudinal axis of the burner, means located on the inner wall surface of said chamber to direct the gases therein in a helical path of movement while passing from the inlet toward the outlet, and means formed on said inner wall surface adjacent the outlet to retard the helical movement of the gases and promote straight line flow thereof upon discharge through said restricted outlet.

9. A gas burner comprising structure forming a substantially cylindrical combustion chamber having a concentrically located restricted outlet at one end thereof, said chamber being lined with high temperature refractory material, the end of said chamber opposite said outlet being formed with a flat surface perpendicular to the cylindrical walls of said chamber, means through which a combustible mixture of fuel may be discharged under pressure into said chamber parallel to said end at a point closely adjacent thereto, said re-

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stricted outlet gradually changing in shape from cylindrical at the beginning thereof in said chamber to an elongated slot at the exit thereof whereby products of combustion issuing from said outlet will be in the form of a narrow stream.
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