

June 11, 1946.

F. O. HESS

2,402,045

ART OF HEATING

Original Filed Jan. 20, 1940

Fig. 2.

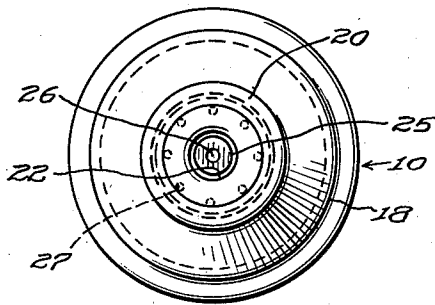


Fig. 4.

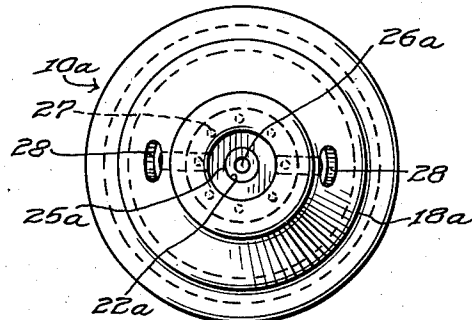


Fig. 1.

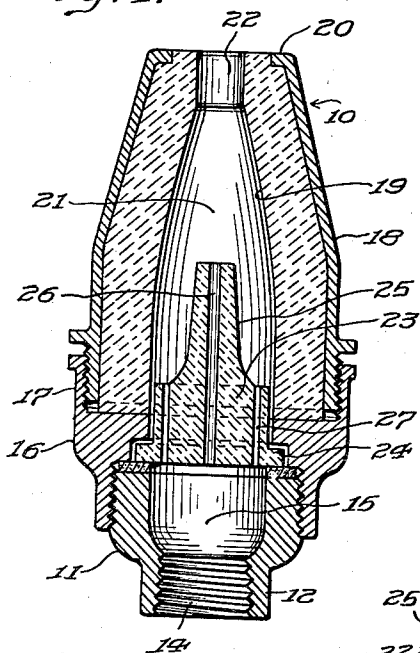


Fig. 3.

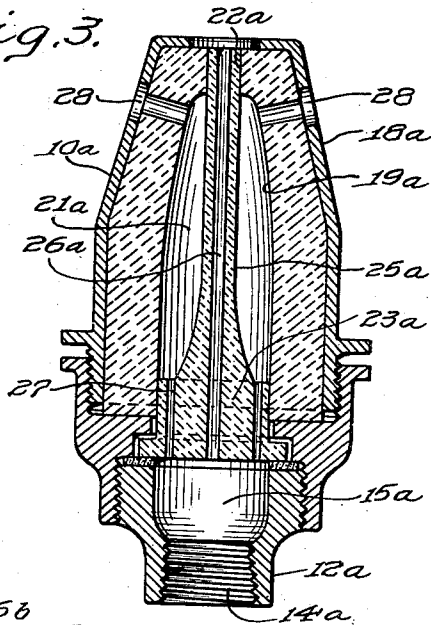


Fig. 5.

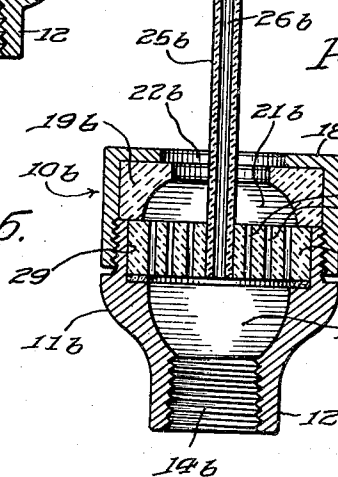
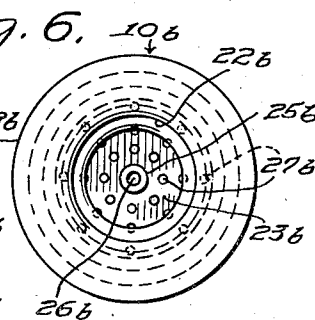


Fig. 6.



WITNESS

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2,402,045

ART OF HEATING

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Original application January 20, 1940, Serial No.
314,754. Divided and this application Decem-
ber 10, 1943, Serial No. 513,708

8 Claims. (Cl. 158—99)

1

My invention relates to the art of burning a combustible gaseous mixture, and is particularly concerned with the production of gaseous heat at extremely high temperatures with the aid of a gas burner to which is supplied a combustible fuel of air and a gas, such as, for example, ordinary city gas, natural gas and the like. This application is a division of my co-pending application Serial No. 314,754 filed January 20, 1940, for an improved "Torch burner," now Patent No. 2,367,119 granted January 9, 1945.

An object of my invention is to provide an improvement for effecting combustion of a combustible mixture of air and a gas of the character above-described, in which heated gases consisting substantially entirely of products of combustion are heated to an elevated temperature sufficiently high for surface hardening of ferrous metals and other heat treating operations heretofore accomplished only by burners of the oxy-acetylene type in which the gas reacts with oxygen instead of ordinary air.

Another object of my invention is to provide an improvement whereby the combustion reaction of air and a combustion supporting gas, such as, for example, ordinary gas, natural gas and the like, is intensified and the transfer of heat to work pieces is accelerated, so that a greater amount of heat can be liberated in a given space than heretofore possible through air-gas combustion.

A further object of the invention is to provide an improvement whereby the combustion reaction of air and a combustion supporting gas of the character just mentioned is intensified and effected at higher temperatures than heretofore possible, so that the rates of heat delivery over selected small areas of work pieces and maximum attainable temperatures are substantially increased, thereby greatly widening the scope and field of application of burners of the type operated with gas and air.

In accordance with my invention, a gas and air fuel mixture is supplied under pressure to a burner providing for the gas mixture a passage or path of flow having wall surfaces formed of refractory material. The path of flow embodies a combustion chamber in which burning of the gas mixture is normally effected. Due to such burning of the gas mixture, the refractory surfaces are heated to incandescence so that the gas mixture will be subjected to an intense heat radiated from the incandescent wall surfaces to effect substantially complete burning and combustion of the gas mixture in the path of flow.

Further, refractory surfaces spaced from and

2

disposed about all or a part of the passage are heated to incandescence, so that the gas mixture passing through the path of flow will be subjected to additional heat radiated from such spaced refractory surfaces. Heating of the gas mixture by such radiated heat accelerates the rate and increases the temperature at which combustion of the gas mixture is effected. During normal burner operation the pressure in the combustion chamber is above that of atmosphere. Due to the intense heating of the gas mixture along the path of flow, the gases expand many fold and from the burner are discharged hot gases at elevated temperatures consisting substantially entirely of heated products of combustion uncooled and undiluted by secondary air, and capable of delivering heat at an extremely high rate and at an elevated temperature of 3000° F. to 3400° F. and higher.

The invention, together with the above and other objects and advantages thereof, will be more fully understood from the following description and accompanying drawing forming a part of this specification, and of which:

Fig. 1 is a vertical sectional view of a burner illustrating one embodiment for carrying out the invention;

Fig. 2 is an end view looking toward the discharge orifice of the burner illustrated in Fig. 1;

Fig. 3 is a vertical sectional view of a burner illustrating another embodiment of the invention; Fig. 4 is an end view of the burner shown in Fig. 3 and similar to Fig. 2;

Fig. 5 is a vertical sectional view of a burner illustrating a still further embodiment of the invention; and

Fig. 6 is an end view of the burner illustrated in Fig. 5.

Referring to Figs. 1 and 2, the burner 10 includes a base member 11 having a nipple connection 12 formed integrally therewith. The nipple connection 12 is formed with an opening 14 constituting the inlet of the burner and is adapted to be connected to a suitable source of supply of a gas and air fuel mixture. The base member 11 is shaped to provide a gas inlet chamber 15 into which the air and gas mixture enters through the opening 14.

To the base member 11 is threadedly secured an intermediate annular part 16 having an outer lip 17 which threadedly receives the lower end of a ring-shaped outer metallic shell 18. Within the metallic shell 18 is disposed a hollow refractory body 19 having the bottom edge thereof resting against the top face of the annular interme-

diate part 16, and having the top edge recessed to receive an inwardly extending flange 20 at the upper end of the shell 18.

The hollow refractory body 19 is shaped to provide a combustion chamber 21 having a more or less straight bottom wall portion adjacent to the inlet chamber 15, and a concave-shaped top wall portion tapering to the outlet or discharge orifice 22. Adjacent to the inlet chamber 15 is positioned an orifice member 23 of refractory material having a shoulder 24 which is held in position at an undercut or recessed portion of the annular part 16.

A hollow tubular part 25 of refractory material is formed integrally with the orifice member 23 and extends or projects upwardly into the combustion chamber 21. The tubular part 25 is formed with a central passage 26 which also extends through the orifice member 23 to the inlet chamber 15. In addition, the orifice member 23 is provided with a plurality of small parallel passages 27 adjacent to and spaced about the peripheral edge thereof, so as to effect distribution of the gas and air mixture into the combustion chamber at regions between the straight wall portion of combustion chamber 21 and the tubular part 25.

When the burner 10 is being operated, a combustible fuel, such as, for example, air and ordinary city gas or natural gas and the like, is supplied under pressure to the inlet 14 from a suitable source of supply. One path of flow for the fuel mixture from the inlet chamber 15 is formed by the passage 26 in the tubular part 25 and by the combustion chamber 21. The fuel mixture is also distributed and discharged into the bottom part of the combustion chamber 21 through the small openings 27. The upper ends of the openings 27 serve as discharge ports, and it is at these regions that a plurality of flames are produced and maintained during normal operation of the burner.

During normal operation of the burner 10, a flame is also produced and maintained at the upper end of the passage 26 from which the fuel mixture is discharged into the combustion chamber 21. The gas flames maintained at the upper ends of openings 27 and the upper end of tubular part 25 effect such heating of the refractory wall surfaces of the refractory body 19 that these surfaces are heated to incandescence. The gas mixture introduced into the combustion chamber 21 is subjected to intense heat radiated from the incandescent wall surfaces of the refractory body 19 to cause complete burning of the gas mixture within the combustion chamber 21 before the gas mixture reaches the outlet 22.

In the burner 10 the air and gas fuel mixture is introduced at such a pressure into the inlet formed by the passage 26 and openings 27, and the outlet 22 is so correlated to the inlet, that the pressure in the combustion chamber 21 is maintained above that of atmosphere. In this way the combustion reaction of the gas and air is intensified, so that a large quantity of heat can be liberated in a given size of combustion chamber 21.

From the outlet 22 is discharged at a high velocity a blast of hot products of combustion at an elevated temperature of about 3200° F. when only using a fuel mixture of air and city gas having a rating of only about 500 B. t. u. per cubic foot. Since combustion of the air and gas fuel mixture is completely effected in the combustion chamber 21, the need for utilizing secondary air

to complete combustion after the heated gases are discharged from the outlet 22 is avoided.

Since the addition of secondary air in an ordinary burner flame effects cooling of the flame, it will be seen that the blast of hot gases discharged from the outlet 22 will not be subjected to objectionable cooling and dilution by secondary air. This is extremely important where high temperatures are desired, because the heating effect produced by the blast of heated gases is dependent upon the temperature differential between the work surfaces and the heated gases at the instant of impingement of such gases on the work surfaces. By maintaining heated gases at as high a temperature as possible, the work surfaces will be heated to a maximum elevated temperature and in the shortest interval of time possible.

The flames produced and maintained at the upper ends of openings 27 project upwardly alongside of the straight walled portion of the refractory body 19 and the outer surface of the tubular part 25. In this way both the outer surface of tubular part 25 and the straight wall portion of the refractory body 19 are heated to incandescence during normal burner operation. Due to such heating of the outer surface of tubular part 25 and the heat radiated thereto from the incandescent wall surfaces of the refractory body 19, the gas mixture passing through the passage 26 is subjected to intense heating.

The heating of the gas mixture while passing through the passage 26 may be sufficient to cause initiation of combustion within the tubular part 25. In any event, even when the burner 10 may be operating under such conditions that combustion of the gas mixture is not initiated while flowing through the passage 26, the heating of the tubular part 25, in the manner just explained, effects such heating of the gas mixture flowing therethrough that combustion of the gas mixture in combustion chamber 21 is accelerated and such combustion is effected at a higher temperature. Thus, by subjecting the gas mixture within tubular part 25 to heat radiated from the refractory surfaces spaced from and disposed about the tubular part 25, and by also heating the outer surface of the tubular part 25 to incandescence, the gas mixture passing through one path of flow in the burner 10 will be highly heated, thereby intensifying the combustion reaction and effecting such combustion at higher temperatures.

Figs. 3 and 4 illustrate a burner 10a like that shown in Figs. 1 and 2 and just described and differs therefrom in that the gas mixture passing through one path of flow in the burner is subjected to heat radiated from a refractory wall surface substantially coextensive in length with and disposed alongside such path of flow. The burner shown in Figs. 3 and 4 is generally similar to that illustrated in Figs. 1 and 2, and similar parts are designated by the same reference numerals.

In Figs. 3 and 4 the tubular part 25a is formed integrally with the orifice member 23a and terminates at its upper end within the opening 22a formed in the refractory body 19a. At the upper part of the shell 18a and refractory body 19a are formed a plurality of openings 28 serving as outlets for the chamber 21a. It will be evident that in the embodiment in Figs. 3 and 4, the gas mixture flowing through the passage 26a in tubular part 25a is segregated from the gas mixture introduced into chamber 21a, and the heated products of combustion are discharged from the

5

tubular part 25a at a high velocity in the form of a jet similar to that indicated by dotted lines in Fig. 5.

In the normal operation of the burner 10a shown in Figs. 3 and 4, flames are produced and maintained at the upper ends of openings 27 in the same manner as explained above in describing the operation of the burner 10 illustrated in Figs. 1 and 2. These flames effect such heating of the inner refractory wall surfaces of the refractory body 19a that these surfaces are heated to incandescence. The flames maintained at the upper ends of openings 27 also effect such heating of the tubular part 25a that the outer surface thereof is heated to incandescence. In addition, the tubular part 25a is subjected to heat radiated from the refractory wall surfaces of the refractory body 19a, thereby maintaining the tubular part 25a at an extremely high temperature. Due to this heating of the tubular part 25a, the gas mixture passing through passage 26a is subjected to intense heating.

The heating of the gas mixture in passage 26a is sufficient to cause initiation of combustion of the gas mixture within tubular part 25a. With such burning or combustion of the gas mixture initiated within passage 26a, the inner wall surface of the tubular part 25a, except the lower portion thereof, is heated to incandescence. The heating of the inner wall surface of tubular part 25a to incandescence by the combustion of the gas mixture taking place in passage 26a, augmented by the heating of the tubular part by the heating effect of the flames in chamber 21a and by heat radiated from the inner wall surfaces of the refractory body 19a, will cause complete burning of the gas mixture within passage 26a before the gas mixture is discharged from the upper end of the passage.

It will now be evident that the passage 26a constitutes a first combustion chamber and the chamber 21a constitutes a second combustion chamber, and that the tubular part 25a serves as a partition or barrier of refractory material between the two combustion chambers. The high temperatures maintained in combustion chamber 21a and the heat radiated from the refractory wall surfaces of the refractory body 19a serve to shield the inner combustion chamber or passage 26a from the surroundings, and to effect preheating or superheating of the gas mixture passing into the passage 26a. Since complete combustion of the gas mixture is effected within the passage 26a, the high temperature jet produced by the burner 10a consists entirely of the heated products of combustion. Such highly heated gases can be utilized to do useful work at an extremely high temperature without objectionable cooling occurring at the immediate vicinity of the burner outlet because, as pointed out above, the need for using secondary air to complete combustion is avoided.

Complete combustion of the gas mixture is also effected in chamber 21a. The heated products of combustion produced and developed in chamber 21a pass therefrom through the outlets 28 and are segregated from the higher temperature heated products of combustion discharged in the form of a jet from the upper end of tubular part 25a.

The burner 10b illustrated in Figs. 5 and 6 differs from the burner 10a just described in that the tubular part 25b is of considerably greater length than the combustion chamber 21b. The burner 10b includes a base member 11b shaped

6

to form an inlet chamber 15b communicating with an inlet 14b formed within a nipple connection 12b. The base member 11b threadably receives the lower end of an annular metallic shell 18b within which is disposed a hollow refractory body 19b.

The refractory body 19b rests upon an orifice member 23b which is held in position within a recessed part 29 of the base member 11b. The inner refractory wall surfaces of the refractory body 19a slope upward and inward toward an outlet or discharge orifice 22b formed at the upper part of the refractory body and shell 18b. The tubular part 25b is fixed at its lower end within the orifice member 23b and projects upward from the combustion chamber 21b through the outlet 22b.

The operation of the burner 10b in Figs. 5 and 6 is similar to that described in connection with the embodiment shown in Figs. 3 and 4. During normal operation of the burner 10b, a plurality of flames are produced and maintained at the upper ends of openings 27b formed in the orifice member 23b. These flames effect such heating of the inner refractory wall surfaces of the refractory body 19b that these surfaces are heated to incandescence. The flames maintained at the upper ends of the openings 27b also effect such heating of the lower portion of the tubular part 25b that the exterior surfaces thereof are also heated to incandescence. The portion of the tubular part 25b within the combustion chamber 21b is also subjected to heat radiated from the refractory wall surfaces of the refractory body 19b, so that the lower portion of the tubular part 25b is heated to an extremely high temperature to preheat or superheat the gas mixture entering the passage 26b.

The gas mixture in passage 25b is heated sufficiently to initiate combustion of the gas mixture, whereby the inner wall surface of the tubular part 25b, at a region above the extreme lower portion thereof, is heated to incandescence. Due to this heating of the tubular part 25b, substantially complete burning of the gas mixture may be effected within passage 26b before the gas mixture is discharged from the upper end of the tubular part 25b in the form of a high velocity gas jet which is of slender form, as indicated by the dotted lines in Fig. 5.

Since substantially complete combustion of the gas mixture may be effected within the passage 26b, the high temperature jet produced at the upper end of the tubular part 25b will consist substantially entirely of the heated products of combustion. The outlet 22b is substantially greater in size than the tubular part or nozzle 25b, whereby the heated products of combustion will issue from the combustion chamber 21b in a relatively slow moving annular stream which does not mix with and is segregated from the high velocity jet produced at the upper end of the tubular part or nozzle 25b.

In each of the embodiments just described, the body of highly refractory material disposed within the outer shell possesses such thermal properties that a poor thermal conductive path is provided through the refractory wall, so that the heat loss therethrough will be kept at a minimum. In order to withstand the high temperatures produced within the burners, the refractory walls of the combustion chambers and orifice members are preferably formed of a highly refractory material. In some cases I have found that the refractory body disposed within the outer

shell may be formed or consist largely of magnesium oxide, and the orifice members and hollow tubular parts may be formed of beryllium oxide.

By providing a burner having refractory wall surfaces, combustion chamber temperatures of 3000° F. to 3400° F. are attained when operating the different burners described and illustrated in the manner explained above. By virtue of the high combustion chamber temperatures attained, the gas mixture introduced into the combustion chambers at a relatively low temperature undergoes considerable expansion, so that the volume of heated gases discharged from the outlet per unit of time is considerably greater than that introduced into the combustion chamber.

In all of the embodiments described above, the combustion chambers are maintained at a pressure above that of atmosphere, as has already been pointed out. This is an essential feature and is an important factor in operating the burners to attain high combustion capacity.

By maintaining the combustion chamber at a pressure above that of atmosphere and utilizing heat radiated from the highly heated incandescent refractory wall surfaces to effect heating of the gas mixture, the rate of flame propagation is accelerated. This permits an increase in the pressure at which the gas and air mixture may be delivered to the combustion chamber.

Since combustion of the gas mixture is effected substantially entirely within the combustion chamber and the gases undergo considerable expansion, as previously stated, any increase in the gas delivery pressure consistent with the intended mode of operation results in an enormous increase in the rate of which the heated gases pass from the combustion chamber. In this way, the rate of heat liberation is stepped up many fold for doing useful work in the shortest possible lengths of time and in a most efficient manner, and with maximum utilization of the gas and air fuel mixture supplied to the combustion chamber.

By virtue of the fact that burners like that illustrated and described above are capable of liberating 14,000,000 B. t. u. or more per hour per cubic foot of combustion space when using a fuel mixture of city gas and air, it will be evident that the scope and field of application of burners of this type have been widened considerably. This represents over a threefold increase when compared to previous methods in prior burner practice in which heat has been liberated at about only 4,000,000 B. t. u. per hour per cubic foot of combustion space. The fact that heat can be liberated at the high rate just stated, when only using as a fuel city gas having a B. t. u. rating of about 500 B. t. u. per cubic foot, is believed to represent a very substantial increase in the rate of heat liberation over burners of the type used heretofore.

While I have shown and described several embodiments for carrying out the invention, such variations and modifications are contemplated as fall within the true spirit and scope of the invention, as pointed out in the following claims:

What is claimed is:

1. A burner comprising structure including a hollow body having an inlet and a restricted outlet and between them an imperforate wall forming a combustion chamber which is smaller in cross section adjacent to the outlet than the inlet, said chamber having an inner lining, said inlet having a number of small passages for subdividing

into a plurality of gas streams a combustible gas mixture adapted to be supplied thereto under pressure, said chamber having its outlet and inner lining formed substantially entirely of high temperature refractory material so that combustion of the gas streams may be effected within said chamber to cause heating of said lining to incandescence and produce a region of intense heat in which substantially complete combustion is accomplished, and a member of high temperature refractory material associated with the inlet and having a passage therethrough to which said combustible gas mixture is adapted to be supplied at one end adjacent the inlet and from which a gas stream is discharged from the opposite end, said combustion chamber being disposed about and enveloping at least a part of said member to effect heating of the gas mixture in said passage.

2. A burner comprising structure including a hollow body which provides a substantially closed cavity having an inlet at one end and a restricted outlet at its opposite end and an imperforate wall between them, said cavity having its outlet and inner wall surface formed substantially entirely of high temperature refractory material so that a combustible gaseous mixture supplied under pressure to the inlet may produce combustion within said cavity to cause heating of the inner wall surface to incandescence and produce a region of intense heat in which substantially complete combustion is accomplished, and said inner wall surface including high temperature refractory wall means forming a passage within said body which extends from the inlet toward the outlet and terminates at a region removed from the inlet so that combustible gaseous mixture in said passage and supplied thereto under pressure at the end adjacent the inlet will be subjected to the heat developed in the cavity as the result of combustion of the gaseous mixture in the latter.

3. A burner comprising structure including a hollow body which provides a substantially closed space having an inlet at one end and a restricted outlet at its opposite end, said space having its outlet and inner wall surface formed substantially entirely of high temperature refractory material so that a combustible gaseous mixture supplied under pressure to the inlet may produce combustion within said space to cause heating of the inner wall surface to incandescence and produce a region of intense heat in which substantially complete combustion is accomplished, and high temperature refractory wall means within said body providing a passage which extends from the inlet toward the outlet so that combustible gaseous mixture in said passage and supplied thereto at one end adjacent the inlet is subjected to the heat developed in the space as the result of combustion of the gaseous mixture in the latter, said passage at a region removed from the inlet being open to said space so that gases in said passage join the gases in said space while a stream of products of combustion is discharged through the outlet from the interior of the body.

4. A burner comprising structure including a hollow body which provides a substantially closed cavity having an inlet at one end and a restricted outlet at its opposite end, said inlet having a number of small passages for subdividing into a plurality of gas streams a combustible gaseous mixture adapted to be supplied thereto under pressure, said cavity having its outlet and inner wall

surface formed substantially entirely of high temperature refractory material so that combustion of the gas streams may be effected within said cavity to cause heating of said inner wall surface to incandescence and produce a region of intense heat in which combustion is accomplished, said inner wall surface including high temperature refractory wall means forming a passage within said body which extends from the inlet toward the outlet and terminates in a restricted discharge orifice exteriorly of the body, said passage being adapted to receive combustible gaseous mixture under pressure at one end adjacent the inlet which is subjected to the heat developed in the cavity as the result of combustion of the gaseous mixture in the latter.

5. A burner comprising structure including a hollow body which provides a substantially closed combustion chamber having an inlet at one end and a restricted outlet at its opposite end, said inlet having a number of small passages for subdividing into a plurality of gas streams a combustible gaseous mixture adapted to be supplied thereto under pressure, said chamber having its outlet and inner wall surface formed substantially entirely of high temperature refractory material so that combustion of the gas streams may be effected within said chamber to cause heating of the inner wall surface to incandescence and produce a region of intense heat in which substantially complete combustion is accomplished, and high temperature refractory wall means forming a passage in said body which extends from the inlet toward the outlet and terminates at a region removed from the inlet, said refractory wall means forming said passage being subjected to the heat developed in said chamber as the result of combustion of the gaseous mixture in the latter.

6. In the art of burning a combustible gaseous mixture with the aid of an elongated member formed of high temperature refractory material which is annular in transverse section and provides a relatively small passage having an inlet and an outlet, the improvement which includes supplying the combustible gaseous mixture under pressure through the inlet into said passage for combustion therein, heating the outer surface of said member to cause flow of heat therethrough to its inner surface, thereby heating said inner surface sufficiently to initiate combustion of the gaseous mixture in said passage at a region intermediate the inlet and outlet, the radiant heat

from said inner surface resulting from flow of heat thereto from said outer surface acting to maintain the gaseous mixture ignited in said passage before the mixture reaches the outlet.

7. In the art of burning a combustible gaseous mixture with the aid of an elongated member having a wall formed of high temperature refractory material and which is annular in transverse section and provides a relatively small passage having an inlet and an outlet, the improvement which includes supplying the combustible gaseous mixture under pressure through the inlet into said passage for combustion therein, heating the outer surface of said wall to cause flow of heat therethrough to its inner surface and heat the latter sufficiently to effect ignition and combustion of the gaseous mixture in said passage, thereby heating said inner surface both by the heat developed from the combustion of the gaseous mixture in said passage and heat flowing thereto from said outer surface, the resulting radiant heat from said inner surface acting to heat the wall to incandescence and effect substantially complete combustion within said passage, and discharging the products of combustion from said passage through said outlet in the form of a jet.

8. In the art of burning a combustible gaseous mixture with the aid of wall structure which is annular in transverse section and provides a passage having an inlet and an outlet from which a slender jet is adapted to be discharged, the wall of said passage and outlet being formed of high temperature refractory material, the improvement which includes supplying the combustible gaseous mixture under pressure through the inlet into said passage for combustion therein, heating the outer surface of the wall to incandescence by a source of heat which is capable by itself of effecting such heating to cause flow of heat through the wall to its inner surface and heat the latter sufficiently to ignite and effect combustion of the gaseous mixture in said passage, thereby heating said inner surface both by heat developed from combustion of the gaseous mixture in said passage and heat flowing thereto from said outer surface, the resulting radiant heat from said inner surface acting to effect substantially complete combustion within said passage, and discharging the products of combustion from said passage through said outlet in the form of a slender jet.

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