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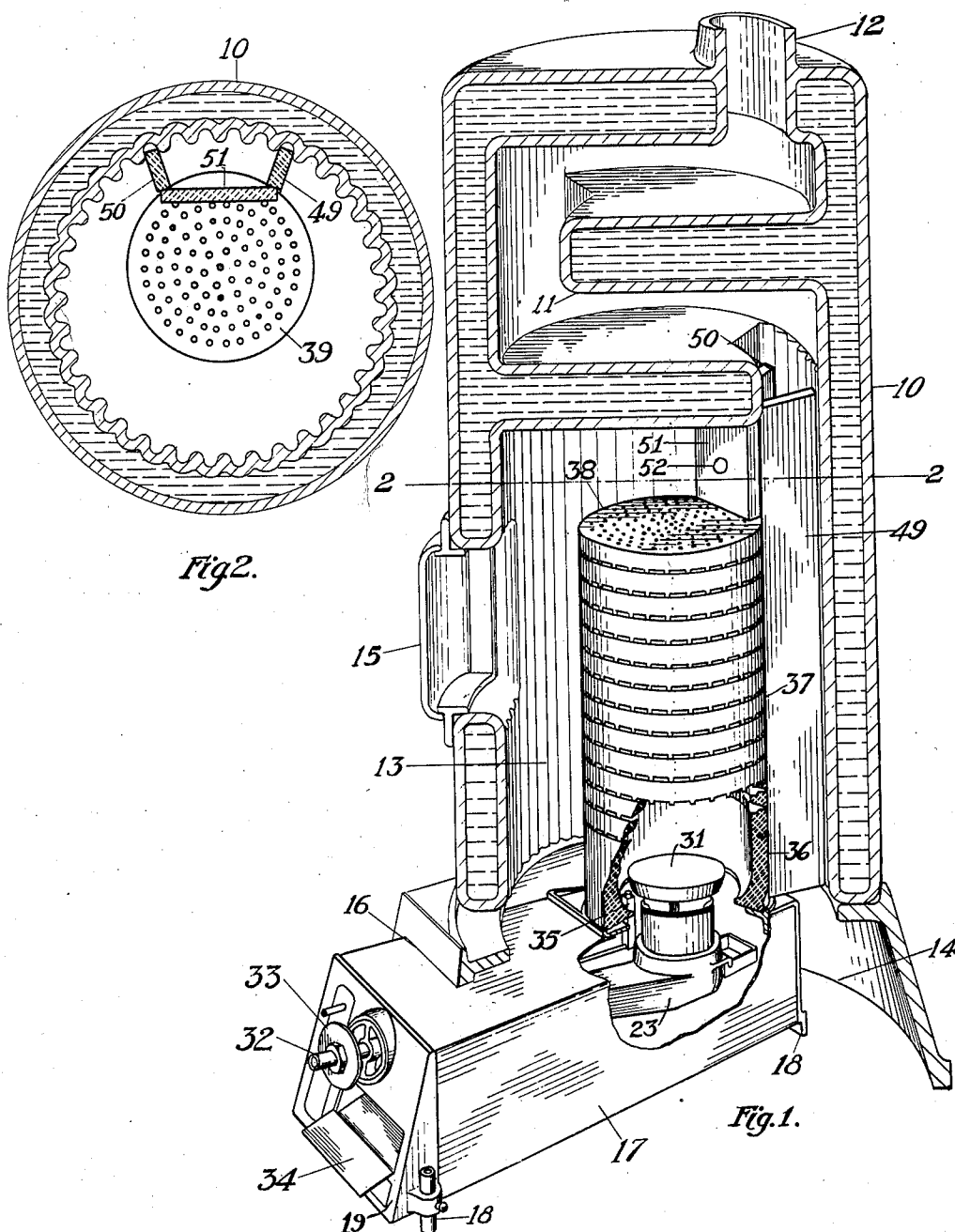
A. U. WETHERBEE

1,978,517

GAS BURNER

Filed Nov. 5, 1930

2 Sheets-Sheet 1



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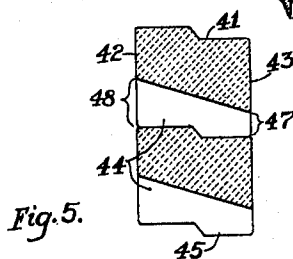
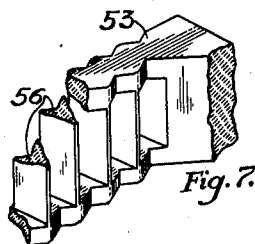
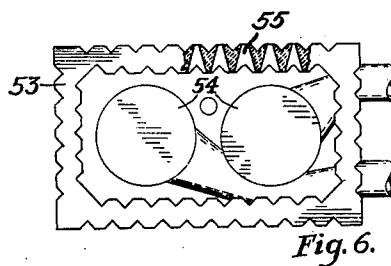
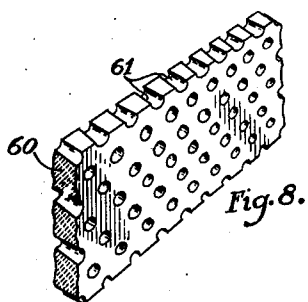
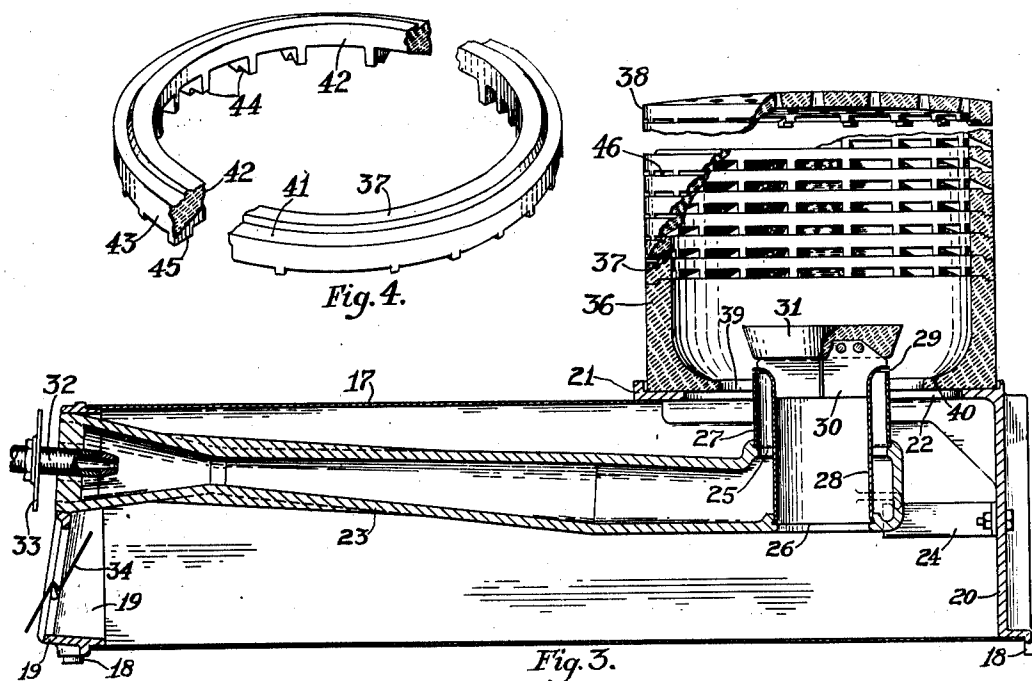
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UNITED STATES PATENT OFFICE

1,978,517

GAS BURNER

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Application November 5, 1930, Serial No. 493,537

23 Claims. (Cl. 158—7)

This invention relates to heating appliances and more particularly to equipment suitable for installation in heating units of the type designed for burning solid or liquid fuels. In its general aspects the invention relates to a novel gas burner arrangement, an insert to be positioned in the firebox of a furnace, such as a domestic heating furnace of the solid or liquid fuel type for converting said furnace into an efficient gas heating system with high economy of heat development and transfer.

Heretofore, inverted cone-like baffling or paddle means for diverting the flame and gases of combustion against the firebox walls of the unit to be heated have been proposed for use in solid and liquid heating units for converting said units into gas heating systems. Such constructions are, however, open to the very serious objection that the gases are burned under atmospheric conditions without positive co-mingling of the gases with the oxygen of the air and to obtain complete combustion, it is necessary to entrain a large amount of excess air. Further, the burning gases are diverted outwardly against the walls of the fire-box where they are cooled resulting in the formation of carbon monoxide gases and other objectionable features.

One primary object of the present invention is to provide a burner structure wherein complete combustion of the combustible gases is effected before the gases contact with the firebox walls and in which a large portion of the heat transfer is effected as radiant energy directly to the fire-box walls.

Another object of the invention is to provide a perforated refractory chamber in which combustion is completed and which acquires a high degree of incandescence on the greater portion of its interior surface reflecting heat on the burning gases to expedite their combustion.

An additional object is the provision of a combustion chamber into which the combustible mixture is discharged and burned at a temperature in excess of that obtainable under atmospheric conditions due to the highly radiant walls surrounding the burning mixture.

Still another object is the provision of a burner which develops a high percentage of radiant heat and emanates this radiant heat to the firebox walls of the heat absorbing appliance, thereby increasing the heat absorbing capacity of said firebox, and by the complete absorption of this portion of the heat of combustion emanated as radiant heat, increasing the overall efficiency of the appliance.

A further object is to provide an efficient burner which generates a smaller amount of products of combustion on account of low excess air with consequent high temperatures, causing better heat transfer.

A still further object is to provide a burner arrangement providing a long path of gas travel and a comparatively long time of retention of the gases in the fire-box.

Additional objects of the invention are to provide a conversion burner capable of universal application with any form of domestic heating plant; to provide a burner of comparatively simple form which is inexpensive to install and of low operating and up-keep costs, yet of a substantial and enduring nature and to provide a burner which is comparatively noiseless in operation.

A further additional object is to provide a burner assembly of long life and universal application, and one which fulfills all requirements of manufacture and service.

Other objects and advantages will be manifest from the description.

The various features of novelty which characterize the invention will be well understood by reference to the following description of the illustrative embodiments thereof shown by way of example, in the accompanying drawings, in which:

Fig. 1 is a vertical sectional view of a conventional boiler showing the invention applied thereto with certain parts broken away to illustrate the interior arrangement of the parts.

Fig. 2 is a horizontal sectional view on line 2—2 of Fig. 1 showing the arrangement of the burner and partition walls in the firebox of the furnace.

Fig. 3 is a central, vertical, sectional view through the casing and burner assembly.

Fig. 4 is a perspective view partly in section of a preferred form of refractory member.

Fig. 5 is a cross section of two of the refractory members, approximately actual size, in assembled position.

Fig. 6 is a plan view with the top removed and certain parts broken away of a modified form of the invention showing the arrangement of a plurality of fuel burners in a rectangular refractory chamber.

Fig. 7 is an elevational view of the refractory of Fig. 6 with certain parts in section and broken away to illustrate the form and structure thereof.

Fig. 8 shows another form of refractory.

The present invention has been shown in connection with a domestic hot water heating plant,

but it is to be understood that this type of heating system is only to be taken as representative of the general type of heating systems. The heating system disclosed comprises a conventional domestic doubled walled hot water boiler 10 provided with a series of baffles 11 in the upper portion thereof forming a series of passes leading to the usual outlet 12. Below the baffles is the firebox 13 usually containing grates, for the support of the coal supplied thru the door 15, and below the firebox is the usual ashpit 14 provided with an opening 16 normally closed by a door. The grates have been removed from the firebox 13 and the door has also been removed from opening 16 for the installation of the burner.

The present disclosure is intended to illustrate the application of the invention to a household type of furnace and the assembly herein featured is designed to be readily installed in such conventional forms of furnaces. There is disclosed an assembly casing 17 preferably of sheet metal of such size as to pass freely thru the ashpit door of the furnace, as shown in Fig. 1, and provided with suitable legs or supports 18, the front ones of which are preferably adjustable to make up for irregularities in the supporting structure. The front end of the casing is closed by a casting 19, structurally arranged to accommodate the necessary operating apparatus, and the rear end of the casing is closed by a casting 20 having an upper extension 21 provided with an opening 22 and fitted to form a support for the refractory cylinder later to be described.

Enclosed within the casing is a mixing tube 23 having a Venturi throat and supported at its forward end by casting 19 and at its rear end by a bracket 24 carried by casting 20, the connection with the bracket 24 being of a detachable character to facilitate removal and replacement of the tube 23. The rear end of the tube is expanded to form the lower portion of the burner head and contributory to that end openings 25 and 26 are provided in the upper and lower walls respectively of the tube, and said openings are preferably concentrically arranged. The concentric space between the short tube 27, fitted into the opening 25, and a longer tube 28, fitted into the lower opening 26, constitutes a continuation of the tube 23 and the upper end of tube 28 is flared outwardly to cooperate with the tube 27 to form therewith an opening 29 of narrow slit-like character thru which the primary mixture of gas and air is discharged. Tubes 27 and 28 are preferably made of heat resisting material, such as ascaloy metal, and tube 28 carries a support 30 in the form of a spider upon which cap 31 is mounted. This cap is preferably made of a refractory material and its primary functions are to divert the secondary air, discharged thru tube 28, into proximity to the flame emitting from the discharge slot 29, and to prevent excessive heating of the burner head.

A spud or nozzle 32 is conveniently mounted in the forward end of the tube 23 for directing the gas into said tube and an air shutter 33, for regulating the flow of air into the end of the tube, is adjustably mounted upon the spud 32 for adjustment to and from the end of the tube. A door 34 conveniently mounted in the casting 19 is adapted to regulate the flow of secondary air to the interior of the casing. Pilot 35, conveniently supplied with gas, is located adjacent the discharge slot 29 for the purpose of igniting the gas when the burner is turned on.

The casing assembly and burner head, while

illustrated in connection with the present invention, form the subject matter of a separate application and are not claimed in this one.

The combustion chamber or burner of the preferred form of the invention, illustrated in Fig. 3, preferably comprises a base ring 36 surmounted by a series of spaced apart refractory rings 37 forming a series of narrow openings therebetween and a foraminated top 38 closing the upper end of the chamber. This composite chamber is supported on the extension 21 of the casting 20, and when the parts are installed in a boiler or furnace, the cylinder occupies a position substantially concentric and spaced from the walls of the firebox on all sides.

Referring more specifically to the structural features of the cylinder in Fig. 3, base ring 36, which may be made of either refractory or heat resisting material, such as ascaloy metal, has its lower interior wall flared inwardly to provide an opening 39 of less diameter than the interior diameter of the cylinder. This opening is also smaller than the opening 22 in the extension 21 and when a cylinder is positioned on the extension 21, a portion 40 thereof projects over the supporting portion 21. This over-hanging portion and the opening 39 therethru form one secondary air inlet to the cylinder and the ledge protects the extension 21 and other mechanism within the casing by excluding heat therefrom, the other secondary air inlet being formed by the tube 27 of the burner head. Although base ring 36 is desirable as directing the burning gases upwardly in the cylinder, satisfactory results may also be obtained with a cylinder composed entirely of ring members, also the height of ring 36 may be varied to suit particular installations and the base may be made in sections.

The individual rings 37 in transverse cross section are generally trapezoidal or triangular in form, as shown in Fig. 5. The rings have a depressed portion 41 forming a ledge in one face thereof, preferably the top, while the inner and outer faces 42 and 43, respectively, are substantially straight and parallel, with the outer face of greater dimension than the inner face and the other or lower face inclined downwardly and outwardly as illustrated. The rings are adapted to be superimposed one above the other upon the base and are provided with spacing members 44, which have complementary raised portions 45 arranged to engage and interlock with the depressed portion 41 of an adjacent ring when assembled, as illustrated in Figs. 3 and 5. This interlocking feature is also applied to the base and top and facilitates assembly of the elements comprising the cylinder and also precludes displacement after they have been assembled.

When rings of the above characteristics are assembled, openings or apertures 46 are formed between adjacent ring sections. These openings, when viewed from the exterior of the cylinder, Fig. 1, appear in the form of a series of slots extending circumferentially of the cylinder. When viewed in cross section, as in Fig. 5, the openings between the rings are substantially triangular or trapezoidal and converge outwardly and downwardly and are relatively long in the direction of gas travel therethru. That is, the length of the slot from the interior to the exterior faces of the chamber is relatively long, while the outer or discharge end 47 of the slot is relatively narrow as measured between adjacent elements forming the walls of the slot. The outer end or discharge opening 47 of the slot is narrower than

the interior end 48 of said slot and the length of the slot in the direction of the travel of the gases therethru is much greater than any portion of the slot.

There are numerous advantages in having the outlet passages for the combustion chamber of the form indicated. By making the openings converge, the escape of the gases from the burning chamber is retarded, thereby expediting combustion of the gases as they travel thru the slot. Escape of the burning gases is further restricted by the downward inclination of the roof or top of the slot which causes the gases to travel downward against the action of gravity. A further advantage, the burning of the gases in a cylinder and the slots therein heating the cylinder to a high degree of incandescence, of the converging slots is that a greater portion of the interior of the cylinder is exposed thru the slots and, consequently, a greater amount of radiant heat emanations pass outwardly thru the slots and to the firebox walls. This is an important feature since the interior of the cylinder is heated to a high degree of incandescence and, therefore, emits radiant heat of high intensity which passes outwardly thru the slots directly to the adjacent walls of the firebox.

While the interior of the cylinder develops a very high state of incandescence and radiant heat emanations, there is also a considerable amount of heat radiated from the exterior surface of the rings, due to the form of the rings, and the combustion of the gases on three sides of each of them, so that they become heated in their entirety, thus causing an external radiation of a lesser intensity from a comparatively large area. Although the above is the preferred form of the slots, satisfactory results may also be attained with the slots diverging outwardly rather than converging outwardly.

When it is desirable to utilize the beneficial results of long travel and long retention of the heated gases in the firebox, the firebox may be divided into a plurality of compartments, either by a pipe communicating with the outlet thru the baffles of the boiler and depending into the firebox to substantially the lower end of the refractory cylinder or by partitioning members 49 and 50. These members, preferably long narrow strips of light-weight refractory, or fire-bricks, are interposed between the adjacent walls of the cylinder and firebox and extend from the top wall of the firebox, usually the lower wall of the first baffle of the boiler, to approximately the lower end of the cylinder. The members may be conveniently supported on the casing, as shown in Fig. 1, and the space above the top of the cylinder and between the vertical members may be closed by a plate or fire-bricks 51, preferably provided with a leak-port 52, thru which any small leakage of gas from the burner may escape when the burner is off. With the members thus positioned, the outlet from the firebox is transferred to the lower terminus of the side members 49 and 50 and the firebox is also divided into two separate and distinct compartments, the larger or front portion of which is preferably three-quarters or seven-eighths of the entire heating surface of the firebox, while the remaining portion serves as a flue for the escape of the gases of combustion. When the baffles are used the cylinder may be placed somewhat eccentric of the firebox thereby affording a larger front-space with a corresponding reduction in the size of the flue space, and the openings 39 between the rings 37 and within

the flue space are preferably closed to prevent the gases by passing the front portion of the firebox.

In the operation of the device thus far described, the gas discharged thru the spud 32 aspirates primary air as it passes into the throat of the mixing tube 23. The shutter 33 is adjusted so that the admixture of air and gas in the tube form therein a combustible mixture. This primary mixture of gas and air flows thru the tube 23 up between the tubes 27 and 28 and out discharge opening 29, where it is ignited by the pilot 35, and burns in the form of a continuous ring of flame. The discharge of the primary mixture coupled with a slight suction in the firebox aspirates the secondary air, admitted thru the door 34, thru the openings to each side of the flame. A portion of the secondary air passes up thru the opening 39 to the underside of the flame, while another portion passes up thru the tube 28 and is deflected outwardly, by the cap 31, to the top or other side of the flame. The flame is thus supplied with an adequate, but not an excess, amount of secondary air to complete combustion and this air is preheated by contact with the cap 31 and ledge 40 before contacting with the flame. The cooling effect of the air on the burner head, cap, and ledge is advantageous since it prevents excessive heating at these points.

The burning gases pass into the slots between the refractory members and complete their combustion within such slots, heating the members to a high degree of incandescence, thereby changing more of the heat generated to radiant heat, also more radiant heat from the inner walls of the cylinder impinges on the sides of the slots, increasing the temperature of the members to the benefit of both combustion and radiation. The gases coming in contact with the incandescent portions of the cylinder and walls of the slots serve to give a measure of surface combustion of the type called "tunnel combustion". This form of combustion enables the burning of a considerably larger amount of gas with a minimum amount of excess air, which is a desirable feature.

The hot gases on leaving the cylinder pass directly into the space between the cylinder and the firebox walls of the furnace or boiler and thence to the usual outlet flue or chimney, or where the baffles are used the gases, unable to escape directly from the firebox, are trapped in the front portion thereof. The gases thus retained give further radiations, while at the same time, cooler gases flow along walls of the firebox with appreciable velocity. The longer the time of retention of the gases, the greater the amount of radiation from such gases, as is well known, while the greater the velocity at the point of contact, the more the scouring action reduces the thickness of the insulating gas film increasing the efficiency of the transfer of heat by convection. The cooler gases find their way underneath the members 49 and 50 and pass up thru the rear portion of the fire-box between said members where they give up an additional amount of their heat before entering the upper passes of the boiler.

From the foregoing, it will be seen that in a burner of the type disclosed herein, a high degree of efficiency is obtained because of the high degree of radiant heat developed and of the extraction of an additional amount of heat from the gases due to the hydraulic flow thereof, since such flow is obtained without interfering in any

way with the radiant heat emanations from the burner. It will also be seen that combustion of the burning gases is completed before the gases contact with the firebox walls, thereby minimizing, if not entirely eliminating, the possibility of the formation of carbon monoxide gases and other dangerous conditions.

While the above described apparatus constitutes the preferred form of the invention, it is obvious that various changes in the relationship and construction of the parts, as for instance, substitution of a polygonal combustion chamber for the cylindrical one, may be made without departing from the spirit of the invention and that some features of the invention may sometimes be used without a corresponding use of other features.

The fundamental features of the device lend themselves readily to various adaptations and modifications and a few of such modifications will now be described.

Referring to Fig. 6, the invention is disclosed as applied to a rectangular refractory member 53 in which two fuel burners 54 are employed. In this particular form of the invention, the refractory member or members has openings or slots 55 formed by substantially triangular shaped vertically extending elements 56, as shown more clearly in Fig. 7, and while these slots are vertically disposed, it will be obvious that they may be horizontally, obliquely or otherwise arranged. The elements preferably have the apexes of the triangle directed toward the interior of the refractory member and in operation, function substantially the same as the arrangement previously described in connection with Fig. 4.

Another form of the invention is illustrated in Fig. 8 wherein the refractory plate 60, representative of one side of a refractory chamber, is provided with a series of tapered openings 61, which in operation, function substantially the same as those previously described. While the openings 61 in the plate 60 are shown as moulded, it is obvious that they may be formed in any other suitable shape or manner.

From the foregoing description, it will be readily appreciated that a heat generating device constructed and arranged according to the present invention is very readily adaptable to existing heating systems. Thus, to install the present device, it is only necessary to remove the grates and ashpit door from the furnace, insert the assembly thru the door, assemble the refractory elements, and fit the partition members in place. Where the partition members are not desired or where the furnace is provided with an outlet adjacent the ashpit, the installation is the acme of simplicity, since there is nothing to fit. The shape of the firebox of the furnace offers no difficulties with the instant invention, since the burner does not contact with the walls of the firebox, therefore, there is no necessity for conformation in either size or shape.

Various changes in details of construction may be made without departing from the spirit of the invention.

What is claimed as new is:

1. A surface combustion burner comprising an enclosure of ceramic material built up in layers to form a stack, the walls of which are provided with a plurality of apertures which converge outwardly from the inner face thereof to define discharge passages in which the last stages of combustion are substantially completed and

means for introducing a combustible mixture into said enclosure.

2. A surface combustion burner comprising a series of superimposed spaced apart refractory elements forming an enclosed combustion chamber, the intervening spaces between adjacent elements converging outwardly to define narrow slit-like discharge openings and means for introducing a combustible mixture into said chamber whereby the mixture burns in said chamber and openings heating the elements to incandescence.

3. A surface combustion burner comprising a base of heat resisting material having a bottom in the shape of an upwardly and outwardly flaring bowl and provided with a central opening, a series of refractory elements surmounting said base and having formed therebetween a series of slit-like apertures, and a nozzle in said opening for projecting a combustible mixture into said base whereby said mixture on rising burns within the enclosure formed by said refractories and the openings therebetween.

4. A burner comprising a base of heat resisting material provided with an opening therein, a series of superimposed refractory elements surmounting said base and forming therewith a combustion chamber, a closure for the upper end of said chamber, said elements being spaced apart and providing intervening spaces converging outwardly to form slit-like apertures in the outer surface of the chamber and a burner nozzle in said opening for projecting combustible mixture into the base whereby said mixture in rising in said chamber burns therein and in said slit-like apertures as it travels outwardly there-through.

5. A surface combustion burner comprising a base formed as an upwardly and outwardly flaring bowl and provided with a burner receiving opening in the bottom thereof, a plurality of superimposed spaced refractory elements mounted on said base and forming therewith a combustion chamber, said elements being generally trapezoidal in cross-section and arranged with their apexes directed inwardly of the chamber and a burner in said opening for introducing a combustible mixture into said chamber which burns therein and in the intervening spaces between adjacent elements as it travels there-through.

6. In a radiant burner, a chamber of ceramic material having apertures therein, the walls of which converge outwardly to the exterior of the chamber, and means for projecting a combustible mixture into said chamber which in burning therein and in said apertures, heats the refractory to a high degree of incandescence.

7. In a radiant burner, a combustion chamber of ceramic material having openings therein which converge outwardly to retard the passage of the burning mixture therethrough and to expose a large area of the interior of the chamber, and means for introducing a combustible mixture into said chamber to heat the same to a high degree of incandescence whereby substantially the entire interior of said chamber emits radiant heat thru said openings.

8. A furnace comprising a combustion chamber having side and top walls of ceramic material built up in layers, said walls provided with outlet passages between said layers which converge outwardly to retard the flow of gas there-through thus increasing the combustion of the gases within the passages, and means for intro-

ducing a combustible mixture into said combustion chamber.

9. A surface combustion burner comprising an enclosure of ceramic material, the walls of which are provided with a plurality of apertures converging outwardly and downwardly to retard the passage of gas therethru and to direct the flow of said gases downwardly, in combination with means for introducing into said enclosure a combustible mixture.

10. A surface combustion burner in which a combustible mixture is burned and comprising an enclosure built up in layers, the walls of which are of ceramic material and are provided with a plurality of outlet apertures between said layers with outwardly converging walls which retard the travel of the burning mixture therethru whereby to increase the pressure in the enclosure above that of the surrounding spaces, in combination with means for introducing into said enclosure a combustible mixture.

11. A burner comprising a base ring and a plurality of rings superimposed thereon and a cover over the top of said rings, said base provided with a depressed portion and said rings also provided with a depressed portion and spacing members, the spacing members of each ring interlocking with the depressed portion of a subjacent ring, and the base and said cover provided with a portion coacting with the complemental portion of the adjacent rings, said depressed and raised portions interlocking one with the other to retain said parts in position.

12. The combination, with the firebox of a furnace having an outlet in its upper part and a ceramic built-up burner structure mounted therein, of vertical baffle walls forming a passage communicating at its upper end with the outlet and having an intake at its lower end below the burner structure for causing a flow of the gases of combustion through the firebox prior to their escape therefrom.

13. The combination, with the firebox of a furnace having an outlet adjacent its top and a ceramic built-up burner structure mounted therein, of vertical baffle walls in said firebox at one side of the burner structure and forming a vertical passage communicating at its upper end with said outlet for trapping said gases of combustion in said firebox and causing said gases to flow downwardly to a point substantially adjacent the lower end of the burner prior to their escape from the firebox.

14. The combination, with the firebox of a furnace having an outlet adjacent its top and a burner mounted therein, comprising a cylinder in which the combustible mixture is burned, of walls in said firebox coacting with said cylinder and firebox walls to form an outlet for said firebox below the normal outlet therefor.

15. Heating means comprising, in combination with a heater having a firebox and an ashpit with a side opening, a gas burner comprising an elongated box structure extending through said opening and provided with a burner head arranged on its upper side substantially at the center of the bottom of the firebox and containing means for supplying gas and air to said burner head and in combination with a hollow radiating structure of refractory material supported wholly by said box structure, with said burner head discharging into the interior of said structure, and with said structure spaced a substantial distance from the inside of the firebox and constructed and arranged to be heated

to incandescence by said burner and to supply heat to the wall of the firebox by radiation in a manner simulating the heating thereof by incandescent coal.

16. Heating means comprising, in combination with a heater having a firebox and an ashpit with a side opening, a gas burner comprising a box structure arranged in said ashpit and provided with a burner head arranged on its upper side substantially at the center of the bottom of the firebox and having means for supplying gas and air to said burner head from outside the heater and in combination with a hollow radiating structure of refractory material supported wholly by the inner end of said box structure, with said burner head discharging into the interior of said structure, and with said structure spaced a substantial distance from the inside of the firebox and constructed and arranged to be heated to incandescence by said burner and to supply heat to the wall of the firebox by radiation in a manner simulating the heating thereof by incandescent coal.

17. Heating means comprising in combination with a heater having a firebox and an ashpit with a side opening, a gas burner comprising a box structure arranged in said ashpit and provided with a burner head arranged on its upper side substantially at the center of the bottom of the firebox and having means for supplying gas and air to said burner head from outside the heater, and in combination with a hollow radiating structure of refractory material supported wholly by the inner end of said box structure, with said burner head discharging into the interior of said structure, and with said structure spaced a substantial distance from the inside of the firebox and constructed and arranged to be heated to incandescence by said burner and to supply heat to the wall of the firebox by radiation in a manner simulating the heating thereof by incandescent coal, said radiating structure being built up of a plurality of separate elements having openings therebetween.

18. Heating means comprising in combination with a heater having a firebox and an ashpit with a side opening, a gas burner comprising a box structure arranged in said ashpit and provided with a burner head arranged on its upper side substantially at the center of the bottom of the firebox and having means for supplying gas and air to said burner head from outside the heater, and in combination with a hollow radiating structure of refractory material supported wholly by the inner end of said box structure, with said burner head discharging into the interior of said structure, and with said structure spaced a substantial distance from the inside of the firebox and constructed and arranged to be heated to incandescence by said burner and to supply heat to the wall of the firebox by radiation in a manner simulating the heating thereof by incandescent coal and forming a hollow shell surrounding the burner head, and of a top superposed on and closing the top of said shell.

19. Heating means comprising, in combination with a heater having a firebox and an ashpit, a gas burner comprising an elongated box structure extending into said ashpit and provided with a burner head arranged on its upper side substantially at the center of the bottom of the firebox and containing means for supplying gas and air to said burner head and in combination with a hollow radiating structure of refractory

material supported wholly by said box structure, with said burner head discharging into the interior of said structure, and with said structure spaced a substantial distance from the inside of the firebox and constructed and arranged to be heated to incandescence by said burner and to supply heat to the wall of the firebox by radiation in a manner simulating the heating thereof by incandescent coal, said radiating structure being built up of a plurality of separate elements having openings therebetween.

20. Heating means comprising, in combination with a heater having a firebox and an ashpit, a gas burner comprising an elongated box structure extending into said ashpit and provided with a burner head arranged on its upper side substantially at the center of the bottom of the firebox and containing means for supplying gas and air to said burner head and in combination with a hollow radiating structure of refractory material supported wholly by said box structure, with said burner head discharging into the interior of said structure, and with said structure spaced a substantial distance from the inside of the firebox and constructed and arranged to be heated to incandescence by said burner and to supply heat to the wall of the firebox by radiation in a manner simulating the heating thereof by incandescent coal, said radiating structure having a hollow body portion built up of separate elements the superposed ones of which have an elongated slitlike aperture between them, together with a cover over the top of and supported by said body portion.

21. A gas burner comprising an elongated box structure having a burner head arranged on its upper side, said box adapted to support the burner head substantially at the lower central portion of a heater firebox, and means in the box for supplying gas and air to the burner head in combination with a hollow radiating structure supported wholly by said box structure and

spaced a substantial distance from the firebox comprising a plurality of ceramic elements adapted to be heated to incandescence to transfer heat outwardly in straight lines by radiation, and which are built up to form a central space surrounding the burner head for burning a combustible mixture and with openings between the elements through which the burning mixture passes while transferring its heat to said elements, said elements being substantially straight and smooth on their inner sides so that the major heating effect is by the passage of the burning mixture through said openings.

22. A gas burner comprising an elongated box structure having a burner head arranged on its upper side, said box adapted to support the burner head substantially at the lower central portion of a heater firebox, and means in the box for supplying gas and air to the burner head in combination with a hollow radiating structure supported wholly by said box structure and spaced a substantial distance from the firebox comprising a plurality of ceramic elements and a cover adapted to be heated to incandescence to transfer heat outwardly in straight lines by radiation, and which are built up in superimposed layers to form a central space closed at its top by said cover and surrounding said burner head for burning a combustible mixture and with openings in the sides of the structure between the elements through which the burning mixture passes while transferring its heat to said elements.

23. A ring of ceramic material for a burner structure having annular surfaces formed on one side, at least one of which is axially offset with respect to another, and having on its other side a series of spacers, the outer edge portions of which are axially equidistant from said annular surfaces.

ASHUR U. WETHERBEE.

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