

Oct. 9, 1951

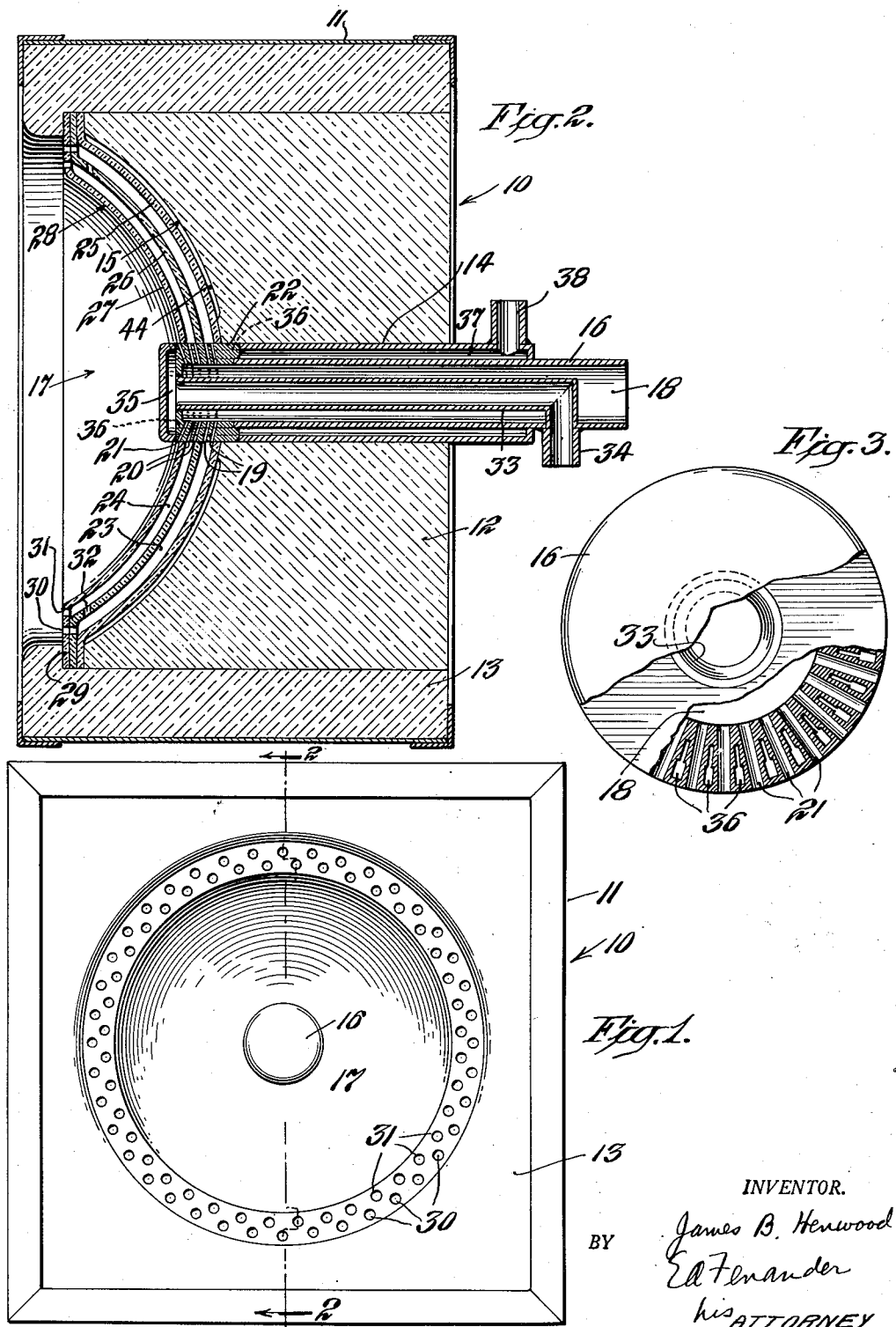
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2,570,554

RADIANT GAS BURNER INTERNALLY FIRED

Filed April 18, 1946

2 Sheets-Sheet 1



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Fig. 4.

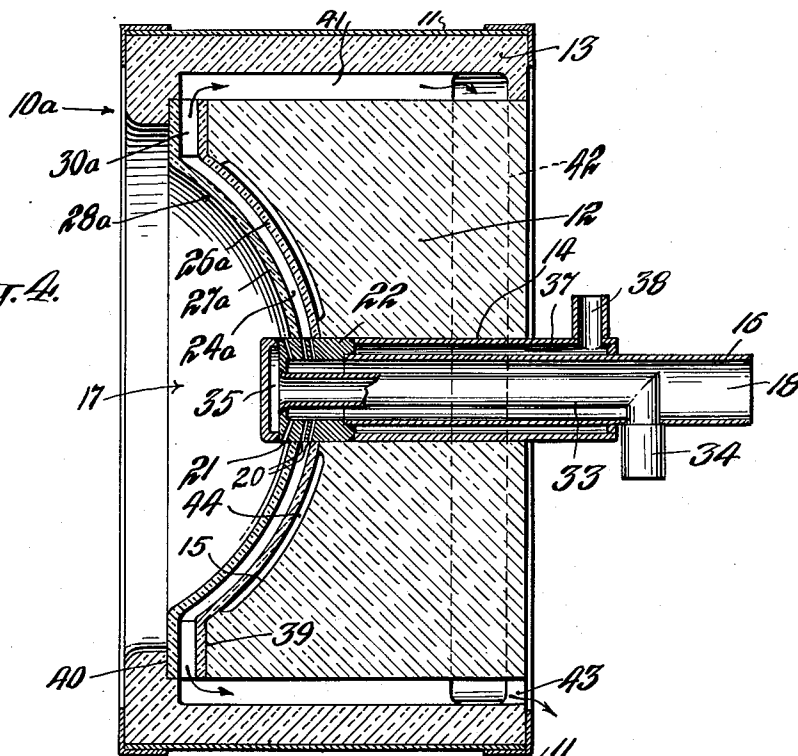
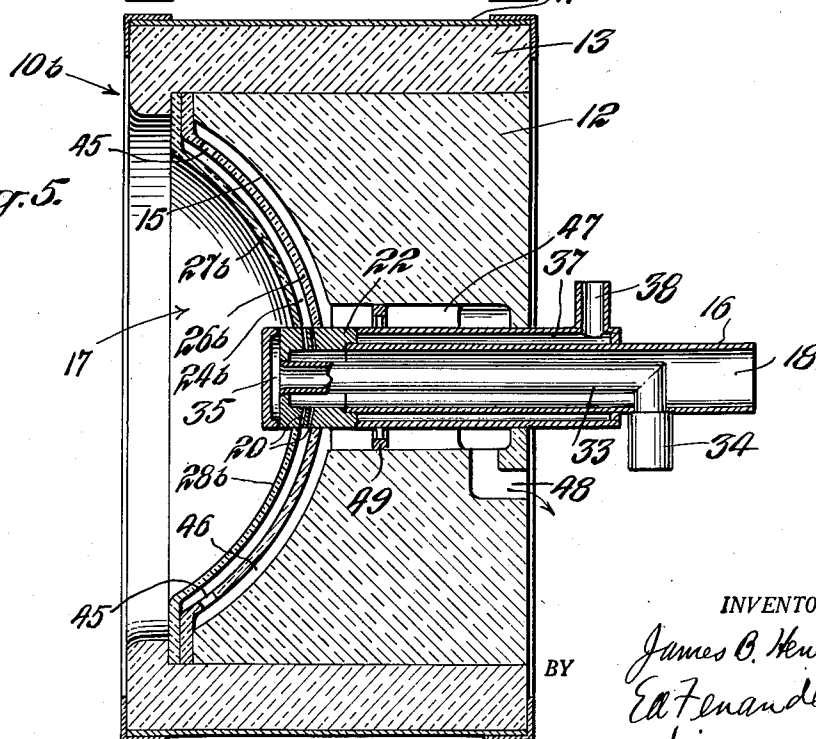


Fig. 5.



UNITED STATES PATENT OFFICE

2,570,554

RADIANT GAS BURNER INTERNALLY FIRED

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Application April 18, 1946, Serial No. 663,003

10 Claims. (Cl. 158—99)

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My invention relates to gas burners, and is especially concerned with burners of the type in which a large fraction of the heat generated and developed by combustion of a combustible gas mixture is converted to radiant heat.

It has already been proposed to produce radiant heat in a body having an open cavity which is provided with an inner refractory lining or surface forming a combustion space. A combustible gas mixture is supplied to such space in which combustion of the mixture is accomplished to heat the surface thereof to incandescence. By accomplishing substantially all of the combustion of the mixture in the combustion space, high combustion temperatures are developed for effectively heating the surface or lining to a highly incandescent condition, thereby promoting the conversion of a large fraction of the heat developed and generated in the combustion space to radiant heat which is projected from the incandescent surface for doing useful work.

It is an object of the invention to provide an improvement in burners of this type, particularly to increase the heating capacity of a given size burner by projecting radiant heat from the refractory lining or surface thereof at a higher temperature or thermal head than heretofore.

The above and other objects and advantages of the invention will be more fully understood from the following description taken in conjunction with the accompanying drawings forming a part of this specification, and of which Fig. 1 is a front elevation of a gas-fired radiant burner embodying the invention; Fig. 2 is a sectional view, taken at line 2—2 of Fig. 1, to illustrate the burner more clearly; Fig. 3 is an enlarged front view of the burner tip embodied in the burner of Figs. 1 and 2, partly broken away and in section, to illustrate details of the burner; and Figs. 4 and 5 are sectional views similar to Fig. 2 illustrating modifications of the invention.

In Figs. 1 to 3 inclusive, I have illustrated one form of gas burner embodying the invention in which a large fraction or proportion of the heat generated and developed by combustion of a combustible gas mixture is converted or translated to radiant heat. The gas burner of Figs. 1 to 3 comprises a refractory burner block 10 of ceramic material provided with an outer metallic shell or jacket 11. When the burner block 10 is mounted or incorporated in a refractory wall of heating apparatus like a kiln, furnace or lehr, for example, the outer metallic shell 11 is not necessary. As will be readily understood, a number of burner blocks 10 may be distributed in a

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wall of a heating chamber in any suitable manner to produce the desired heating effect.

The burner block 10 is rectangular in cross section and formed of a number of ceramic parts or shapes including parts 12 and 13 which are united together by a suitable high temperature cement. As shown, the burner block 10 is formed with a central passage 14 which extends therethrough and terminates at a cup-shaped wall 15 formed at the front face of the refractory part 12. Within the passage 14 is disposed a metallic burner tube or sleeve 16 having the closed inner end thereof terminating in a cup-shaped space or cavity 17 at the front of the burner 10.

A passage 18 of sleeve 16 is adapted to be connected to a suitable source of supply of a pre-mixed combustible gas mixture, it being understood that suitable controls (not shown) may be provided to control and adjust the pressure and rate at which such gas mixture is supplied to the burner 10. The gas mixture in the passage 18 is subdivided into a plurality of gas streams by a multiplicity of discharge ports or small openings 19, 20 and 21 formed about the periphery of a wall section 22 of the sleeve 16. The gas mixture is discharged from the outlet ends of the discharge ports 19, 20 and 21, at the outer peripheral surface of the sleeve 16, and it is at these regions that the burner flames are produced and maintained.

The individual flames produced at the outlets of the discharge ports or openings 19 and 20 flare outwardly and project into narrow spaces 23 and 24 formed between three dished or concave-shaped wall members 25, 26 and 27. The individual flames produced at the openings 21 flare outwardly and project into the cavity 17 alongside the outer or exposed surface 28 of the outermost wall member 27.

The gas flames maintained at the outlets of the discharge ports 19, 20 and 21 effect such heating of the wall members 25, 26 and 27 that the outer surface 28 at the cavity side of the wall member 27 is heated to a highly radiant condition, as will be explained presently. The rims or peripheral edge portions of the wall members 25, 26 and 27 are held in overlapping relation between the front outer edge portion of the refractory part 12 and the inwardly extending flange portion of the refractory shape 13, as indicated at 29 in Fig. 1.

At the outer edges or rim portions of the wall members 26 and 27 are provided a series of openings 30 and 31 through which heated products of combustion are discharged from the spaces 23

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and 24, respectively. In addition, a series of openings 32 is provided in the intermediate wall member 26, adjacent to the discharge openings 30 and 31, to permit flow of heated gases between the spaces 23 and 24 at the outer extremities thereof.

The inner end of the sleeve 16 including the wall section 22 thereof serves as a tip for the burner 10 to effect the desired distribution of the combustible gas mixture at the discharge ports or small openings 19, 20 and 21. In order to avoid excessive heating of the inner end of the sleeve 16, a suitable cooling agent, such as water, for example, is circulated therethrough. I accomplish this by providing in the passage 18 of sleeve 16 a tubular member 33 to which a cooling agent is supplied through an inlet connection 34.

The cooling agent passes through the tubular member 33 to a space 35 at the closed inner end of the sleeve 16 which is located beyond the discharge ports 21. From space 35 the cooling agent passes through a series of slots or channels 36 which are formed in the wall section 22 between the regions thereof in which the openings 19, 20 and 21 are provided, as shown most clearly in Fig. 3. The channels or slots 36 communicate with an outer passage 37 of the sleeve 16 from which the cooling agent is discharged through an outlet connection 38.

When it is desired to operate the burner 10, a premixed combustible gas mixture, such as, for example, air and ordinary city gas, natural gas or the like, is supplied to passage 18 of the burner sleeve 16 from a suitable source of supply. When the burner 10 is initially placed in operation, the gas mixture supplied thereto flows through the passage 18, discharge ports 19 and 20, and spaces 23 and 24 from which it is discharged through the openings 30 and 31, respectively. The gas mixture in the passage 18 is also subdivided by the discharge ports 21 into a plurality of small gas streams which project from the sleeve 16 and can be ignited immediately.

The combustible gas mixture is initially supplied to the burner sleeve 16 at a relatively low pressure which may be equivalent to 5 or 6 inches of water column, for example, so that the gas mixture discharged from the spaces 23 and 24 can be ignited to produce and maintain flames at the openings 30 and 31. When the flames are being maintained at the openings 30 and 31, the pressure of the gas mixture supplied to the burner 10 is then reduced sufficiently to cause the flames to back fire from the openings 30 and 31 onto the wall section 22 of the burner sleeve 16. When this occurs a plurality of flames are produced and maintained at the outlet ends of the discharge ports 19 and 20.

When the flames are being maintained in the spaces 23 and 24, the pressure of the gas mixture supplied to the burner sleeve 16 may be increased. After a short interval of time, the flames maintained at the discharge ports 19 and 20 effect such heating of the inner refractory surfaces of the spaces 23 and 24 that these surfaces are heated to a high incandescent temperature. Due to heating of the inner wall surfaces of the spaces 23 and 24 to a high temperature, complete combustion of the gas mixture is accomplished in these spaces before the gas mixture reaches the outlets 30 and 31. From the openings 30 and 31 are discharged streams of heated gases consisting substantially entirely of heated products of combustion.

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The refractory wall members 25, 26 and 27 are of such shape and the flames project at such an angle from the axis of the burner, taken axially of the burner sleeve 16, that the flames are closely adjacent to and follow the surfaces of the refractory wall members and yet the inner cones thereof do not impinge against the surfaces to cause objectionable low temperature spots or regions to be formed. Thus, a group of gas flames project into the narrow space 23 from a first series of discharge ports 19 alongside of and closely adjacent to the front surface of the wall member 25, while another group of gas flames project from a second series of discharge ports 19 alongside of and closely adjacent to the rear surface of the intermediate wall member 26. Similarly, the gas flames project into the space 24 from two series of discharge ports 20 at regions alongside of and adjacent to the front surface of the intermediate wall member 26 and the rear surface of the outermost wall member 27.

The gas flames project from discharge ports 21 at regions alongside of and closely adjacent to the front or exposed surface 28 of the outermost wall member 27. These gas flames maintained at the cavity side of the outermost wall member 27 effect such heating of the outer surface 28 that the latter is heated to incandescence. The gas mixture introduced into the cavity 17 is subjected to the intense radiant heat of the outer wall surface 28, so that substantially complete burning of the gas mixture may be accomplished in the cavity before the heated gases pass from the open ends of the cavity.

The cavity side 28 of the outermost refractory wall member 27 serves as a heat radiating surface which is heated to a high incandescent temperature and from which radiant heat is projected for doing useful work. In order to project radiant heat from the surface 28 of the wall member 27 at the highest possible temperature, combustion of the gas mixture is effected at the rear side or surface thereof as well as at the exposed front side or surface 28.

To effect optimum heating of the rear surface of the wall member 27, the combustion of the gas mixture is accomplished in the combustion space 24 whose depth is relatively small or shallow and approximately the same over a major portion of its cross sectional area. Due to the intense heating accomplished in the confined combustion space 24 and the flames which project closely adjacent to and alongside the rear surface of the outermost wall member 27, such rear surface can be maintained at an incandescent temperature at least as high as the temperature to which the heat radiating surface 28 is maintained by the flames which project from the discharge ports 21.

Since the rear side of the wall member 27 forms a part of the inner refractory lining of the combustion space 24 to which combustible gas mixture is supplied through two groups or series of discharge ports 20 while combustible gas mixture is supplied through only one group or series of discharge ports 21 over the outer surface 28, it will be evident that the rear surface of the outermost wall member 27 may be maintained at a higher temperature than the exposed heat radiating surface 28. Under such operating conditions, heating of the rear surface of the wall member 27 promotes heating of the opposite exposed surface 28 to a high incandescent temperature by conduction of heat through the wall member. Hence, by pumping heat from the rear side or surface of the wall member 27

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to the opposing heat radiating surface 28, the latter will be maintained at a high temperature or thermal head. Moreover, the gas streams issuing from the discharge ports 21 will be highly heated due to such pumping of heat through the wall member 27 to the heat radiating surface 28, thereby intensifying the combustion reaction and effecting combustion at the heat radiating surface 28 at an increased temperature.

The flames projected from one group of discharge ports 20 at regions closely adjacent to and alongside of the front surface of the intermediate wall member 26 not only promote the development of high temperature heating gases in the combustion space 24 but also effectively heat the front surface of that wall member to incandescence. Hence, the rear side or surface of the outermost wall member 27 is subjected to heat radiated from the front surface of the intermediate wall member 26, thereby contributing to the pumping of heat to the exposed heat radiating surface 28 to maintain the latter at the highest possible temperature.

The heated gases generated and developed in the combustion space 24 act to thermally shield the highly heated rear side or surface of the outermost wall member 27. By effecting combustion of the gas mixture at the rear side of the intermediate wall member 26, the surface at the rear side is heated to an incandescent temperature approaching the temperature to which the front surface of the wall member 26 is heated, thereby contributing to the heating of the intermediate wall member and the radiation of heat therefrom to the outermost wall member 27.

Moreover, by accomplishing combustion of the gas mixture at the rear side of the wall member 26 in the confined combustion space 23, intense heating is accomplished therein which heats the entire inner lining of the space 23 to incandescence. In this way the heat loss rearwardly from the outermost and intermediate wall members 26 and 27 is effectively retarded so that, for a given size radiant burner of the type herein described, the heating capacity is appreciably increased and a source of radiant heat is provided which is at an extremely high temperature or thermal head.

In the embodiment of Figs. 1 to 3 the heated gases generated and developed in the combustion spaces 23 and 24 are effectively utilized by discharging such gases through the openings 30 and 31 at the front face of the burner 10. The heated gases discharged from the openings 30 and 31 mix with the high temperature heated gases generated and developed in the cavity 17 and pass outwardly from the latter to promote convection heating which augments the transfer of heat to work by radiant heat rays projected from the heat radiating surface 28. Such convection heating is utilized advantageously when a number of radiant burners like the burner 10 are mounted or incorporated in the refractory walls of an enclosed heating space.

All or a part of the heated gases generated or developed by combustion of the combustible gas mixture may be withheld from the burner cavity 17. In Fig. 4 is illustrated a modification of the invention in which a part of the heated gases are discharged rearwardly from a burner 10a. The burner 10a is generally like the burner 10 just described and similar parts are referred to by the same reference numerals. The burner 10a differs from the burner 10 just described in that only two refractory wall members 27a and 26a

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are disposed in nested spaced-apart relation in the cup-shaped opening at the front of the refractory part 12. The outer peripheral edge portion of the wall member 26a is secured at 39, as by cement, for example, to the front outer edge portion of the refractory part 12. Similarly, the outer peripheral edge portion of the wall member 27a is secured at 40, as by cement, for example, to the inwardly extending flange portion of the refractory part 13.

The gas mixture supplied to the passage 18 of sleeve 16 in burner 10a passes through discharge ports 21 to produce a multiplicity of gas streams adjacent to and alongside the exposed surface 28a of the outer wall member 27a. The gas mixture also passes from the passage 18 through discharge ports 20 into the combustion space 24a. The heated gases developed by combustion of the gas mixture in space 24a flow through and outlet 30a of annular form into a number of spaced-apart passages 41 which extend rearwardly from the front face of the burner 10a. The rear ends of the passages 41 communicate with an annular manifold 42 having an outlet 43.

In the burner 10a of Fig. 4, the heat radiating surface 28a of the outer wall member is heated to a high temperature in a manner generally like that described above in connection with the embodiment of Figs. 1 to 3. By effecting combustion of the gas mixture at the rear surface of the outer wall member 27a and accomplishing such combustion in the confined space 24a, the rear surface of the wall member 27a is heated to a higher temperature than the heat radiating surface 28a, so that flow of heat takes place by conduction through the wall member to the heat radiating surface from which radiant heat is projected.

While a second combustion space is not provided at the rear side of the wall member 26a in the burner 10a, as in the embodiment first described, the rear side of the outer wall member 27a is still effectively shielded thermally by the heated gases in the combustion space 24a. Further, the heat radiated from the front surface of the inner wall member 26a contributes to maintaining the rear surface of the outer wall member 27a at a high incandescent temperature.

In order to reduce heat loss from the inner wall member 26a to the refractory part 12, gaps 44 are provided between these parts. Similar gaps 44 are provided in the embodiment of Figs. 1 to 3 between the innermost wall member 25 and the refractory part 12. The gaps 44 form dead air spaces which serve to thermally shield the inner wall members 25 and 26a in the burners 10 and 10a, respectively. Since the wall member 26a in the burner 10a only engages the refractory wall part 12 at the inner and outer regions of the cup-shaped wall 15, a poor thermal conductive path is provided between these parts. By keeping the heat loss from the inner wall member 26a to a minimum, the inner wall surfaces of the combustion space 24a are maintained at a high incandescent temperature to promote heating of the exposed heat radiating surface 28a to a highly radiant condition.

The burner 10b in Fig. 5 illustrates another modification of the invention in which all of the heated gases generated and developed by combustion of the combustible gas mixture are withheld from the burner cavity. In Fig. 5, in which parts similar to those in Figs. 1 to 4 are referred to by like reference numerals, the gas mixture passes from the passage 18 of sleeve 16 only through discharge ports 20 into the space 24b

formed between spaced-apart wall members 27b and 26b. The heated gases developed and generated by combustion of the gas mixture in the space 24b flow through openings 45 at the outer extremity of the wall member 26b into a second space 46 which overlies the space 24b. The highly heated gases flow through the space 46 and pass therefrom into a central opening 47 which communicates with an outlet 48 through which the heated gases are discharged from the burner 10b. In order to position the burner sleeve 16 accurately in the opening 47, an apertured spider 49 may be provided in the opening 47 intermediate the ends thereof.

In the burner 10b the inner refractory wall surfaces of the combustion space 24b are heated to a high incandescent temperature by the burning of the gas mixture accomplished therein. After the burner 10b has been in operation for an interval of time, the refractory wall member 27b is heated to incandescence in its entirety and radiant heat is projected from the exposed outer surface 28b. Although no combustion of the gas mixture is effected at the exposed surface 28b of the outer wall member 27b, such outer exposed surface is heated to a highly radiant condition by conduction of heat through the outer wall member from the rear surface thereof. The fact that combustion of the gas mixture is accomplished at the rear surface of the outer wall member 27b, in the confined and narrow space 24b, contributes significantly to the pumping of heat to the exposed heat radiating surface 28b to maintain the latter at a highly radiant condition.

In addition, the gas flames projected from the discharge ports 29 are closely adjacent to and alongside of the rear and front surfaces of the wall members 27b and 26b, respectively, so that the gas mixture is subjected to radiant heating, thereby intensifying the combustion reaction and effecting such combustion at extremely high temperatures. By flowing the heated gases through the relatively narrow space 46, such heated gases sweep over the rear surface of the wall member 26b and the cup-shaped wall 15 to heat these surfaces to incandescence. In this manner the heat loss from the inner wall member 26b is effectively retarded and the front surface of the wall member 26b is maintained at a high incandescent temperature.

In view of the foregoing, it will now be understood that a radiant burner has been provided which is capable of releasing an exceedingly large amount of heat at a high thermal head in a given interval of time. The concave-shaped wall members are formed of suitable refractory material having good thermal conductive properties, such as silicon carbide or beryllium oxide, for example, which is capable of withstanding thermal shock and the high temperatures produced at the exposed heat radiating surface and in the crescent-shaped combustion spaces formed between the wall members.

The refractory wall members are of sufficient thickness to stand up under the burner operation conditions encountered. By way of example and without limitation, concave-shaped wall members one-fourth inch thick and formed of silicon carbide have been successfully employed in a burner generally like that of Figs. 1 to 3 having a heat radiating surface 28 of about 175 square inches. In such a burner like that being referred to and having only a single crescent-shaped combustion space about three-eighths inch deep formed be-

tween two refractory wall members, the burner was operated satisfactorily when supplied with a gas mixture of air and ordinary city gas at a rate of about 500,000 B. t. u. per hour. Under such operating conditions the exposed heat radiating surface was heated to temperatures of 2800° F. and higher when the burner was operated in the open.

The burner of the invention operates satisfactorily with slow burning gases, such as methane and natural gas, for example, because the exposed heat radiating surface is maintained at an incandescent temperature which is always well above the ignition temperature. Further, in my improved burner the problem of blowoff of the gas flames, at customary gas mixture delivery pressures ranging up to five pounds per square inch, is completely absent.

In radiant burners of the kind described and illustrated, the concave-shaped wall members are formed with central apertures and fit snugly about the burner sleeve 16. While the refractory wall members fit snugly about the burner sleeve 16, a gas-tight seal is not obtained between these parts because a slight space must be provided therebetween to allow for expansion which results when high burner temperatures are produced. The slight leakage of gas mixture that occurs about the burner sleeve 16 at the apertures in the refractory wall members is insignificant, because the gases will pass into the paths of flow provided which offer considerably less resistance to the flow of the gases. Moreover, any gases passing through the refractory wall members about the burner sleeve 16 are carried along the surface of the wall members by the injection action of the gas streams issuing from the discharge ports of the burner sleeve.

Due to the slight spacing of the refractory wall members about the burner sleeve 16, it has been found that the burners herein described may be initially ignited by simply applying a needle-like flame at the periphery of the burner sleeve which projects into the combustion space or spaces at the rear of the outer refractory wall member.

While several embodiments of the invention have been shown and described, such variations and modifications are contemplated which fall within the true spirit and scope of the invention, as pointed out in the following claims.

What is claimed is:

1. A gas burner comprising a burner block having a central passage therethrough terminating at the small end of a cup-shaped depression at one face of the block, means including inner and outer cup-shaped wall members of refractory material nested in the depression and in spaced apart relation to provide a combustion space therebetween, the outer wall member forming a cavity and having the outer or exposed surface thereof providing a heat radiating surface, at least said inner wall member having a central aperture therein, passage means for a combustible gas mixture disposed in the central passage of said block and passing through the aperture in said inner wall member, said passage means providing a series of flame projecting orifices for projecting flames into the combustion space, and means forming an outlet for said combustion space adjacent to the outer peripheral edge portion thereof.

2. A gas burner as set forth in claim 1, in which said burner block is formed with passage means communicating with the outlet of the combus-

tion space for discharging heated gases from said block at a region removed from said one face.

3. A gas burner as set forth in claim 1, in which the outer wall member adjacent the peripheral edge portion thereof is formed with a series of openings constituting the outlet for the combustion space.

4. A gas burner comprising a burner block having a central passage therethrough terminating at the small end of a cup-shaped opening at the one face of the block, inner and outer cup-shaped wall members of refractory material nested in the opening and in spaced apart relation to provide a combustion space therebetween, the outer wall member forming a cavity opening outwardly and having the outer or exposed surface providing a heat radiating surface, said inner and outer wall members each having a central aperture substantially in alignment with the passage in the block, passage means for supplying a combustible gas mixture disposed in the block and passing through the apertures in the inner and outer wall members, said passage means providing a series of flame projecting orifices for projecting flames into said combustion space and another series of flame projecting orifices for projecting flames closely adjacent to and alongside the exposed or outer surface of the outer wall member, and said combustion space having an outlet adjacent to the outer peripheral portion thereof.

5. A gas burner as set forth in claim 4, including means for circulating a cooling agent through said combustible gas mixture supply means, especially the portion thereof adjacent to said inner and outer wall members.

6. A gas burner comprising a block of refractory material having a depression formed in one face thereof and an opening leading from the bottom of the depression to an opposite face of the block, a pair of cup-shaped wall members each having a flange on its periphery, said members being of different radii whereby when one is placed within the other a space will be left between them, means to attach said members by their flanges within the depression formed in said block, means to supply a combustible fuel mixture adjacent to the bottom of the space formed between said members to be burned therein, said means extending through the opening in said block, and means forming exhaust openings adjacent to the periphery of said space through which the products of combustion may be withdrawn.

7. A gas burner comprising a block of refractory material having a cup-shaped depression formed in one face thereof and an opening extending from the bottom of said depression to an opposite face of said block, a concave-shaped wall member mounted in said depression and spaced from said block to form a space of substantially the same shape as said depression in section, a fuel mixture supply means extending

through said opening and an aperture in said member aligned with said opening, said means being provided with orifices through which the fuel mixture can flow to be burned in the cup formed by said member to heat the front thereof, and with a plurality of orifices through which the fuel mixture can be discharged to burn in said space to heat the back of said member.

8. A gas burner comprising a block of refractory material formed with a cup-shaped depression in one face thereof and a passage extending from the bottom of said depression to an opposite face of said block, means having front and back faces enclosing a space forwardly of the surface of said depression substantially coextensive in size with said depression, and substantially of a uniform thickness, fuel supply means extending through said passage, said last mentioned means being provided with orifices opening into said space and through which fuel may be discharged to be burned in said space to heat the front face of said enclosing means by conduction through the material between said front face and said space.

9. The combination of claim 8 in which said fuel supply means is also provided with orifices extending in front of said enclosing means through which fuel can be discharged to be burned alongside of said front face to heat the latter directly.

10. A gas burner comprising a block of refractory material having a cup-shaped cavity formed in one face thereof and an opening extending through the block from the bottom of the cavity to an opposite face, first and second cup-shaped members received in nested relation in said cavity, said members being so shaped that a space is left between them, and each being provided with a flange at its periphery to engage said first mentioned face of the block and by means of which they can be definitely located, each member also being provided with an aperture aligned with said opening, and means extending through said opening and apertures through which a fuel mixture may be supplied, said means being provided with a plurality of orifices in front of said first cup-shaped member and a plurality of orifices opening between said cup-shaped members.

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