

Feb. 21, 1933.

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1,898,799

GAS BURNER

Filed July 21, 1927

2 Sheets-Sheet 1

Fig. 1.

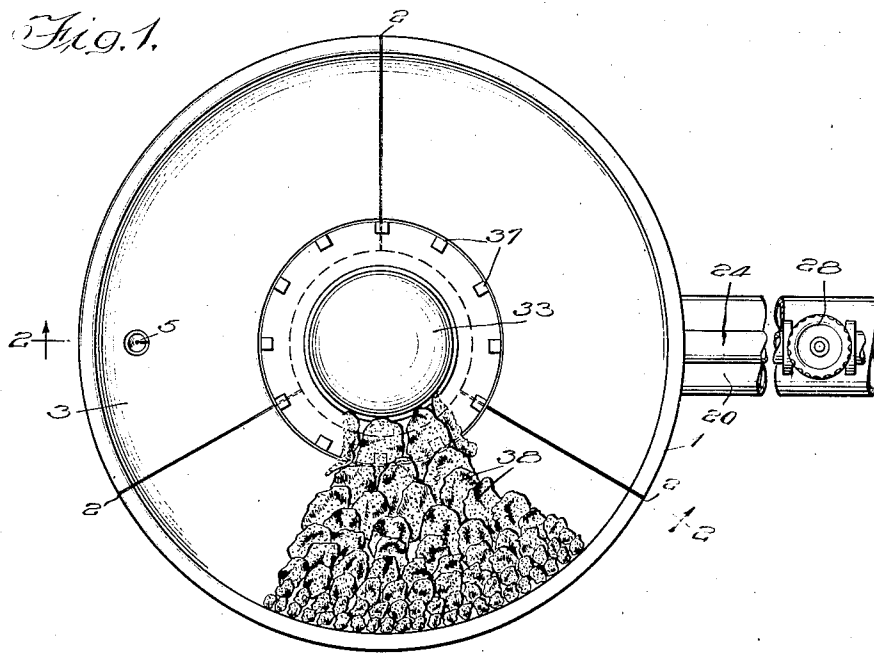
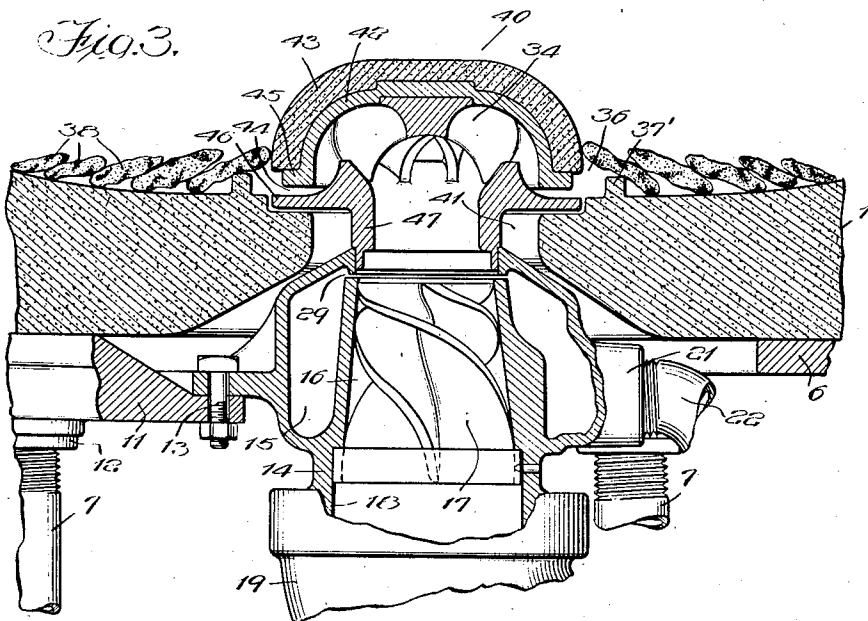


Fig. 3.



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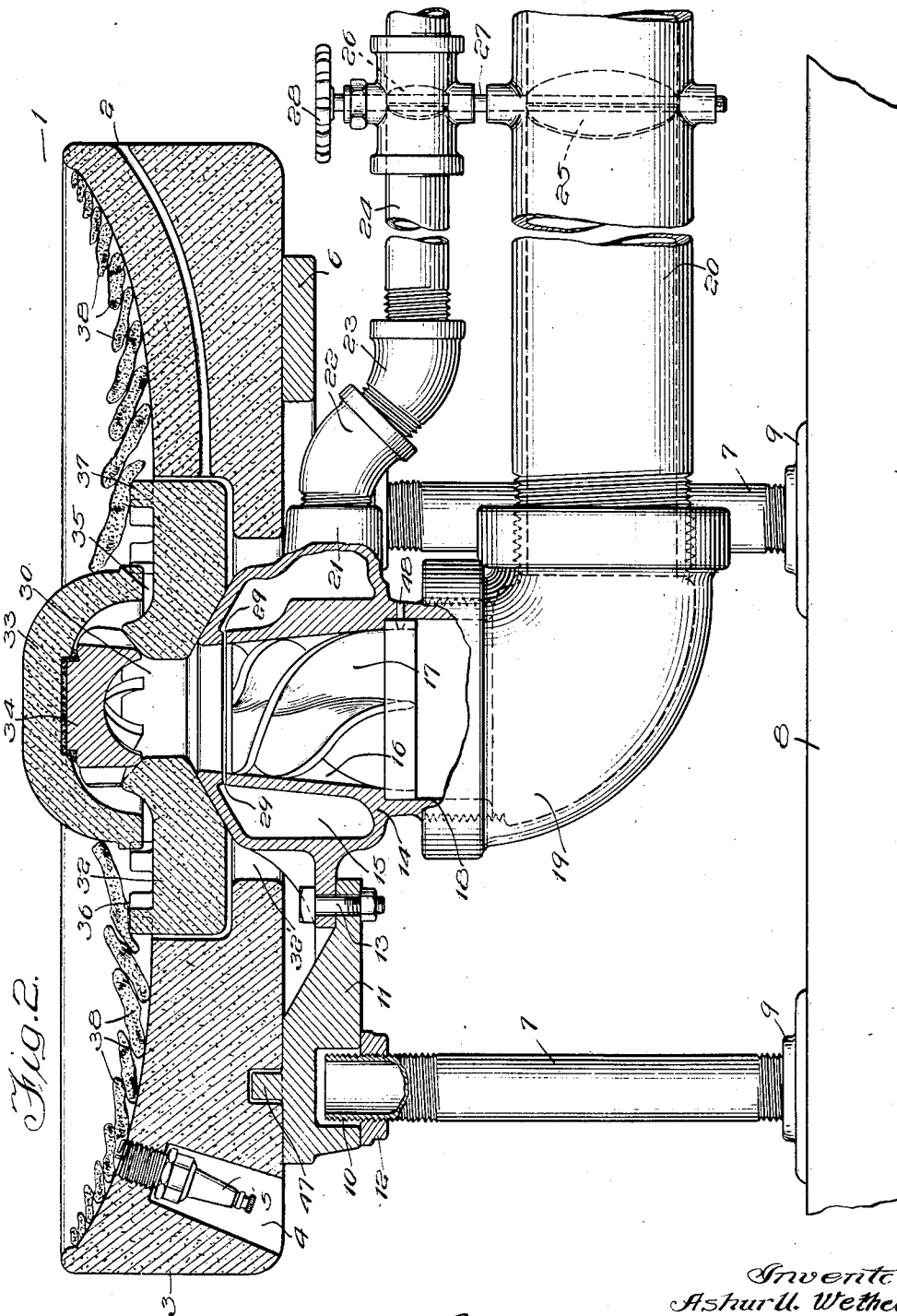
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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GAS BURNER

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My invention relates to combustion of gaseous fuel, and the object of the invention is, broadly, to provide a more economical method of developing the heat generated by combustion of a gaseous fuel.

While throughout the specification and claims herein I refer to the fuel as gas or as being gaseous, I do not intend to limit the invention to the burning of a fixed gas, as the principles of the invention and the structural features herein disclosed are applicable to the combustion of any fuel of sufficient fineness that it acts substantially as a gas, that is, either vaporized, atomized, or pulverized to a degree where its combustion is capable of occurring with substantially explosive rapidity.

The specific problem which I have set out to solve is the provision of means and a method for burning city gas with high economy of heat development and transfer, and having the ability to stop and start operation of the burner with ease and certainty.

Where known methods of utilizing gas combustion for house heating service have been employed, the cost has generally been excessive as compared with the cost of other fuels. This is particularly true in connection with known types of steam or hot water systems which have been worked out in connection with the combustion of solid fuel. It has been a generally accepted fact that with known types of steam or hot water boilers or furnaces, the substitution of gas fuel for the solid fuel, for which such boilers or furnaces were designed, has been out of the question because of inefficiency and consequent excessive cost.

I have studied the problem and come to the conclusion that the reason for this is largely chargeable to the method of heat transfer involved.

In the combustion of solid fuels there is always a mass of incandescent solid fuel which radiates heat. Where gas is burned in the Bunsen type of burner, the flame, although short, has very small heat radiating power. It appears to be a known fact that radiation from a given mass is a function of temperature of that mass and other characteristics thereof. According to the law of Stefan and Boltzman, radiation of heat from a given mass is approximately proportional to the difference between the fourth power of the absolute temperature of the heated mass and the temperature of the receiving surface.

I have therefore taken, as the primary consideration in my invention, the possibility of transferring the heat from the combustion of the gas to the boiler walls by employing a mass of suitable character involving the maximum amount of heat radiation.

As a means for providing the incandescent mass, I employ a mass of refractory of large superficial surface and of a loose granular or foraminated structure. In the preferred embodiment later to be described, I utilize relatively thin flat chips of fire-brick laid on a solid base of refractory. The mass of loose refractory is heated by the combustion of gas within the body of the same.

I am aware of the employment of a somewhat similar scheme of combustion within a mass of loose refractory material originally patented by Lucke, but, as I shall point out later, there are very important and essential differences between my method and that of the prior art. I am also aware of the use of targets against which a blast burner is directed for the production of a radiating mass. As I shall point out later, there are serious objections to the use of such a method of combustion in the service in which my invention is particularly useful, namely, domestic heating.

For the development of maximum temperature of the mass, the heat of the flame must be as great as possible. To this end no excess air should be admitted and, at the same time, no unburned fuel should be passed out of the stack in the interest of economy. It is one of the essentials of my invention that there must be as complete mixing of the gas and supporting air as possible.

For house heating service, the combustion should be capable of automatic control, i. e., preferably "off and on", or, alternatively, "up and down", and, above all, there must be no danger of explosion at any time, nor

should there be any appreciable explosive puff when the burner comes on after being shut off, or when the burner is shut off after an operation. Likewise, the burner must be
5 so constructed that the flame cannot strike back into any confined space, both because of danger of explosion and because of danger of injury to the burner by excessive heat.

The avoidance of explosions or explosive
10 puffs requires that the gas be not confined and that there be at no time a volume of mixed gas and air in the burner or furnace capable of creating a disturbance.

One of the features of my invention provides for mixing the gas and air substantially at the point where the same enter the combustion space. The mixture is then passed through an orifice at such velocity that striking back is not possible. I have tried flame
20 arresters in the form of screens. They have proven impracticable.

According to my invention I employ only a thin bed of refractory of small mass supported on a bowl or plate of solid refractory,
25 which, at the same time, serves both as a non-conductor of heat and as a reflector of the heat of the mass of broken refractory. I pass the flame or burning gases edgewise through this mass of loose refractory and
30 carry on combustion at a high rate, i. e., at substantially an explosive rate. The mass of loose refractory becomes incandescent and the radiation of heat occurs from the lateral face of the bed, i. e., from the exposed upper
35 surface. The propagation of heat rays is therefore at substantially right angles to the general direction of the burning gases. By this means only a small mass needs to be heated up to start and a large radiating surface is provided. This great ratio of radiating surface to mass permits of a much greater rate of fuel combustion within a given space than has been possible heretofore. Overheating of any part of the mass is prevented.

45 By propagation of heat radiation from the side or flank of the path of gas travel, the length of the flame is not of importance.

I am aware that it is old to fire upward through a mass of refractory and project the
50 heat in the same direction, but the prior art has this inherent defect, namely, that the central inner part of the mass attains a high degree of incandescence which can radiate only through interstices of the upper layers.
55 The top layers are an effective barrier to radiation from the central mass. The major parts of the combustion is at the center and, hence, the top layers, from which effective radiation must occur, if at all, are unheated
60 by direct contact with the fire. If the input of combustible material is too great, then burning over the mass occurs. If the input is too small, the fire occurs wholly inside the mass and the top layer effectively prevents
65 radiation.

In my burner the length of flame and, hence, the amount of fuel burned may be greater or less, without interfering with proper development of incandescence and free radiation from the burner.

70 There are many features of novelty incidental to the above main features which will be apparent from the following detailed specification and claims, taken in connection with the accompanying drawings which illustrate an embodiment of my invention.

In the drawings:—

Fig. 1 is a plan view of a burner embodying my invention;

Fig. 2 is a vertical section taken on the
line 2—2 of Fig. 1 shown on an enlarged scale; and

Fig. 3 is a similar section through a portion of a modification.

Referring now to Figs. 1 and 2, I provide
a bowl 1, which is preferably constructed of sections. This bowl is made of fire-brick of high heat resisting and insulating properties. The sections are provided with overlapping
joints 2—2 so as to prevent an open crack
90 where the sections come together.

This bowl constitutes, in reality, a plate or disc of refractory insulating material for radiating the heat developed by the gas combustion upwardly and for preventing the travel of heat there developed downwardly through the mass of the same.

The section 3 contains a recess 4 in which there is disposed a spark plug 5, the metallic shell of which is suitably grounded and the central electrode of which is connected through suitable control apparatus with a source of high tension current.

I have, for the sake of clearness, omitted from the present disclosure the control apparatus, reserving the same for a later application.

The electrodes of the spark plug are so disposed with respect to the path of gas travel as to be capable of igniting the combustible mixture readily.

The bowl or disc 1 is seated on a supporting frame comprising the ring 6. This ring 6 in turn is supported by three or more posts 7 resting upon a foundation 8. These posts
115 are preferably sections of pipe having pipe flanges 9 at their lower ends and having their upper ends disposed in pockets 10 and engaging the lugs 11 through the medium of a threaded nut 12 by which the height of the posts may be adjusted.

The lugs 11 on the ring 6 extend inwardly and are apertured to receive the clamping bolts 13 for clamping the mixer 14 to the frame.

The mixer 14 comprises an outer gas chamber 15 and an inner air passage 16 within which is disposed a helical directing vane 17 for producing a whirling action of the air passing through the passage 16. The lower
130

end of the mixer 14 comprises a cylindrical threaded extension 18 connected by a pipe elbow 19 to an air inlet pipe 20, this pipe 20 in turn leading to the delivery of a fan or blower (not shown). The gas chamber 15 communicates through a hollow lateral boss 21 and pipe fittings 22—23, which latter, in the present case, are 45 degree L's, with the gas inlet pipe 24. The air pipe 20 is provided with a throttle valve 25 and the gas pipe 24 is provided with a similar throttle valve 26, these two valves being connected by a stem 27 and having a suitable operating handle 28 for simultaneous adjustment. The gas pipe 24 leads to the city main through a pressure regulator, preferably of the mercury type, for holding the gas pressure substantially constant at all times. It is apparent that the butterfly valves 25 and 26 may be independently regulated, but after the pressure regulator for the gas has been suitably adjusted to the delivery of the blower connected to the air pipe 20, a simultaneous adjustment of air and gas, such as is possible by the butterfly valves 25—26, is desirable.

The gas chamber 15 empties into the air passage 16 above the vane 17 through a slot 29. The gas and air then proceed from the outlet of the mixer 14 through a short passageway 30, which passageway is, in the form shown in Figs. 1 and 2, provided as a central aperture in a disc or plate 32 of firebrick, let into a recess or counterbore in the bowl or plate 1. The mixer 14 extends up through the central opening 32' which is formed in the disc or bowl 1.

The opening 30 in the disc 32 is covered by a cap 33 of fire-brick or like material, supported on a central spider 34, which spider has a series of directing vanes preferably, but not necessarily, helically disposed in a direction opposite to the twist of the directing vane 17. The spider 34 is conically formed at its lower end to seat in the conical upper end of the opening 30 for centering these two parts with respect to each other. The cap 33 is preferably cemented to the spider 34 so that the lower edge of the cap 33 is held a fixed distance above the plate 32 to provide a peripheral slot or outlet 35 around the periphery of the cap 33.

Along its outer margin, where the plate 32 comes flush with the surface of the bowl or disc 1, I provide a series of projections disposed a short distance from the rim of the cap 33. Flat chips 36 of fire-brick rest at their inner edges against the cap 33 and are supported away from the surface of the disc 32 and bowl 1 by the projecting ends or projections 37.

Chips graduated in size are then laid in overlapping rings in the fashion of shingles from the central chips 36 to the outer edge of the bowl 1 with the smaller chips disposed at the outer periphery of the bowl 1.

In effect, the bowl 1 comprises the central disc 32 as well as the outer sections. The central disc 32 is, in this case, made of a single piece, but this is not essential, since, due to the great heat to which it is subjected, it expands and contracts and tends to crack in case it is made of one piece.

As shown in Fig. 3, I prefer therefore to make the gas passages of metal throughout until they discharge into the zone of combustion.

It will be seen that by disposing the coarser chips at the center and raising them slightly above the floor of the bowl, a relatively free passageway for the mixture of gas and air is provided within the central part of the bowl and the passageway becomes more and more restricted to the outer rim by the use of graduated chips.

I have found the use of such chips of fire-brick highly satisfactory, but I do not aim to convey the impression that other forms of granular material may not be used.

Theoretically, the ideal way of making up this burner would be to have the bowl 1 covered by a mass of checker work in a very thin layer, preferably graduated from coarse checker work at the central part to fine checker work at the outside, and then to have a layer of some material, assume, for example, quartz, overlying the top surface of the checker work and serving to direct the gases of combustion all out to the outer periphery, but permitting freely of radiation from the top surface of the same. Now the construction which I have shown, namely, the flat thin chips of refractory material, that is, broken fire-brick, serve to perform this function sufficiently well to direct the flow of burning gases out along the surface of the bowl 1 so that burning occurs within the mass of broken refractory, even though it is very thin, and the heat thus developed is projected off by radiation substantially normal to the surface of the granular mass. It will be seen that by the shingling effect the gases are diverted downwardly toward the surface of the bowl 1 and thereby are held more or less in contact with the same.

I have tried the burner without the layer of granular refractory. It will burn gas, but two things are noticeably absent; first, only a very small amount of radiant heat will be developed; and, next, only a small amount of gas can be burned within the bowl as compared with the amount that can be burned when the layer of loose refractory is disposed thereupon.

Preferably in the operation of the device, the blower is started and the spark plug is caused to act, and thereafter the gas is admitted through the pipe 24. When combustible mixture reaches the spark plug, it will be ignited and it will burn back to substantially the edge of the cap 33.

If the amount of mixture delivered to the burner is increased, the edge of the flame reaches out further towards the periphery of the bowl 1, and if the amount of fuel supplied is decreased then the flame recedes in the refractory layer towards the cap 33; but the size of the flame within the limits of the burner is immaterial, or substantially so for the development of radiant heat. The amount of fuel which can be burned per unit of time in a burner of this character is amazing. The efficiency of the device as a radiator of heat is very high, because of the large radiating area as compared to the volume of gas under combustion or the volume of material which is at incandescence.

In Fig. 3 I have shown a modified form of nozzle construction. In this construction the bowl 1 is made of a plurality of sections, the edges of which overlap, as explained in connection with Figs. 1 and 2. This bowl, likewise, has the central aperture 41 through which the mixture of gas and air is delivered under the cap member 40 which comprises a metal cap member 42 covered with a layer or covering 43 of fire-brick or like material. The spider 34 may be made integral with the metal cap 42, or it may be made separately. The spider 34 has suitable vanes which serve both to support the cap and also to direct the mixture. The nozzle gap 44 is formed between two metallic surfaces, namely, the flange 45 of the cap and a companion flange 46 of a neck member 47 which forms an extension of the air passageway 16 above the vane 17 and the peripheral inlet 29 from the gas chamber 15.

I wish to call attention to the very small volume of mixture which can at any time exist between the slot 29 and the slot 44, in the form shown in Fig. 3, or between the slot 29 and the slot 35, shown in Fig. 2. The volume of combustible mixture is so small at any time that, even if the same should be ignited, no serious injury can be done, particularly in view of the fact that the cap 33 or 40 is held in place only by its own weight. The velocity of the gases through this part of the path is normally so great that combustion does not strike back. In addition, mixing is carried on in such a short space that a combustible mixture, as such, is not attained until substantially the very outlet into the combustion space. Hence, in starting or stopping combustion under automatic control, the objectionable explosive start or stop of the prior art is not encountered.

Tests which I have made on this burner, in conjunction with a standard and well known cast iron boiler very widely sold for domestic heating, known as the "Ideal" boiler, manufactured by the American Radiator Company, and designed for the combustion of solid fuels such as coal or coke, show amazingly high efficiencies.

These tests were made with a burner in which the bowl 1 had a diameter of 18", and being 2" thick at the center and $3\frac{3}{8}$ " thick at the periphery. The weight of the bowl 1 was approximately 45 lbs., and the weight of the firebrick chips 5 lbs.

Due to the small mass of the chips 38, and their being spread out in a thin layer, the appearance of incandescence was almost immediate, especially in a ring just outside the point 37. This ring of incandescence spreads very rapidly, and the temperature increases rapidly, until a balance is obtained between the heat absorbed from the combustion and that radiated to the boiler. Numerous observations with a Leeds & Northup optical pyrometer show a temperature of approximately 3000° F., or slightly more, these observations being taken through the interstices between the chips. Since the points observable are those which radiate heat through the interstice, the temperature of the point seen is less than the majority of these surfaces, which are radiating and/or reflecting heat back and forth between each other. It is believed that the temperature of the lower side of the chips approximates 3300° F., as there are very visible evidences of the softening of the surfaces of these chips now being used, which are of the brand known as Empire, which softens at that temperature.

It is evident that with a single layer of chips, such as were used in these tests, having the under side of such chips at such a high temperature, gives a maximum of radiation to the heat absorbing surface.

Two of these tests were run in strict accordance with the code of the American Gas Association, under the direction and supervision of two technical experts of a prominent public utility company, and with the cooperation of their laboratory in obtaining accurate determinations of the heating value, density, etc. of the gas used.

In one of these tests, the output of the boiler was 87.4% of the rating given it by the Master Steam Fitters Code of Chicago, and an efficiency of 81.2% was obtained, based on the higher heating value of the gas. In the other test, the output of the boiler was 176.8% of the Master Steamfitters Code, and an efficiency of 76.45% was obtained. Since very little convected heat absorption is possible in this type of boiler, these efficiencies are truly remarkable. This is especially true when the unavoidable loss up the stack of the latent heat of the water of formation, and the radiation to the room from the uncovered portions of the boiler (charged as a loss in these tests), is considered.

The average rate of gas consumption in these tests varied from 259 cubic feet per hour to 385 cubic feet per hour, and its heating value from 523 B. t. u. to 540 B. t. u. The gas pressure just outside the boiler varied

from a minimum of 2.05" to 3.75" of water, and the air pressure from 1.55" to 3.65" of water, both being largely a function of area of passageways provided and the quantities of each required. Later experiments with larger pipes, etc. have burned successfully 500 cubic feet of gas per hour with the small pressures available.

The carrying away of heat up the stack due to excess air was very little, as shown by the following analysis of the flue gases:

CO ₂ -----	13.2 -----	12.0
O ₂ -----	3.9 -----	4.6
CO -----	0.0 -----	0.0
Total -----	17.1 -----	17.5

The percentage of excess air shown is much below that obtained in large central station power plants, with very large combustion volume surrounded by hot refractories as compared with this case where the unit volume is very small and surrounded by walls cold as compared with the heat of combustion.

It will be appreciated that in Fig. 1 I have shown only a small part of the surface of the bowl covered with the chips of fire-brick, but that in practice the entire upper surface is so covered.

The sections of the bowl 1 are preferably held by dowel pins, such as shown at 47 in Fig. 2 for loosely holding the parts together upon the frame ring 6. The vane member 16 is preferably formed on an increasing pitch in conical shape, and it will be observed that, in general, the cross section of the passage for the mixture of air and fuel continues to be restricted through the outlet at 35 or 44. The lower end of the vane member 17 comprises a ring which is set in a recess in the lower part of the mixer 14 and held therein by a pin 48.

Instead of having the top surface of the bowl 1 smooth, I may provide the same with a series of sections which serve, in part, to support the chips 38.

Instead of using separate chips or granular bodies, I may form a foraminated or reticulated plate or body to be disposed upon the refractory base 3 or such formation of the upper face or portion of the base 3 may be made as to secure the desired structure of loose or foraminated mass within which combustion may be carried on and from which heat radiation may occur.

I do not intend to limit the invention to the details shown or described.

I claim:—

1. In combination, a dished plate of refractory and insulating material, a layer of relatively thin flat refractory bodies supported on the dished plate with their flat sides generally upwardly disposed, and a central nozzle projecting a sheet of quick burning mixture radially into the layer of refractory bodies.

2. In combination, a disc of refractory ma-

terial having a central aperture, a supporting frame for said disc, a layer of granular refractory disposed on said disc, a nozzle supported on said frame and registering with said aperture, said nozzle having a peripheral outlet for discharging a combustible mixture edgewise into said layer of granular refractory.

3. In combination, a thin bed of granular refractory, a supporting refractory bowl, and a spark plug supported on said bowl and having its sparking terminals disposed within said bed of granular refractory.

4. In combination, a frame comprising a ring member having supporting means therefor, a nozzle member having inlets for gas and air and a short discharge passageway terminating in a peripheral slit, a segmental disc of refractory material supported on said ring member, said disc being apertured at its center and surrounding said nozzle, said nozzle having a cap member comprising refractory material and a thin layer of overlapping refractory chips disposed on said disc in register with said peripheral slit.

5. In combination, a bowl of refractory material, a central stationary nozzle comprising a stationary cap, means for projecting a thin sheet of combustible mixture out radially from under the edge of the cap, and a layer of refractory chips on said bowl.

6. In combination, a supporting frame, a facing of refractory material comprising a bowl, central inlet means for a combustible mixture, a cap over said inlet means providing a discharge slot below the cap between its rim and the bowl, and a layer of refractory chips on said bowl overlying the edge of the cap.

7. In combination, a supporting frame having a refractory facing forming a bowl, and a layer of refractory chips on the surface of said bowl, said chips being of graduated fitness from the central part of the bowl to the rim thereof the top of the layer being substantially bowl shaped.

8. In combination, a supporting frame having a refractory facing forming a bowl, a layer of refractory chips on the surface of said bowl, and means for discharging substantially all of a fast burning mixture from the central part of the bowl outward towards the rim through said layer of chips.

9. In a burner, the combination of a bowl having a central aperture, a cap covering said aperture, a layer of refractory material in the bowl extending from the cap to the periphery, a supporting spider between the cap and the bowl, and a gas-air mixer having a discharge port leading through the spider under said cap.

10. In a radiant heater, a thin layer of pieces of refractory material, and centrally located means for projecting a blast of a combustible mixture in the form of a sheet mov-

ing through and substantially along the layer of refractory material.

11. In combination in a radiant heater, a plate of refractory material, a plurality of refractory members inclined to the plate with their lower ends in contact therewith and their upper ends spaced above the plate, said members being disposed in overlapping relation and defining a substantially continuous sheet of refractory material, and means for projecting a burning mixture in a sheet edge-wise between the plate and said refractory sheet, the inclined under faces of the refractory members acting to deflect the burning mixture downwardly toward the plate and away from the upper face of the refractory sheet.

12. In combination in a radiant heater, a plate of refractory material, a relatively thin sheet of refractory material spaced from the plate and comprising a plurality of elements disposed in overlapping relation, the plate and the sheet defining a passage therebetween for flow of a burning mixture therethrough, and means for projecting a burning mixture through said passage and along the inner face of the sheet for heating it to incandescence.

13. In combination in a radiant heater, a thin sheet of refractory material comprising a plurality of elements disposed in overlapping relation, and means for projecting a burning mixture along one face of the sheet and in contact therewith for heating the sheet to incandescence, the other face of the sheet acting to radiate the heat therefrom.

14. A burner comprising a base of heat resisting material, a series of superimposed refractory elements surmounting said base and arranged in a single layer defining one side of a combustion space and with interstices between adjacent elements opening directly into said space, and means for introducing a combustible mixture between said base and said refractory elements and burning it in said interstices and said space.

15. A burner comprising a base of heat resisting material having a central opening, a series of superimposed refractory elements surmounting said base and arranged in a single layer defining one side of a combustion space and with interstices between adjacent elements opening directly into said space, and means arranged in said central opening for introducing a combustible mixture between said base and said refractory elements and burning it in said interstices and said space.

In witness whereof, I hereunto subscribe my name this 16th day of July, 1927.

ASHUR U. WETHERBEE.