

April 9, 1935.

H. A. ATWATER
GAS BURNER CONSTRUCTION

1,997,036

Filed June 27, 1931

3 Sheets-Sheet 1

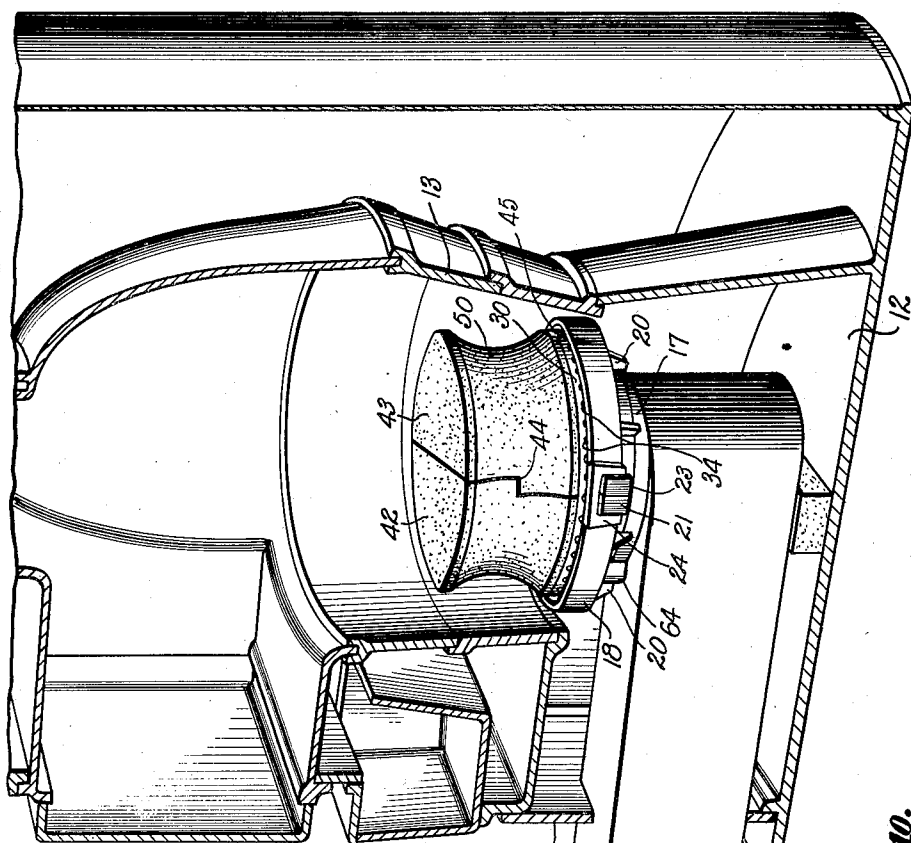


Fig. 9.

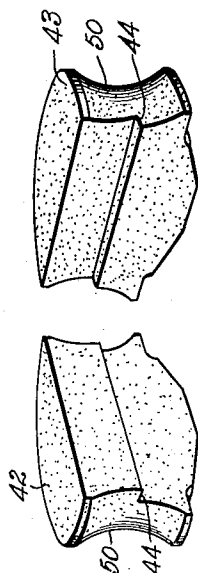


Fig. 1.

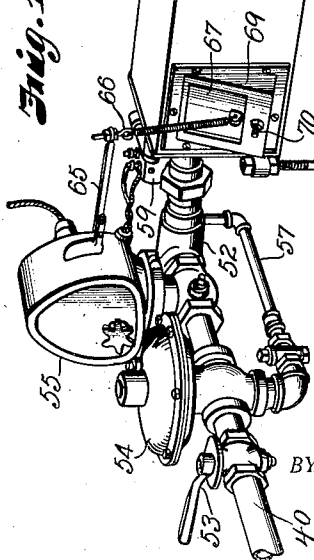


Fig. 10.

INVENTOR:
Harry A. Atwater.

BY: *Chas. W. Hard*

ATTORNEY.

April 9, 1935.

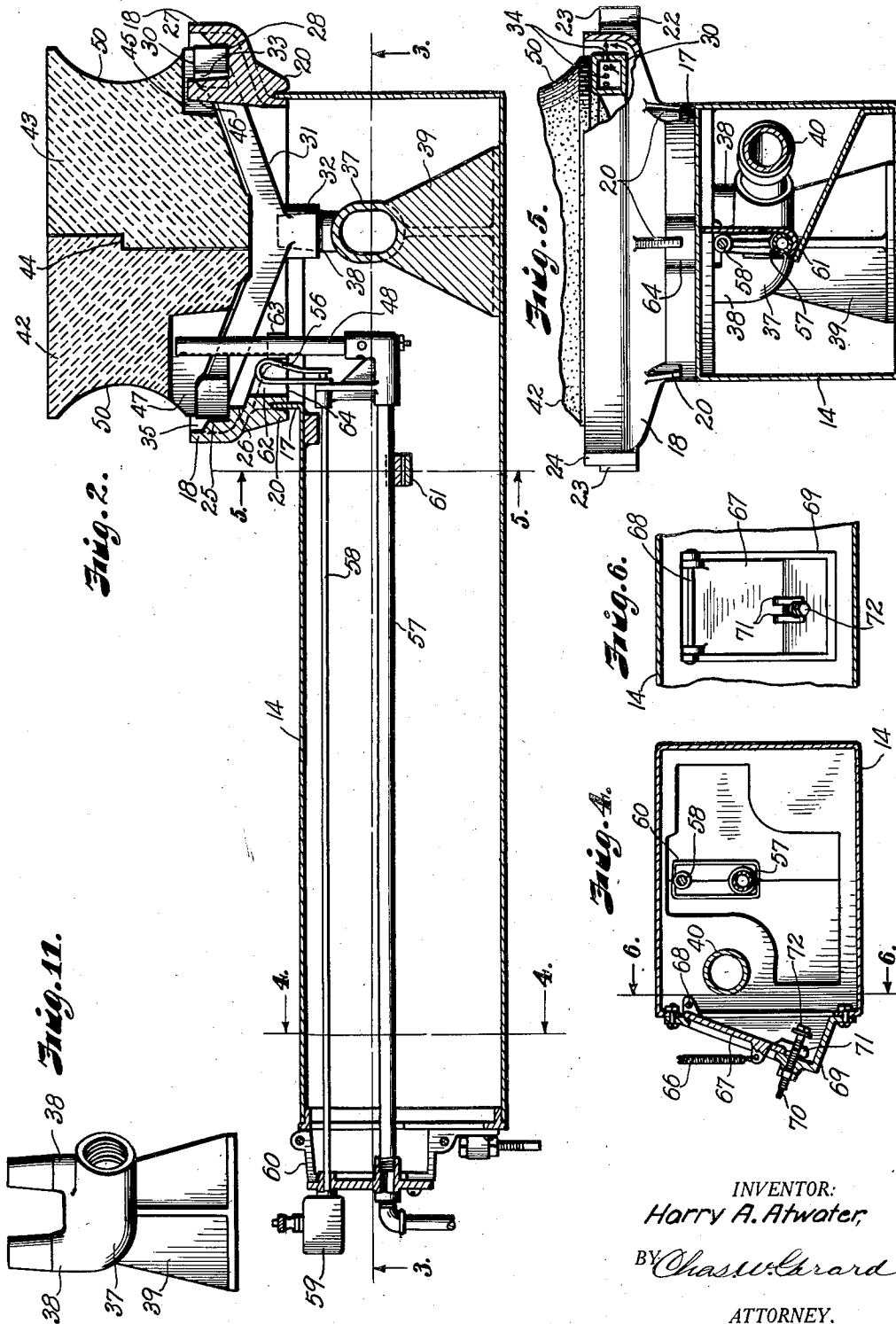
H. A. ATWATER

1,997,036

GAS BURNER CONSTRUCTION

Filed June 27, 1931

3 Sheets-Sheet 2



INVENTOR:
Harry A. Atwater,
BY *Chas. W. Clark*,
ATTORNEY.

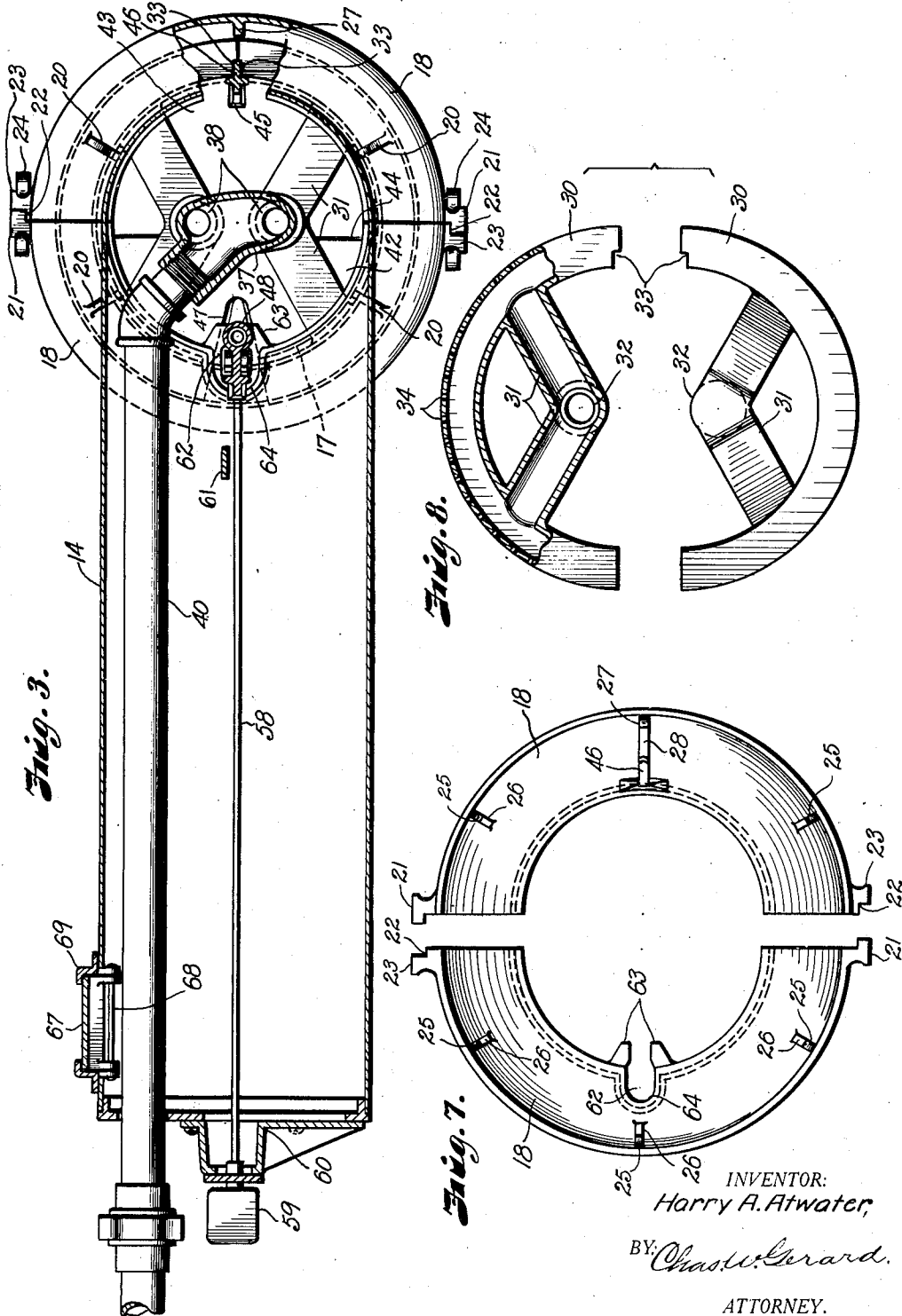
April 9, 1935.

H. A. ATWATER
GAS BURNER CONSTRUCTION

1,997,036

Filed June 27, 1931

3 Sheets-Sheet 3



INVENTOR:
Harry A. Atwater,
BY: *Charles Gerard.*
ATTORNEY.

UNITED STATES PATENT OFFICE

1,997,036

GAS BURNER CONSTRUCTION

Harry A. Atwater, Kansas City, Mo.

Application June 27, 1931, Serial No. 547,219

13 Claims. (Cl. 158—104)

My invention has relation to combustion apparatus, with particular reference to gas burning equipment, and the primary object in view is to devise an improved gaseous fuel burning construction for furnaces of various types, and in which the combustion operation is carried out more economically and efficiently and with a greater degree of heat transference from the burner unit to the heat absorbing surfaces of the burner.

To this end I have devised a novel type of burner construction to which the gaseous fuel is conducted without premixing of air, and with corresponding elimination of "snap back" action or back firing from the burner, as well as increase in radiating properties by reason of the more luminous character of the flame produced by the burner.

A further important object of my invention is to devise a more efficient mixing of the gas with the air by an improved arrangement of the gas jet orifices by which the gas is discharged in the path of the air at substantially right angles to the direction of the air flow past the orifices, with the result that a more ideal and effective combustible mixture is produced.

A further improvement lies in the provision of a novel and greatly improved type of combustion zone around the flame orifices, to the end that ample space is provided for the expansion of the combustion gases and all pinching or smothering of the combustion zone is eliminated, as a result of which the process of combustion is promoted in the highest degree for the purpose of maintaining as hot temperature conditions in the combustion zone as possible.

This condition is further promoted by an improved arrangement of the refractory block unit whereby more effective heat reflection angles are maintained, both as regards reflection of heat back into the combustion zone as well as in the direction of the heat absorption surfaces of the fire chamber; and in this connection a most important object of the invention is to insure the highest possible degree of heat transfer by direct radiation, not only by virtue of the luminous type of combustion flame already referred to, but also by the elimination of all interference with such direct radiation which would be offered by materials interposed between the combustion zone and the inside surfaces of the fire chamber, and thus insuring the complete exposure of all heat absorption surfaces thereof to such direct radiation.

It is a still further object of the invention to provide a construction of the character described which will be especially adapted for furnace installations of the so-called conversion type, in which a gas burning structure is substituted for original equipment, and the present improved construction is designed to enable the same to be installed under such conditions with the greatest possible convenience and facility by ordinary workmen and with practically no tools of any description.

With the foregoing general objects in view, as well as various minor objects which will appear in the course of the detailed specification, the invention will now be described by reference to the accompanying drawings illustrating a typical furnace installation equipped with a gas burner construction embodying the various features of improvement, after which those features and combinations deemed to be novel and patentable will be duly set forth and claimed.

In the drawings—

Figure 1 is a sectional perspective view illustrating a portion of a warm air furnace equipped with a gas burner construction embodying the present invention;

Figure 2 is a vertical longitudinal sectional view, showing the burner structure on a larger scale;

Figure 3 is a horizontal sectional view and Figures 4 and 5 are transverse sections, representing sections taken on the lines 3—3, 4—4 and 5—5, respectively, of Figure 2;

Figure 6 is a detail section taken on the line 6—6 of Figure 4;

Figure 7 is a plan view of the sectional ring castings forming the base shell of the burner;

Figure 8 is a plan view of the sectional ring castings forming the burner ring, one of the sections being partly broken away;

Figure 9 is a perspective view of the refractory block sections forming the top of the burner, the same being illustrated in separated relation;

Figure 10 is bottom plan view of the same in assembled relation; and

Figure 11 is a side elevation of the combination burner supporting stand and gas supply connection for uniting the gas ring sections.

In the various kinds of gas burner installations commonly met with, whether of the warm air, hot water or steam type, gas burner castings are provided, having orifices for the discharge of the gas at approximately the bottom of the fire chamber.

The prevailing practice is to premix the gas with certain proportions of air as the gas travels through the burner or before it discharges from the burner orifices, while in some instances, in addition to this primary air, a certain amount of secondary air is conducted to the combustion zone separately from the primary air. In either case, the combustion process produces the well-known Bunsen type of blue flame, burning with a relatively short flame body, and the practically universal practice is to employ what are commonly known as "leaning radiants" of refractory or metallic material for the purpose of deflecting the burning gases over against the inside surfaces of the fire chamber. The advocates of such constructions also claim that this radiant material becomes incandescent and thereby promotes the transfer of heat from the surfaces of the radiant material to that of the walls of the fire chamber by the principle of direct radiation.

Several obstacles to attaining the desired efficiency are apparent in such constructions, some of which are inherent in the burner principle itself, for in all air premixing types, operating on the injection action of the Venturi tube, any effective premixing action depends upon a careful observance of very definite and precise proportions, including a definite fixed gas pressure at the mixer nozzle, and properly proportioned flows of air and gas to correspond to that pressure. For any given set of values for these factors, the physical dimensions of the proper mixer may be determined from specific formulae, and any material variation from the predetermined rate of air and gas flow will very appreciably affect the mixer's performance. As a matter of fact, it is demonstrated in actual practice that these premixing burner designs give satisfactory performance only when limited to relatively narrow ranges of pressure and flow.

Moreover, the presence of a combustible mixture in the burner in advance of the flame orifices is constantly attended by more or less frequent "snap backs" or back firing toward the mixer.

The next most serious obstacle to obtaining the desired degree of efficiency in these types of burner constructions is in the character and position or arrangement of the radiant devices used as part of the equipment. Since in these designs the radiants are placed in angular position directly overlying the combustion zone, they are thus subjected to severe temperature conditions, causing those of refractory material to spall and break off and other types to warp and break out of shape, with the result that the entire radiant assembly is disarranged, often to the point of obstructing the flow of gas from the burner orifices, so that the installation suffers a marked reduction in efficiency unless properly serviced and the deterioration of the radiant structure given the necessary attention and repairs. Another difficulty attending the use of the leaning type of radiants is the restriction of the combustion zone by the overlying radiant elements, which results in unburned gas being allowed to escape past the radiants into zones of lower temperature where there is little likelihood of complete combustion taking place. This crowding of the combustion space reaches an aggravated state whenever the rate of the gas flow is stepped up to meet excessive heat demands from the boiler or heater. Another effect of the use of leaning radiants is the tendency to bottle up the heat of combustion and concen-

trate it about the gas burner rings and other castings comprising the burner structure proper; such overheating of these parts of the burner involves excessively severe service conditions, with rapid deterioration of the parts affected.

As one of the benefits claimed for the use of the leaning radiants is that these become incandescent and promote the transfer of heat by direct radiation, it is worthy of note that in practice the combustion conditions in the usual domestic heater, coupled with the relatively large area of heat absorbing surfaces acting to keep down the combustion temperatures to a correspondingly low point, result in operating conditions which do not favor any very marked degree of radiant transmission in such installations. Moreover, it is apparent that the angle of these radiant elements is such as to restrict the greatest part of the heat transfer to that portion of the fire chamber lying below the tops of the radiants, which in itself greatly reduces the heat transfer into the relatively larger area of heat absorbing surfaces within the fire chamber above this level, and to that extent therefore the full effect of exposing the entire area of the fire bowl surface for such direct radiant heat absorption is lost.

The present invention aims to provide a construction in which the various difficulties before mentioned are largely overcome, and in the accompanying drawings the improved construction is, as above indicated, illustrated as installed in a warm air furnace of the conventional type comprising the ash pit chamber 12, and the fire bowl 13, from which the usual grates are removed. It is to be understood however that while the type of furnace illustrated is of round design, the improved burner construction is applicable to either round, rectangular, or other forms of fire boxes, the gas burner orifice structure being simply changed in shape in whatever way may be necessary to conform to the shape of the firebox.

Extending from the outside of the furnace and into the ash pit chamber is an air box casing 14 through which a controlled supply of air is conducted to the burner, and the opening into the ash pit otherwise closed, or walled in, in any suitable manner as indicated at 15 (Figure 1).

Directly beneath the fire bowl 13, the top of the inner end of the air box is provided with an opening surrounded by a vertical flange 17 upon which is mounted the base shell or casting of the burner, comprising a pair of ring sections or castings 18 (see Figures 2 and 7), the lower edge of which is telescoped into the flange 17 of the air box, the sections of said ring castings combining to form a bowl extending outwardly and upwardly from the air box, with which it is also engaged by external lugs 20 projecting downward into engagement with the outer face of said flange (see Figure 5). The meeting portions of the ring sections are also provided with interlocking means comprising an external lug 21 on each section projecting past the meeting edge of the companion section for seating in a notch 22 in an external lug 23 on said companion section (compare Figures 3 and 7), in which interlocked relation the parts are held by means of yoke-shaped clips 24 (Figures 1 and 3).

The upper interior of each ring section 18 is formed with a plurality of angle lugs 25 providing horizontal shoulders 26, in addition to which one ring is formed with a stiffening rib 27 also providing a similar shoulder 28, these shoulders

acting as supports for a pair of hollow gas ring sections and for spacing the latter slightly away from the interior surfaces of the base shell, each of said gas ring sections having a hollow rim portion 30 to which the gas is conducted through hollow spider arms 31 from a downturned sleeve 32 at the junction of said arms.

One end of each rim portion 30 is also notched, as indicated at 33, for positioning and retaining engagement with a lug 46 projecting up from the stiffening rib 27, and the outer vertical faces of the rims are provided with horizontal or outwardly directed and equally spaced gas jet orifices 34, adapted to discharge the gas (which is as yet unmixed with air) in jets directed substantially at right angles to the air which flows up vertically past the outer faces of said rims, or through the passages 35 between the gas rim and the base ring sections (Figure 2). A flow of gas is supplied equally to the gas burner sections through a fitting 37 having a pair of tapered and machined elbow nipples 38 engaging both the sleeves 32 (providing smooth and gas-tight joints) and formed as part of a supporting stand 39 mounted on the floor of the air box (see Figures 2 and 5). This fitting 37 is tapped for connection with the gas flow line 40 leading out through the front end of the air box as shown in Figure 3.

Above the gas ring is mounted a block structure comprising two front and rear sections 42, 43, of suitable refractory material, with their meeting faces joined in ship-lap fashion as indicated at 44 (Figures 1 and 2). The outer margins of the block sections are supported on the rims 30 of the gas ring sections, and the central portion of the block structure projects downwardly sufficiently for support upon those parts of the ring sections which connect with the fitting 37 and stand 39; at the same time the rear block section 43 is provided with a bottom recess 45 for positioning and retaining engagement with the upper end of the lug 46 already referred to, and the other block section 42 is also provided with a bottom recess 47 for the tip of the pilot burner tube 48 forming part of the pilot assembly hereinafter described.

The lateral faces 50 of the block structure are of concave curvature, the base of the block assembly being of approximately the same diameter as the gas ring, and said curvature receding from the outer rim edge of the gas ring, and flaring again to the top of the block assembly, which is of the same diameter as its base (as clearly illustrated in Figures 1 and 2).

The gas flow connections and controlling equipment for the burner comprise the following construction assembled with relation to the outer end of the air box. The gas supply pipe 40 (Figure 1) is equipped with a manual control valve 53, pressure regulating device 54, electric flow-regulating valve 55, and also a variable flow orifice unit 52 of the type illustrated in my Patent No. 1,913,149 of June 6, 1933, filed June 22, 1931 for adjusting and setting the rate of gas flow to the burner. The pilot burner tube 48 is provided with a gas supply tube 57, connected with the gas flow line 40, as at the pressure regulator 54, and also with an electric automatic control structure comprising a thermostat device 56 having a control connection 58 with safety cutoff switch 59 which controls the operation of the flow regulating valve 55 in a manner well-known. The pilot assembly is supported by the framework 60 at the front end of the air box and by an open hanger structure

61 connecting the top and one of the side walls of the air box (see Figure 5), which facilitates the location of the pilot assembly into proper position, in which the tube 57 and thermostat device 56 are located in a recess 62 and between lugs 63 formed on the interior of the bowed portion 64 of the front base ring or shell section 18 (Figures 3 and 7).

The air flow through the air box 18 is also automatically controlled or regulated by the electric unit 55, which is provided with an automatically actuated arm 65 having a connection 66 with a swinging damper plate 67 which is hinged at 68 within a frame 69 at the front end of the casing 14.

The damper opens inward by gravity and the extent of its opening movement is adjusted or regulated by means of a bolt 70 adjustably mounted in the frame 69, as shown in Figure 4, said bolt extending between a pair of lugs 71 depending from the plate 67, and its inner end or head 72 forming an adjustable stop for engaging said lugs and thereby limiting the maximum opening movement of the damper.

From the foregoing it is apparent that a burner structure is provided in which all premixing of the gas with primary air is eliminated, with corresponding elimination of "snap backs" or back firing action, as well as dispensing with the necessity for the precise design required for any premixing tube as well as making it possible to operate over a wide range of rates of gas flow without operating difficulties. Again, a marked improvement in efficiency is due to the mode of mixing the gas and air in the passage 35 where the small jets of gas issuing from the openings 34 impinge upon the upflowing sheet of combustion air at angles of substantially 90 degrees. It is apparent that the improved method of mixing the gas and air is much more thorough and efficient, due to its right angle impact, than in those conditions where the air and gas meet at angles approaching a more nearly parallel relation.

The design and construction of the refractory block unit also possesses several features of advantage. In the first place, the concave design of the outer exposed faces of the block provides for a greatly increased volume for the combustion zone, and hence correspondingly less restriction or opposition to the expansion of the combustion gases, thereby resulting in much more complete combustion than is possible with the leaning or other types of radiant elements projecting into positions overlying the combustion zone, or even with refractory blocks having straight vertical faces above the burner.

The improved concave design also promotes higher temperature conditions within the area of greatest combustion in a manner similar to the "heat bottling" effect secured by the use of "dutch ovens" or refractory arches in the combustion chambers of industrial furnaces. This higher temperature range, coupled with the increased volume or size of combustion space made available, makes for a very marked increase in the efficiency of the complete combustion process. It will also be apparent that the concave curvature of the refractory block assembly also has the effect of imparting a pronounced outward direction of flow to the combustion gases as they pass the upper edge of block, without the necessity of producing this deflecting action by a crowding of the gases over against the fire bowl surface by masses of inclined radiant material.

This advantage of a control of the combustion gas movement is also secured without sacrificing the benefit of ample combustion space within the combustion zone, and there is also a marked advantage in this construction in that it permits the use of one certain size of refractory block assembly for different fire bowl diameters, as it is evident that even with larger sizes of fire chambers no difficulty is experienced in securing the proper deflection of the combustion gases in the direction of the interior surfaces of the fire bowl.

Since the principle of the use of leaning baffles or radiant elements requires an assembly of such elements of diametrical proportions almost equaling the diameter of the fire bowl (in order to heat the radiant structure to any appreciable degree of incandescence), it is apparent that one of the essential conditions necessary for any efficient propagation of heat transfer by direct radiation is lost, since such direct radiating action must occur in straight line paths emanating from the source of radiation.

Obviously, in the case of the leaning or overlying baffle types of designs, the burning flame body itself is entirely shut off from direct line radiant transmission to any point of the fire bowl surface beyond the outer limits or tops of the radiant elements. By the present improved design, however, there is made possible a vastly increased degree of heat transfer activity by direct radiation from the flame body to practically the entire surface of the fire chamber, due to the opening up of the combustion zone by the removal of all overlying portions of the radiants or refractory assembly. The operation of this principle of direct radiation is further enhanced in the improved construction by the fact that the combustion flame is purposely made of a brilliantly luminous character, by the elimination of all premixing of the gas with primary air, as it is well known that the blue or Bunsen type of flame possesses nowhere near the heat radiating power of flames having brilliantly luminous properties.

In the interest of convenience, and expediting the installation operation, the improved burner structure is so arranged as to facilitate its installation in the usual small type of domestic heating unit or boiler, where working space is so restricted as to prohibit almost altogether the use of tools. Accordingly, the design enables the main air box and base to be assembled through the ash pit door opening, and the remaining parts comprising the base shell, gas rings and refractory block structure made in half sections adapted to be easily passed through the fire door opening and assembled in place as illustrated. The various guides, lugs and fittings insure the assembly being made in only one correct manner and without the use of tools for the purpose, thus simplifying the installation to the greatest possible extent and making the same practically fool proof.

It will thus be seen that a very practical and comparatively simple burner apparatus of very superior efficiency has been devised for carrying out the various objects of the invention as herein set forth, and while a typical arrangement and construction have been shown and described for illustrating one proposed embodiment of the several improvements, I desire to be understood as expressly reserving the right to make whatever changes or modifications may fairly fall within the scope of the appended claims.

Having described my invention, what I claim to be new and desire to secure by Letters Patent is:

1. A gas burner equipment comprising a burner casting having a plurality of outwardly directed gas jet orifices, means for conducting a flow of gas unmixed with primary air for discharge outwardly through said orifices, means for conducting a flow of air exteriorly to said orifices for mixing with the gas emitted therefrom, and means providing an annular combustion zone directly above said orifices having unrestricted space for direct heat radiation from the combustion flames in all directions upwardly and outwardly from said zone.

2. A gas burner equipment comprising a burner casting having a plurality of outwardly directed gas jet orifices, means for conducting a flow of gas unmixed with primary air for discharge outwardly through said orifices, means for conducting a flow of air exteriorly to said orifices for mixing with the gas emitted therefrom, and a block structure of refractory material of a horizontal diameter approximating that of the burner casting and overlying the same, said block structure having concave lateral faces forming the inner boundary of the combustion zone and providing ample expansion space for the combustion gases while permitting direct heat radiation from the combustion flames freely in all directions upwardly and outwardly from said combustion zone.

3. Gas burning equipment for furnace fire chambers, comprising a burner base housing member, a burner orifice unit and refractory block structure adapted to be assembled in superposed relation within the fire chamber, said housing member having interior spaced shoulders supporting the outer margins of the orifice unit in slightly spaced relation to the interior surface of said housing member, and means providing a combination central support and gas supply connection for said orifice unit.

4. Gas burning equipment for furnace fire chambers, comprising a sectional burner orifice unit adapted to be assembled within the fire chamber, and a combination supporting standard and gas supply fitting comprising a floor pedestal portion formed integrally with a gas supply elbow having spaced vertical nipples for engaging and supporting both sections of said orifice unit in matched assembled relation.

5. Gas burning equipment for furnace fire chambers, comprising a burner base member, a burner orifice unit, and a refractory block structure all constructed in half sections insertable through the bottom opening of the fire chamber for assembly in superposed relation therein, and a pilot structure adapted to be mounted in operative relation to said orifice unit, and engaging means formed as a part of said base member for positioning and retaining said pilot structure in said operative relation.

6. Gas burning equipment for furnace fire chambers, comprising a burner base member, a burner orifice unit, and a refractory block structure all constructed in half sections insertable through the bottom opening of the fire chamber for assembly in superposed relation therein, one of said refractory block sections having a pilot tube recess and a pilot structure including a pilot flame tube projecting within said recess, the other refractory block section and corresponding base member section having interengaging portions for positioning and holding the said base member

and block structure in a predetermined assembled relation.

7. A gas burner construction comprising a base shell casting, and a gas burner member enclosed by said base casting and provided with laterally directed gas jet orifices, said base casting having interior shoulders supporting said burner member in spaced relation to the inner surface of the base casting to provide a passage for the upflow of air vertically past said orifices.

8. A gas burner construction comprising a base shell casting, a gas burner member enclosed by said base casting and provided with laterally directed gas jet orifices, said base casting having interior shoulders supporting said burner member in spaced relation to the inner surface of the base casting to provide a passage for the upflow of air vertically past said orifices, and a refractory block structure mounted over said burner member and extending in position to provide ample combustion space while permitting direct radiant heat transmission in all directions both upwardly and outwardly therefrom.

9. A gas burner construction comprising a base shell casting, a gas burner member enclosed by said base casting and provided with laterally directed gas jet orifices, said base casting having interior shoulders supporting said burner member in spaced relation to the inner surface of the base casting to provide a passage for the upflow of air vertically past said orifices, and a refractory block structure mounted over said burner member and provided with concave lateral faces providing an ample combustion zone space and leaving unobstructed the vertical upward and outward paths for direct radiant heat transmission above said combustion zone.

10. Gas burning equipment comprising an air box for furnace ash pit chambers, said box having a top opening at its inner end, a burner base shell casting fitting over said opening, a burner orifice unit enclosed by said base casting in spaced relation to the inner surface thereof and provided with outwardly directed orifices for dis-

charging the gas in jets at right angles to the air flowing between said burner unit and base casting, and a refractory block structure mounted over said burner unit and formed with concave lateral faces providing an ample combustion zone space above the burner unit and leaving unobstructed the vertical upward and outward paths for direct radiant heat transmission above said combustion zone.

11. Gas burning equipment comprising an air box for furnace ash pit chambers, said box having a top opening at its inner end, a burner base shell casting fitting over said opening, a burner orifice unit enclosed by said base casting in spaced relation thereto and provided with outwardly directed gas orifices, a laterally concave faced refractory block structure mounted over said burner unit and formed with a pilot tube recess opening into the combustion space above the burner unit, a pilot structure including a pilot tube adapted to be projected above the burner unit into said recess, and an open-sided hanger device within the air box adapted for positioning and supporting the pilot structure with said tube in operative position.

12. Gas burning equipment for furnace fire chambers, comprising a sectional burner orifice unit adapted to be assembled within the fire chamber, and a combination supporting standard and gas supply fitting having vertically spaced nipples for connecting with and holding both sections of the orifice unit in matched and assembled relation, and a refractory block structure having its base seated upon those portions of the burner sections which connect with said nipples.

13. A fluid fuel burner comprising a pipe elbow with two separate pipes forming one arm of the elbow, a base connected to and supporting said elbow with the double pipe arm extending upwardly, a pair of burner sections abutting edge to edge and each removably mounted upon one of the pipe branches of the said elbow, and means for supplying fuel to the other arm of said elbow.

HARRY A. ATWATER.