July 7, 1936. H. A. DREFFEIN 2,046,371

COMBUSTION APPARATUS

Filed Nov. 9, 1931 2 Sheets-Sheet 1

Fig. 1

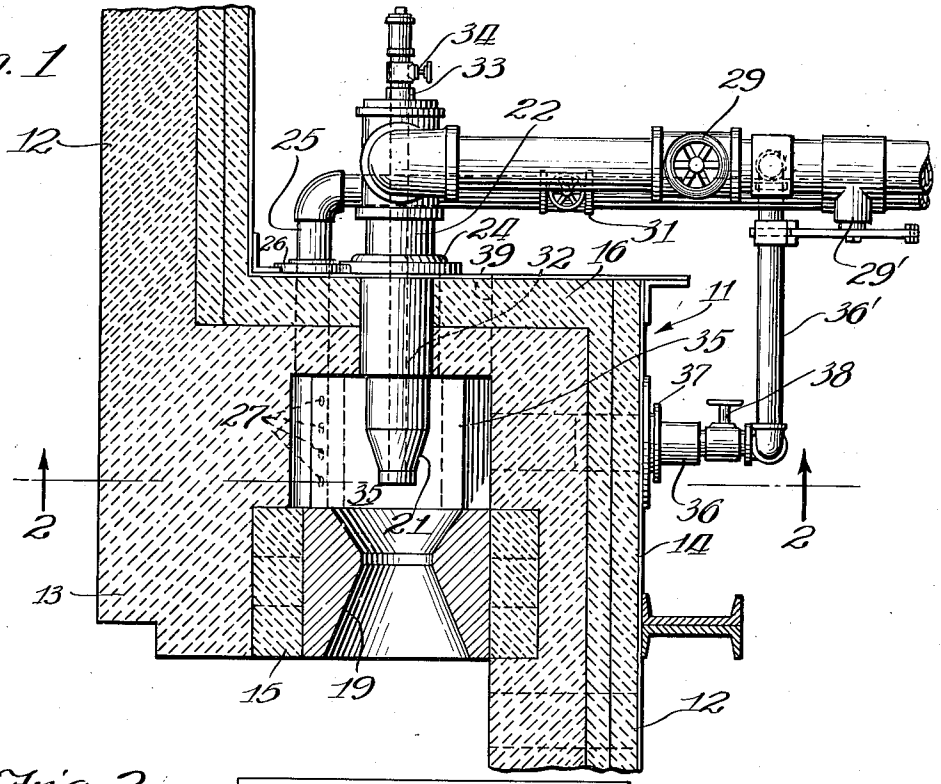
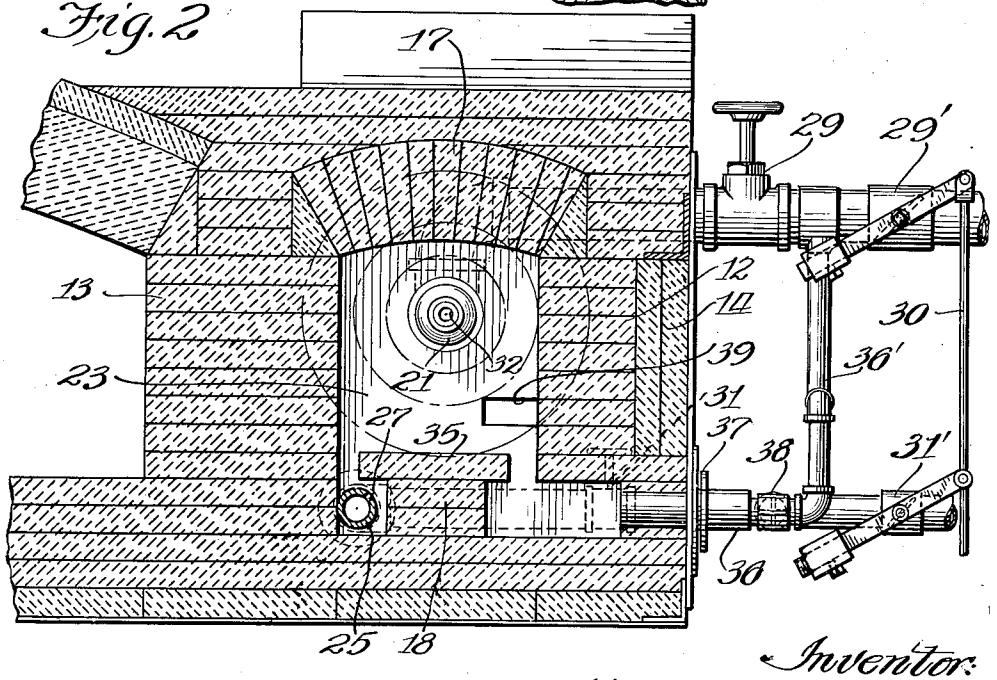


Fig. 2



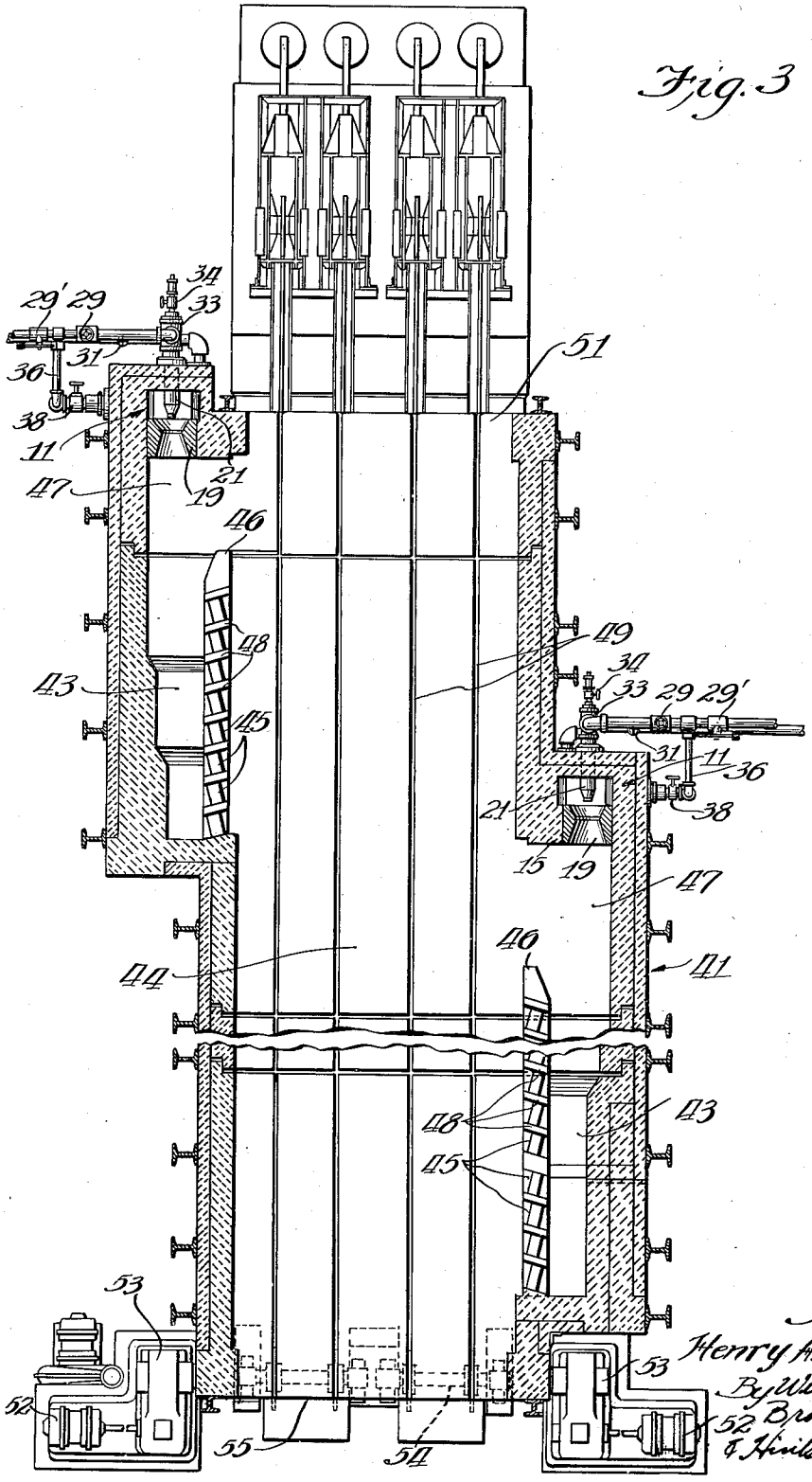
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Fig. 3



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UNITED STATES PATENT OFFICE

2,046,371

COMBUSTION APPARATUS

Henry A. Dreffein, Chicago, Ill.

Application November 9, 1931, Serial No. 573,312

7 Claims. (Cl. 263—43)

This invention relates in general to combustion apparatus and methods, and has more particular reference to a novel burner construction and method of combustion.

While I do not wish to limit my invention to any particular use, it is particularly applicable to furnaces used in various metallurgical processes involving the heat treatment of, for example, metal packs of sheets, bars and the like. The invention includes, among other objects, the provision of a novel method and apparatus whereby a fixed or substantially constant air supply at constant velocity supplements another air supply which is simultaneously variable with a fuel or gas supply to obtain efficient fuel or combustion mixtures at all operating pressures of the simultaneously variable gas and air supplies; whereby not withstanding the relatively high velocity and pressure of the fuel mixture either a non-luminous or a luminous hazy flame may be obtained at the will of the operator and the hitherto objectionable cool zone between the burner and the flame is eliminated in the case of a luminous flame by a species of pilot light which ignites and maintains the flame at the burner heat outlet; whereby such a luminous hazy flame is caused by innumerable solid carbonaceous particles produced from the fuel and utilized as heat conveyors and radiators; whereby to produce a luminous flame with sufficient velocity of fuel supply to cause the flame to extend a desired distance from the burner outlet; whereby to provide a method and means for producing such a flame in combination with a furnace of the type disclosed in my United States Letters Patent No. 1,779,964; and whereby, in general, to provide novel apparatus for carrying out the objects of the invention.

Other objects and advantages of the invention will be apparent from the following description and from the accompanying drawings, in which similar characters of reference indicate similar parts of the several views.

In the drawings,

Fig. 1 is a cross section through a portion of a novel combustion apparatus embodying the features of my invention;

Fig. 2 is a cross section taken substantially on the line 2—2 of Fig. 1; and

Fig. 3 shows in horizontal section a furnace equipped with the novel burner of my invention.

To accomplish the foregoing objects I provide a burner 11 for a combustion apparatus, diagrammatically illustrated at 12 in Figs. 1 and 2. This burner 11 has side walls 13 and 14, end walls 15 and 16, a top 17 and a bottom 18 of suitable refractories, and is so arranged as to supply heat to the combustion apparatus 12 through an orifice or nozzle 19 carried in the end wall 15.

The nozzle or orifice 19 cooperates with an air supply nozzle 21 carried at the inner end of an air supply main or pipe 22 to provide an injector for entraining or inducing fuel from a fuel chamber 23 defined by the side, end, bottom and top walls of the burner, and mixing the air from the pipe 22 with the fuel for combustion at the nozzle or orifice 19. The air supply pipe 22 enters the chamber 23 through the end wall 16 and suitable packing or connections 24.

Any hydro-carbon gas such as natural gas, producer gas or a suitable mixture of producer gas and natural gas, is supplied to the chamber 23 by means of a supply pipe or main 25 entering the chamber 23 through the wall 16, and suitable packing or connections 26, this pipe 25 extending substantially the full length of the fuel chamber wherein it is provided with a plurality of spaced gas jets or orifices 27.

The rate of gas and air supplied to the burner 11 may be independently controlled by an air control valve 29 and a gas control valve 31 in the pipes 22 and 25. Preferably, however, the rates of air and gas supplied to the burner to produce a combustion mixture at the orifice 19 are simultaneously adjustable by a common valve operating device 30 for an air control valve 29' and a gas control valve 31'. As will be apparent, the common operating device may be actuated manually or by any suitable automatic actuating means.

In order to avoid improper mixtures of air from the pipe 22 and gas from the chamber 23 due to reduced air pressures and velocities at the nozzle 21 during low heat supply from the burner to the combustion apparatus, and in order to cause the mixing of the air and gas during such conditions in the orifice 19, I employ a constant or fixed supply of air which is delivered to the burner through a supply pipe 32 concentrically arranged in the supply pipe 22 by a reducer coupling 33. The air supplied from this pipe has sufficient pressure and velocity to maintain the injector action with the orifice 19 and to project or extend the flame and gases into the nozzle 19 even during periods when the burner is delivering a minimum of heat to the combustion apparatus. A valve 34 is provided for controlling this fixed or constant air supply from the pipe 32.

Notwithstanding the high pressure and velocity of air delivered by the constant air supply pipe

32 from the nozzle 21, I provide means for producing a luminous hazy flame at the orifices 19, which flame is more rapid to heat and more rapid to cool than non-luminous clear flames, and which transfers more radiant heat than such clear non-luminous flames for quickly bringing the combustion apparatus 12 up to heat and for efficiently utilizing the heat available from the flame. In order to accomplish this I provide a T-shaped baffle 35 extending the full length of the chamber 23 and so arranged that the baffle retards or impedes the velocity of the gas coming from the jets or orifices 27 and impinging against a side of the baffle. The baffle 35 is so arranged in respect of the side wall 13 that the gas from the jets 27 are directed first against the baffle and then permitted to rise slowly upwardly above the baffle, following generally the surface of the side wall 13.

As the gas rises in the chamber 23 it will gradually diffuse laterally and transversely of the chamber, from which it may be entrained by the injector action of the nozzles 19 and 21. An air supply pipe or main 36 enters the burner 11 and communicates with the chamber 23 through the side wall 14 and suitable packing and connections 37 at the opposite side of the T-shaped baffle 35 from the gas supply pipe 25. The air supplied by the pipe 36 may come from the same source as the air supplied by the pipe 22 to which it is connected by a pipe 36′ and is controlled by a suitable valve 38 so that when the valve 38 is open and the common control 30 is operated to control the rate of supply of gas through the pipe 25 and air through the pipe 22, the pipe 36 will deliver sufficient air to the chamber 23 to support partial combustion of the gas from the jets 27 ignited in the chamber 23 through a suitable aperture or opening 39 in the end wall 16.

The air supplied by the pipe 36 impinges against the side of the T-shaped baffle 35 opposite the side against which the gas from the jets 27 impinges and is retarded in velocity, rising like the gas from the jets generally along the side wall 14 and diffusing slowly with the gas above the T-shaped baffle 35. This partial combustion of the gas in the chamber 23 produces innumerable solid products of partial combustion, such as particles of soot and carbon which are entrained along with the partially burned fuel by the injector action of the nozzles 19 and 21, the flame in the chamber 23 serving as a species of pilot light or burner to ignite the mixture of the partially burned fuel and the air from the nozzle 21 and to maintain the flame extending from adjacent the nozzle 21 into the nozzle 19. By maintaining the flame at the nozzle 21 in this manner I eliminate the relatively cool zone which has heretofore been caused in such burners between the nozzle and the flame.

These products of partial combustion, soot or carbon produced in the chamber 23 by the slow partial burning of any hydro-carbon gas in a deficiency of oxygen, are good absorbers of heat and may, therefore, be employed as heat conveyors and radiators. When the partially burned fuel, laden with or containing these soot particles, is mixed with the air from the nozzle 21 and ignited by the flame from the chamber 23, a luminous hazy flame results at the nozzle 21 and extends into the combustion apparatus. The sooty particles, having become luminous by the heat absorbed from the partial combustion of the fuel in the chamber 23 and the final combustion in the flame projecting from the nozzle 21 serve as conveyors of heat and serve to protect the refractories. The sooty particles may subsequently be deposited upon the materials being treated to reduce the tendency in the case of metal sheets of sticking together when such sheets are rolled in packs, thus serving to produce the effect of carbon coating which is frequently employed to avoid such sticking together.

Where desired, the burner 11 may be employed as a non-luminous or clear flame burner by closing or nearly closing the valve 38, controlling the air which supports the partial combustion of the fuel in the chamber 23, and permitting the fuel from the jets or orifices 27 in the fuel supply pipe 25 to be diffused by the T-shaped baffle 35 in the chamber 23. Where the burner is so used, the rate of air supply from the pipe 22 and the rate of gas supply from the pipe 25 may be independently controlled by the valves 29 and 31. When so employed the constant or fixed air supply from the pipe 32 assures the proper delivery of the combustion mixture and burning of the fuel mixture and the delivery of heat from the burner to the combustion apparatus even during the periods when a minimum heat is required by the combustion apparatus from the burner, or in other words, during such time as the rate of supply of gas from the pipe 25 and air from the pipe 22 is reduced for a minimum heat delivery by the burner. This is particularly important where one or more burners 11 are employed to supply heat to a metal pack heating furnace, as illustrated at 41 in Fig. 3, because this central jet or constant air supply 32 will provide sufficient velocity to insure the proper functioning of restricted chambers 43 respectively alined with the nozzles 19 and communicating with the material treating chamber 44 of the furnace 41 through a plurality of gas apertures 45 in baffle walls 46. Each baffle wall 46 extends from the end of each chamber 43 to a point short of the end wall 15 of the burner 11, providing a chamber 47 communicating at one end with the nozzle 19 and at its opposite end with the restricted portion 43, and having an open side communicating with the treating chamber 44. The hot gases and flame emanating from the orifice 19 are at first unconfined in the chamber 47 and thereafter by virtue of the velocity of air from the constant air supply pipe 32 propelled into the restricted chamber 43 for inducing gases through the open side of the chamber 47 from the main or treating chamber 44 and for subsequently recirculating such induced gases into and through the restricted portion or chamber 43 into the treating chamber 44. During this unconfined period of the gases they are permitted to expand and heat the materials in the chamber 44 by radiation.

The velocity of the gases carries them through the relatively unconfined space into the more restricted gas chambers 43, setting up therein a greater pressure than that obtaining in the treating chamber 44. The hot gases in the restricted portions 43 flow through the gas apertures 45 into the chamber 44 at the upper portion thereof by virtue of the arrangement of the apertures and directional baffles 48 and pass across and around the articles being treated in the furnace.

As will be understood, the furnace 41 is merely illustrative of one type of furnace to which my novel burner is applicable and as illustrated, is preferably of the type disclosed in my United States Letters Patent No. 1,779,964 dated October 28, 1930. In such a furnace the material to be treated may be carried through the heat treating chamber 44 by suitable conveyors 49, on which

such articles may be loaded at a charging end **51** and carried by the conveyors under the action of any suitable driving means, such, for example, as electrical motors **52**, speed reducers **53** and a conveyor drive shaft **54** coupled therewith to a discharge end **55** of the furnace.

When a low luminous flame is to be utilized, the rate of gas supply from the pipe **25** and the rate of air supply from the pipe **22** may be reduced sufficiently to provide such a low flame, but the air supply from the pipe **32** has sufficient pressure and velocity to insure the proper delivery and flow of the flame and gases to and in the furnace.

Thus I have provided a novel burner which may optionally produce either a luminous hazy flame or a non-luminous clear flame and which employs a fixed air supply at a constant pressure and velocity sufficient to obtain a suitable combustion mixture at the burner outlet and to deliver the heat from the burner to the combustion apparatus associated with the burner even during periods when the rate of fuel supply to the burner is a minimum. This constant air supply by virtue of its relatively high pressure and velocity, enables me to employ such a burner even when producing a luminous hazy flame in connection with metal heating furnaces of the unrestricted portion type disclosed in Fig. 3, without blowing the flame away from the burner and thereby producing a cool zone between the flame and the burner outlet or nozzle. It will be noted that where the burner is being employed as a luminous hazy flame burner, the air supply from the pipe **22** and the air supply from the pipe **36** for supporting partial combustion in the chamber **23**, as well as the fuel supply from the pipe **25**, are controlled together and simultaneously by the common control **30**, thereby assuring the proper mixtures of fuel and air for partial combustion in the chamber **23** and for the final combustion of fuel and air at the nozzle **21**, while the constant air supply from the pipe **32** is independently controlled for obtaining efficient combustion mixtures at the nozzle at all operating pressures of the simultaneously variable gases and air supplies.

Having thus described my invention, what I claim as new and desire to secure by United States Letters Patent is:

1. In a furnace, a fuel chamber, means for introducing fuel gas into said chamber, means for introducing air for the partial combustion of said fuel gas in said chamber, a chamber outlet member including an orifice communicating with said chamber, a variable air supply nozzle in said chamber and forming with said orifice an injector for inducing the gas and products of partial combustion from said chamber into said outlet member and for providing therein air for the final combustion of said gas, a constant air supply nozzle in said chamber and forming with said orifice an injector for maintaining the injector action during periods of low heat requirements in the furnace, and means for simultaneously varying the rate of supply of the gas, the air for partial combustion, and the air for final combustion.

2. In a furnace, a fuel chamber, means for introducing fuel gas into said chamber, means for introducing air for the partial combustion of said fuel gas in said chamber, and means for removing the products of the partial combustion and the gas from said chamber, comprising a chamber outlet member having an orifice therein communicating with said chamber, a variable air supply nozzle and a constant air supply nozzle in said chamber and each forming with said orifice an injector for inducing the gas and products of partial combustion from said chamber into said outlet member and for providing therein air for the final combustion of said gas, the injector formed by said constant and variable air supply nozzles and said orifice being arranged in the flame zone of said chamber whereby the combustion of the unburned fuel from said chamber and the air for final combustion of the fuel is maintained.

3. In a furnace, a fuel chamber, means for introducing fuel gas into said chamber, means for introducing air for the partial combustion of said fuel gas in said chamber, and means cooperating with the aforesaid means for producing a discharge of the gas and products of partial combustion at a relatively high velocity from said chamber, comprising a chamber outlet member having an orifice therein communicating with said chamber, a variable air supply member and a constant air supply member in said chamber and each forming with said orifice an injector for removing the gas and products of partial combustion from said chamber through said outlet member and for providing air for the final combustion of said fuel gas, the injector formed by said orifice and each said constant and variable air supply members being arranged in the flame zone of said chamber.

4. In a furnace, a fuel chamber, means for introducing fuel gas into said chamber, means for introducing air for the partial combustion of said fuel gas in said chamber, and means cooperating with the aforesaid means for producing a discharge of the gas and products of partial combustion at a relatively high velocity from said chamber, comprising a variable air supply member and a constant air supply member in said chamber and each with a chamber member forming means for removing the gas and products of partial combustion from said chamber and for providing air for the final combustion of said fuel gas, the last said means extending into the flame zone of said chamber.

5. In a furnace, a fuel chamber, means for introducing fuel gas into said chamber, means for introducing air for the partial combustion of said fuel gas in said chamber, a variable air supply member and a constant air supply member in said chamber for providing air for the final combustion of said gas, means in said chamber for coacting with said variable and constant air supply members whereby the gas and products of partial combustion from said chamber and the air for final combustion of the gas are removed from said chamber, and means for simultaneously varying the rate of supply of the gas, the air for partial combustion, and the air for final combustion.

6. In a furnace, a fuel chamber having a heat outlet, means for introducing fuel gas into said chamber, and means for providing a luminous hazy flame outwardly adjacent said heat outlet and fed from said chamber by a combustible fuel mixture at a relatively high velocity, comprising means for introducing air for the partial combustion of said fuel gas in said chamber, a variable air supply member and a constant air supply member in said chamber for providing air at a relatively high velocity for the final combustion of said gas, and means in the flame zone of

said chamber for coacting with said variable and constant air supply members whereby the gas and products of partial combustion from said chamber and the air for the final combustion of the gas are projected through said heat outlet.

7. In a furnace, a fuel chamber having a heat outlet, means for introducing fuel gas into said chamber, and means for providing a luminous hazy flame outwardly adjacent said heat outlet and fed from said chamber by a combustible fuel mixture at a relatively high velocity, comprising means for introducing air for the partial combustion of said fuel gas in said chamber, a variable air supply member and a constant air supply member in said chamber for providing air at a relatively high velocity for the final combustion of said gas, and means in the flame zone of said chamber for coacting with said variable and constant air supply members whereby the gas and products of partial combustion from said chamber and the air for the final combustion of the gas are projected through said heat outlet, and operable means for controlling said means for introducing air for the partial combustion of said fuel gas, whereby the second said means provides a clear flame outwardly adjacent said heat outlet and fed from said chamber by a combustible fuel mixture at a relatively high velocity.

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