April 27, 1965 L. F. CONWAY 3,180,394

GAS BURNER

Filed April 26, 1955 2 Sheets-Sheet 1

Fig. 1.

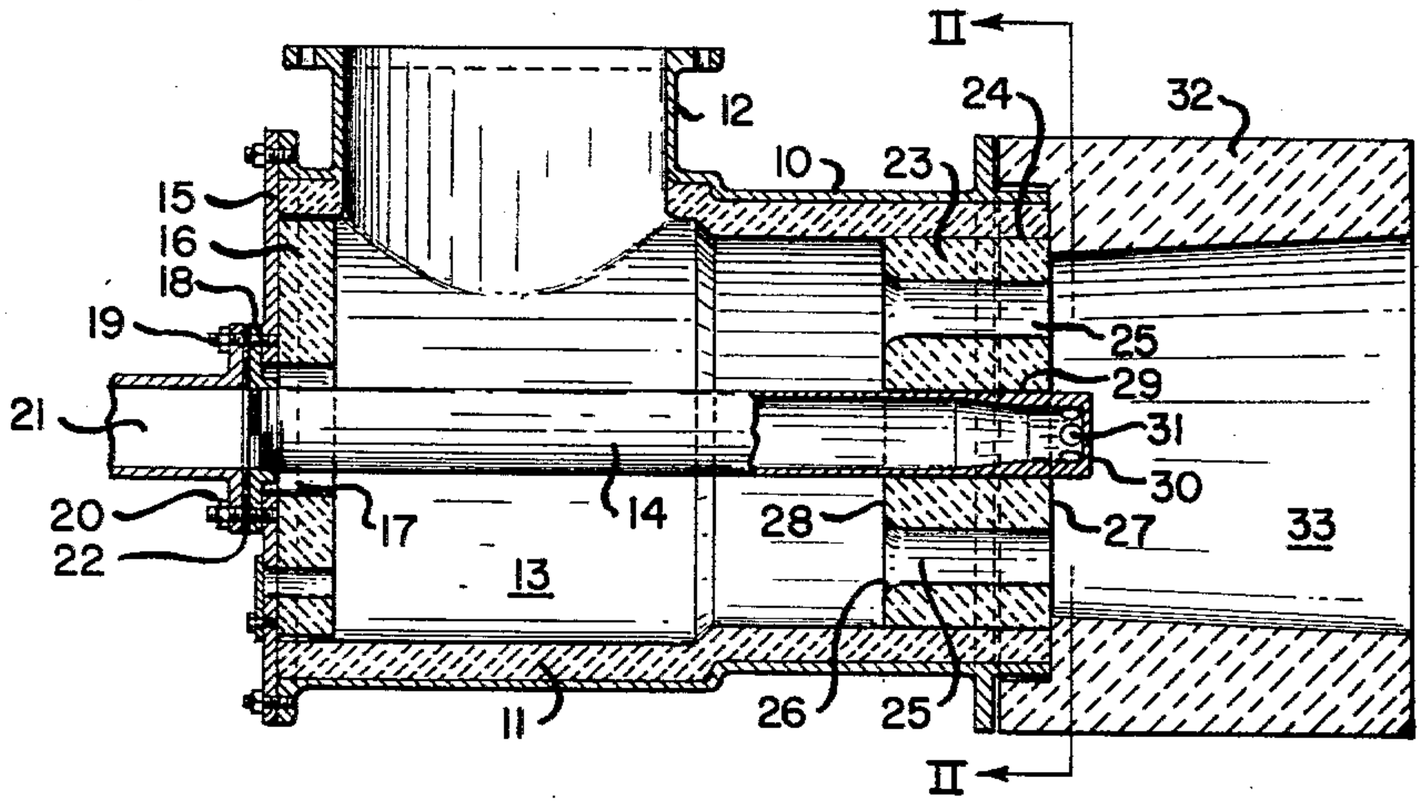

Fig. 2.

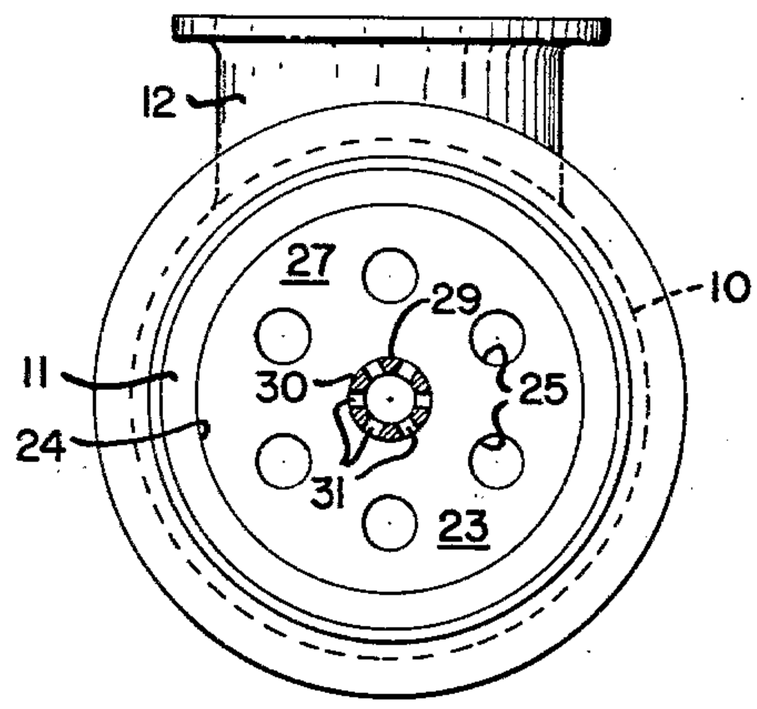

Fig. 5.

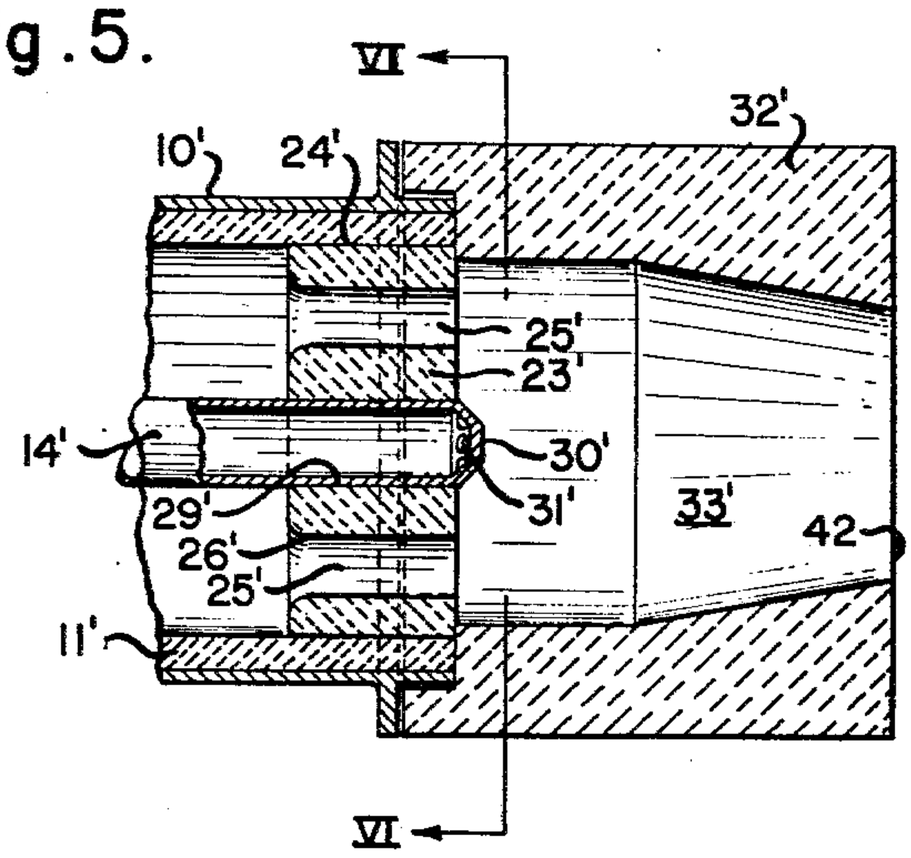

Fig. 6.

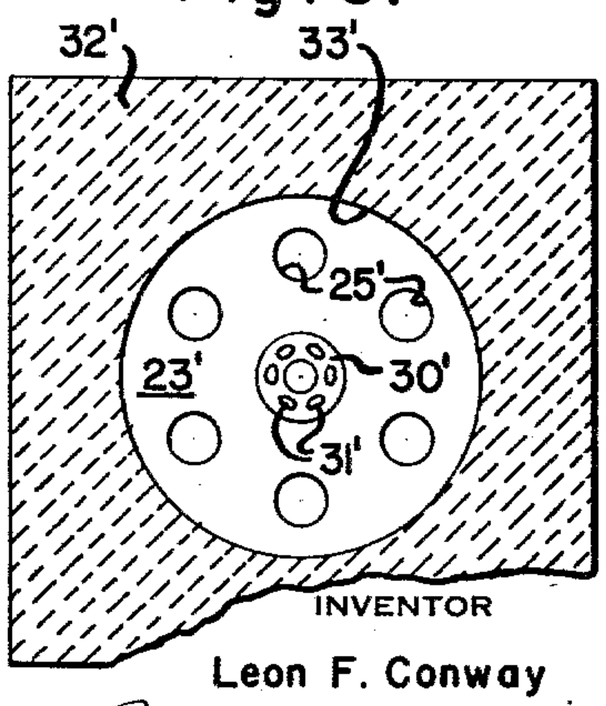

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Fig. 7.

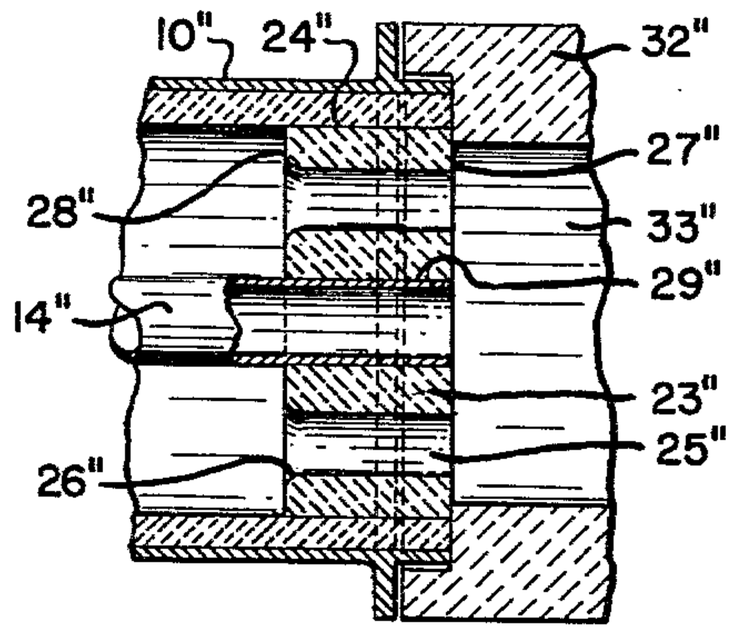


Fig. 3.

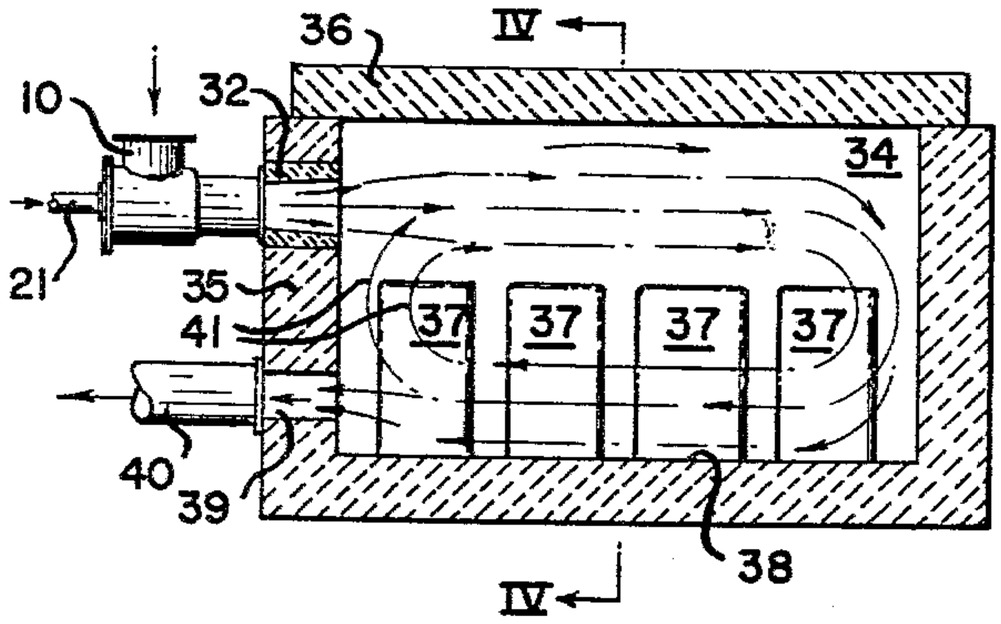


Fig. 4.

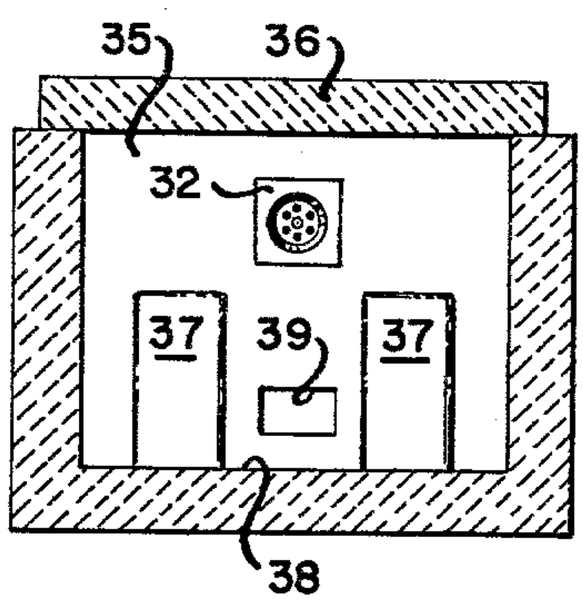
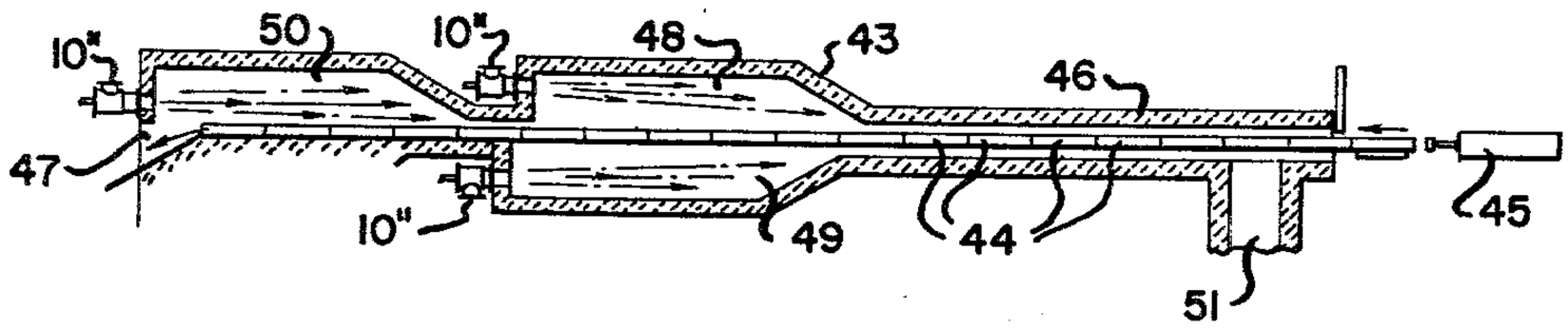


Fig. 8.



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United States Patent Office

3,180,394

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GAS BURNER

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3 Claims. (Cl. 158—7)

This invention relates to a new burner and system for industrial furnaces. More particularly, this invention relates to a flexible new burner construction with a relatively wide combustion air range and relatively high turndown ratio which is capable of providing stable flame of selected character especially suited to a service to be performed.

The new burner construction and system of this invention provide a flexible device capable of providing stable flame of different character for use in varying industrial heating furnace services. Thus, one of my new burner embodiments disclosed herein is capable, for example, of being utilized in a soaking pit furnace and of producing flame therein which is relatively clear, intensely hot and short. Hence, my new construction enables such a soaking pit to have its temperature brought up relatively uniformly from top to bottom without overheating the tops of such ingots as may be positioned in that furnace. Heretofore, numbers of soaking pits where hot gases were recirculated developed a suitable bottom temperature considerably later than such temperature was reached at the top, or there was danger of overheating the tops of ingots in such prior pits when a relatively luminous flame was used.

Further, the new burner of this invention is suitable for luminous flame provision such as is often desired in slab or billet heating furnaces where little or no recirculation is wanted. I have found that my new burner device will operate satisfactorily at relatively high combustion air pressures, at intermediate combustion air pressures and at relatively low combustion air pressures without detriment to the flame characteristic selected in terms of being relatively clear or relatively luminous and without adverse effect on the turndown ratio of the burner irrespective of whether excess combustion air is present or not. It also appears that my new burner achieves relatively simple yet effective combustion air distribution without special apparatus or complex guides, controls or meters of various kinds used in prior burner systems.

Other objects and advantages of this invention will be apparent from the following description and from the accompanying drawings, which are illustrative only, in which

FIGURE 1 is a view in side sectional elevation of one embodiment of a new burner of this invention for producing a relatively clear flame;

FIGURE 2 is a view taken along line II—II of FIGURE 1 and with the port block removed from such burner;

FIGURE 3 is a schematic view in side sectional elevation of a soaking pit furnace employing the new burner embodiment shown in FIGURES 1 and 2;

FIGURE 4 is a sectional view taken along line IV—IV of FIGURE 3;

FIGURE 5 is a view in side sectional elevation of a modified embodiment of a new burner of this invention for producing a relatively clear flame;

FIGURE 6 is a view in section taken along line VI—VI of FIGURE 5;

FIGURE 7 is a partial view in side sectional elevation of a modification of the new burner shown in FIGURES 1 and 2; and

FIGURE 8 is a view in side sectional elevation of one form of slab or billet heating furnace in which new

burners as shown in FIGURE 7 may be used for advantageous relatively "luminous" flame heating of workpieces passed through such furnace.

Referring to FIGURES 1 and 2, the embodiment shown therein of one form of my new burner construction comprises a tubular combustion air body 10 which may be lined with castable refractory 11. A branch conduit 12 may be made integrally with body 10 for the admission of combustion air to the interior space 13 of the new burner surrounding a fuel tube 14 which may be made of a suitable alloy. The rear or outer end of burner body 10 may be closed by a removable cover plate 15 faced with refractory 16 and having a central opening 17 for the passage therethrough of the rear end of fuel tube 14. The rear end of fuel tube 14 may be screwed into a base plate 18 having an annular flange drilled in registry with studs 19 for the accommodation thereof with their respective securing nuts 20.

A fuel fitting 21 is provided with a flange drilled in registry for the passage of studs 19 and is held against a packing ring 22 which in turn is held against the flange of base plate 18 by the aforesaid nuts 20. The fuel admitted to fitting 21 may either be a fuel gas such as natural gas or coke oven gas or still another gas, or it may be a relatively fluid fuel oil in atomized form admixed with an atomizing medium such as steam or atomizing air such as would be produced by a so-called emulsion type ("ET") oil burner atomizer as will be understood by those skilled in the art to whom this invention is disclosed. Other kinds of oil atomizers may also be used to supply fuel to my new burners.

Adjacent the front end of space 13 within body 10, I provide a combustion air baffle 23, preferably of refractory bonded to body 10 at the peripheral meeting surface 24. The forward face 27 and the rear face (outer side) 28 of the illustrated baffle 23 preferably will be normal to the axis of the burner and to the axis of fuel tube 14 which coincides with the burner axis.

Baffle 23 in the illustrated embodiment is provided with a series of axially extending passages 25 passing entirely therethrough. The entry ends 26 of openings 25 may be rounded to facilitate the flow of combustion air into and through openings 25, the aggregate cross-sectional area of openings 25 being sufficient for the combustion air needs of fuel issuing from fuel tube 14. The length of each opening 25 relative to its diameter should be such as to impart a directional effect to the combustion air passing therethrough substantially irrespective of the combustion air pressure selected and of the particular service in which the illustrated burner is applied. In that illustrated embodiment, each of the openings 25 has a length which is about 3 times the diameter thereof. Thereby, particularly at relatively higher velocities produced by combustion air inlet pressures in space 13 of about five-inches of water or above, the openings 25 tend to act as air jets and exert an aspirating effect. Combustion air may be supplied to new burners of this invention at room temperature or otherwise as desired.

A central opening 29 extends entirely through baffle 23 to provide a relatively close fitting passage for fuel tube 14 to enable such fuel tube to pass thereinto. The surface of opening 29 may be bonded to the exterior of fuel tube 14 if desired except in those cases where fuel tube 14 may be withdrawn for ready interchange with a fuel tube selected to provide a different character of stable flame where the service in which my new burner may be used, is varied. If the surface of opening 29 is not bonded to fuel tube 14, such fuel tube may readily be slid into or out of opening 29 in a respective assembly or disassembly of the burner. Removing the nuts 20, in a case where fuel tube 14 is to be withdrawn, would enable another fuel tube such as that illustrated in FIGURE 7 for ex-

ample to be substituted and provide an opportunity for adjustment in the flame character to be selected.

The embodiment shown in FIGURES 1 and 2 is a relatively clear flame burner. In achieving a stable flame of that character, I provide a nozzle 30 projecting somewhat forwardly of face 27 and having fuel discharge openings 31 extending therethrough around the periphery of nozzle 30. The axes of the fuel discharge outlets 31 are at an angle to the axis of the burner and of fuel tube 14. The axes of fuel outlets 31 preferably fall between the edges of adjoining combustion air holes 25 as may be seen in FIGURE 2. Although nozzle 30 in the embodiment of FIGURES 1 and 2 is welded to the forward end of fuel tube 14 to make it an integral part thereof, such nozzle 30 may readily be made so that it is removable from the forward end of fuel tube 14 whenever such a removable nozzle construction is desired.

A forward end of the new burner being described fits against the rear end of a refractory port block 32, the space between the two generally being sealed. Port block 32 is usually installed in a refractory wall of a furnace of a high temperature industrial furnace and has a port 33 in which a combustible mixture is formed by the admixture of fuel discharging from outlets 31 and of combustion air discharging from openings 25.

One of many possible installations of the embodiment of FIGURES 1 and 2 is shown in FIGURES 3 and 4. Therein, a schematic rectangular top-fired soaking pit 34 lined with refractory is provided with an end wall 35 in which port block 32 may be mounted with a new burner of FIGURES 1 and 2, as shown. Pit 34 may be provided with a refractory lined cover 36 and may have steel ingots 37 therein on its hearth 38. A waste gas passage 39 may be provided through wall 35 adjacent the bottom of pit 34 for the discharge of waste gases therethrough into a flue 40 leading to a stack. When soaking pit 34 is in operation, recirculation of hot gases therein may be caused to occur as indicated by arrows 41.

My new burner construction enables such a soaking pit 34 to be started up and raise the temperature in the lower portion to that in the upper portion substantially at the same time without risk of overheating or "burning" the tops of ingots 37. Heretofore, furnace "soaking" might be employed to bring temperatures in the lower portion of such a furnace up to the temperature in the upper part of the furnace before "soaking" of at least the lower parts of the ingots themselves began at the desired selected temperature.

I have discovered that such a new burner provides advantages mentioned above in a soaking pit like that illustrated wherein recirculation takes place. Thus, the flame production by the new burner is relatively short, intensely hot and relatively clear. It does not overheat or radiate excessive heat to the tops of ingots such as ingots 37. Moreover, my new burner provides a stable flame with various fuels with relatively high turndown ratios and with relatively wide ranges of combustion air pressure and quantities for a given size of new burner. For example, a burner such as that shown in FIGURES 1 and 2 will operate successfully on relatively low fuel or combustion air velocities corresponding to a pressure which may not exceed a pressure of one-inch of water or which may be even lower; it will operate successfully on intermediate velocities such as those that would be provided by a pressure up to three-inches of water or higher; and it will operate successfully on relatively high velocities such as those that might be produced by as much as ten-inches of water pressure or more. At the same time, the turndown ratio of the new burner is excellent, the flame remaining stable even when the fuel is greatly reduced in flow or the quantity of combustion air becomes substantially in excess of the theoretical requirement. Still further, the flame provided by such new burner tends to hug the forward face 27 of the baffle 23 even at higher operating pressures. Such hugging is particularly noticeable around

the discharge ends of the combustion air openings 25 and in port 33. It is also notable that a baffle like baffle 23 eliminates any need for special combustion air distribution or flow patterning devices such as heretofore used.

The modification shown in FIGURES 5 and 6 also produces a relatively short, intensely hot and relatively clear stable flame while enjoying advantages described in connection with the embodiment illustrated in FIGURES 1 and 2. Parts substantially corresponding in construction and functioning to elements in the embodiment of FIGURES 1 and 2, are provided with the same reference numerals with the addition of a prime factor thereto. In the further embodiment of FIGURES 5 and 6, port 33' tapers instead of flares, so that the discharge opening 42 of port 33' is relatively smaller than the size of port 33' rearwardly of such opening. The discharge opening defined by peripheral edge of discharge opening 42 may be circular as shown or it may be shaped in rectangular form as, for example, whenever a burner embodiment of FIGURES 5 and 6 may be used in a Fretz-Moon type of furnace to heat the edges of skelp for making pipe. In the embodiment of FIGURES 5 and 6, further, nozzle 30' is provided with fuel outlets 31' directed in a flaring direction rather than being normal to the axis of the burner as is the case in the embodiment of FIGURE 1.

FIGURE 7 shows a modification patterned on the embodiment of FIGURES 1 and 2. The FIGURE 7 embodiment is a form of my new burner which will provide a stable and relatively luminous flame or a relatively clear flame. At relatively low or intermediate combustion air velocities issuing from passages or openings 25'' in baffle 23'', relatively luminous flames are produced by the FIGURE 7 embodiment. On the other hand, at relatively higher combustion air velocities producible by pressures in the order of five-inches of water and above on the rear side of baffle 23'', the non-annular peripheral combustion air jetting appears to have an aspirating mixing action producing a stable relatively clear flame. Indeed, in the various forms of my new invention the higher the pressure of the combustion air supplied to such burners, the relatively clearer and shorter the flame tends to be. At all combustion air pressures in the various forms, uniform flame cross-section around the axis of the burner also appears to result.

A relatively luminous flame is sought in many slab and billet heating furnaces, one of many forms of which is shown in FIGURE 8. Parts in FIGURE 7 generally corresponding in construction and functioning to elements of the embodiment shown in FIGURES 1 and 2 are provided with the same reference numerals with the addition of a double prime factor thereto. The parts of the burner construction in FIGURE 7 and of its port block, which are not fully shown, may be precisely like those shown and described in the embodiment of FIGURES 1 and 2. Advantages in the embodiment of FIGURES 1 and 2 relating to stable character of flame, the ability of the burner to provide an excellent turndown ratio, to utilize combustion air over a wide range of pressures, and, to accept substantial quantities of combustion air in excess of theoretical requirements for the fuel involved, are also present in the embodiment of FIGURE 7. However, the fuel tube 14'' in the embodiment of FIGURE 7 discharges fuel substantially directly parallel to the axes of the combustion air openings 25''. The flame produced by the new burner in the embodiment shown in FIGURE 7 is relatively luminous at relatively low or intermediate combustion air pressures and velocities, even with a relatively fast-burning atomized or gas fuel. One possible operation of a FIGURE 7 embodiment burner utilizing combustion air pressures such that relatively luminous flames are produced is illustrated in FIGURE 8.

In FIGURE 8, a three-zone slab heating furnace 43 is shown utilizing burners of my FIGURE 7 embodiment having body 10'' and the other elements described

above. In furnace 43, workpieces which may be slabs 44 are pushed into and through the furnace by a pusher 45 over a hearth enclosed within furnace walls 46. Such slabs are discharged at the delivery end 47 of furnace 43 as shown and pass through heating zones 48, 49 and 50 prior to such discharge. Those heating zones may be fired with slab heating relatively luminous flames by means of new burners 10'' in the manner illustrated in FIGURE 8 without recirculation of hot gases which may pass out through a common flue 51 adjacent the entry end of the furnace. Such luminous flame from the new burners of the FIGURE 7 embodiment is relatively long and heats over a relatively greater distance during the course of combustion.

Various changes may be made in details of my new burner construction and system without departing from the spirit of my new invention or the scope of the appended claims.

I claim:

1. In combination, a burner adapted to fit snugly into a port block providing access to a furnace enclosure for heat treating metal work or the like, comprising, a body with a longitudinally extending tubular portion, an axially extending centrally positioned fuel tube within said longitudinal portion, a nozzle connected to said fuel tube, said nozzle having fuel outlets positioned at an angle to the axis of said burner and surrounding the same, said angle being not greater than a right angle measured from the inner end of said axis, means for admitting substantially all of the combustion air required by said burner to said body outwardly of the inner part of said longitudinal portion, a transverse fixed refractory baffle positioned in and substantially closing the inner part of said longitudinal portion, said baffle having an axially extending generally central opening therethrough for said fuel tube for discharging relatively gaseous fuel through said nozzle adjacent the inner end of said central opening, a plurality of cylindrical combustion air passages extending axially and straight through said baffle, said longitudinal portion being open to receive said combustion air and conduct it to said combustion air passages, said combustion air passages having streamlined entrance edges and being positioned in appreciably radially spaced relation to said central opening and fuel outlets, said combustion air passages further being in transversely spaced relation to one another by more than one passage radius generally uniformly around the axis of said central opening, said combustion air passages still further having a length about three times the diameter thereof to provide axially directed streams of air passing through said combustion air passages which continue in an axially extending direction upon discharge, said baffle further having a generally uninterrupted forward face on the discharge side thereof extending transversely between the edge of said central opening and said combustion air passages and between and around said combustion air passages, said fuel outlets discharging adjacent said forward face of said baffle, and a refractory port block having a port therein with a single generally frusto-conical refractory surface into which said burner discharges for ignition against said forward face under all operative conditions, said surface adjoining said forward face and being spaced radially outwardly from said combustion air passages.

2. A burner as set forth in claim 1 in which said longitudinally extending portion and baffle are circular and the axes of said fuel outlets are positioned readilly intermediate the axes of said combustion air passages.

3. In combination, a burner adapted to fit snugly into a port block providing access to a furnace enclosure for heat treating metal work or the like, comprising, a body with a longitudinally extending tubular portion, an axially extending centrally positioned fuel tube within said longitudinal portion having an unobstructed outlet, means for admitting substantially all of the combustion air required by said burner to said body outwardly of the inner part of said longitudinal portion, a transverse fixed refractory baffle positioned in and substantially closing the inner part of said longitudinal portion, said baffle having an axially extending generally central opening therethrough for said fuel tube for discharging relatively gaseous fuel through said outlet adjacent the inner end of said central opening, said baffle having a plurality of cylindrical combustion air passages extending axially and straight through said baffle, said longitudinal portion being open to receive said combustion air and conduct it to said combustion air passages, said combustion air passages having streamlined entrance edges and being positioned in appreciably radially spaced relation to said central opening and outlet, said combustion air passages further being in transversely spaced relation to one another by more than one passage radius generally uniformly around the axis of said central opening, said combustion air passages still further having a length about three times the diameter thereof to provide axially directed streams of air passing through said combustion air passages which continue in an axially extending direction upon discharge, said baffle further having a generally uninterrupted forword face on the discharge side thereof extending transversely between the edge of said central opening and said combustion air passages and between and around said combustion air passages, said outlet discharging substantially at said forward face from said inner end of said central opening, and a refractory port block having a port therein with a single generally frusto-conical refractory surface into which said burner discharges for ignition against said forward face under all operative conditions, said surface adjoining said forward face and being spaced radially outwardly from said combustion air passages.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,180,394 April 27, 1965

Leon F. Conway

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 66, for "readilly" read -- radially --; column 6, line 7, strike out "re-"; lines 30 and 31, for "forword" read -- forward --.

Signed and sealed this 28th day of September 1965.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents