This invention relates to a furnace burner comprising a primary air duct fed by a combustible gas source, and whose outlet is surrounded by a water jacket, a secondary air duct extending through the center of the primary duct and fed by a crude oil source, and a damper in the secondary duct for controlling the gas/air and oil-air ratios.

An object of the present invention is to provide a novel burner which utilizes a laminar flame to produce stratification in the combustion chamber with the advantage of maintaining an extremely reducing atmosphere on the bath or reheating product but with extremely good fuel efficiency (that is, with a very slight deficiency of air).

Another object of the present invention is to provide a novel burner which provides a rich air/gas mixture that will ignite slowly throughout the combustion chamber and provide sufficient heat to crack fuel oil, thus producing luminous carbon particles which provide the luminosity normally associated with an oil fired burner.

A still further object of the present invention is to provide a novel burner which, through variation of air/gas and air/fuel oil ratios (without changing total air/total fuel ratio), provides either a short flame with quick heat release or a long slow heat release flame with a reducing combustion chamber atmosphere.

Other objects and advantages will become more apparent from a study of the following description taken with the accompanying drawings wherein:

FIG. 1 is a vertical cross-sectional view of an industrial furnace burner embodying the present invention; and FIG. 2 is a front view taken from the right of FIG. 1 with the furnace wall omitted.

The burner operates for best results on a ratio of about 70% natural gas to 30% fuel oil, based on B.t.u input. This ratio may be varied as desired for a specific application.

The total air required is divided into primary air duct 1 and secondary air duct 2. This air may be provided by one blower (not shown) with the division of air into duct 1 and duct 2 determined by duct sizing and further controlled by damper 3 in duct 2. As an alternative, the primary and secondary air may each be provided by individual blowers with the air flows controlled by a damper on the upstream side of each blower and interconnected through controls to provide the proper ratios. In either case, it is necessary to provide a gas safety shutoff valve (not shown, but which is well known in the art) which will automatically close should the primary air supply fail.

The total (primary plus secondary) air required is determined by the total B.t.u. input and the desired furnace atmosphere (oxidizing, neutral or reducing) which will vary with each application. For quick firing and a neutral atmosphere the diameter of the primary air duct 1 and the flow nozzle 4 are to be sized to handle a maximum Max. primary air+gas mixture based on the equation:

\[ \text{Max. primary air+gas mixture (cubic feet/hr.)} = 0.01 \times \text{cubic feet/hr. gas} \times \text{B.t.u./cubic ft. for gas plus cubic feet/hr. gas} \]

For a reducing atmosphere duct 1 sizing and damper 3 adjustment must provide a minimum primary air+gas mixture based on the equation:

\[ \text{Min. primary air+gas mixture (cubic feet/hr.)} = 0.005 \times \text{cubic feet/hr. gas} \times \text{B.t.u./cubic ft. for gas plus cubic feet/hr. gas} \]

The diameter of the secondary air duct 2 is sized to handle a maximum secondary air flow (cubic feet per hr.) = total air required (determined as stated above by total oil plus gas B.t.u. input and desired furnace atmosphere) - minimum primary air.

The total air may be preheated provided the primary air will not be sufficiently high in temperature to cause cracking of the gas. However, the burner operates at high efficiency on cold air. The normal operation of this burner is to provide a reducing atmosphere as described in the equation for minimum primary air+gas mixture.

Natural gas (at low or high pressure, 15 p.s.i.g. works well) passes through feed line 5 and enters the primary air duct through manifold 6 around the perimeter of the duct, through ports 7 and is thoroughly mixed with the primary air. The velocity pressure of this air+gas mixture is increased as it passes through the flow nozzle 4. The mixture then passes the water cooled jacket 8 and into the furnace F at port 9 where ignition begins.

This rich mixture containing a deficiency of air creates an outer ring which covers the bath or reheating product with an extremely reducing atmosphere. As this air+gas mixture progresses through the furnace, the excess natural gas, due to expansion from the heat, converges on the excess air in the core of the combustion chamber where the majority of the combustion is completed by the time the gas reaches the furnace stack. The effect of entering a rich air+gas mixture around the core of secondary air utilizes furnace stratification in a beneficial manner to provide a stratified horizontal level of reducing atmosphere. In addition, it provides the heat necessary to cause some cracking of the fuel oil thus producing the luminous flame normally associated with oil fired burners.

A support pipe 10, held in place by support bars 11, is inserted into the secondary air duct. Inside the support pipe is the atomized oil supply pipe 12 with an oil burner nozzle 13 attached to the furnace end of the supply pipe. The oil (No. 6) bunker C works well) may be atomized by either steam, air or mechanically. To provide a reducing furnace atmosphere, the oil should be atomized to a minimum degree, just sufficient to keep the oil from clogging the burner. When a quick, short, hot flame is desired the degree of atomization is increased. Should air be used as the atomizing agent, this additional air must be taken into account when determining total air required. The oil burner is to be sized depending upon total B.t.u. input and the desired percent of oil to total fuel (usually 50% based upon B.t.u. value).

The oil provides luminosity and overcomes shortcomings normally associated with natural gas flames. The secondary air, plus atomized oil, passes into the furnace at port 14. The excess of secondary air creates a core surrounded by the aforementioned rich air-gas mixture. Thus, this excess secondary air does not reach the bath or reheating product and as it travels through the furnace slowly mixes with the excess gas and extends combus-
tion as it travels through the combustion chamber to the stack. Cold secondary air assists to cool the oil, which, along with a low degree of atomization, prevents immediate combustion of the oil. Consequently, the heat provided by the combustion of the gas heats any unburned oil until it cracks and produces luminous particles of carbon.

It should be noted that any material consisting of a high percentage of carbon, and particularly pulverized coal, could be used in place of fuel oil and still provide the luminosity which this burner produces through cracking of fuel oil.

Therefore, it will be seen that I have provided an efficient combination gas/oil burner which is useful as an industrial burner or for homes, having characteristics which are summarized as follows:

Burning 30% No. 6 crude oil with 70% natural gas (measured on thermal input) produces an excellent luminous flame. Increasing the degree of atomization of the oil reduces the luminosity, as will a reduction of natural gas much below 70%.

It is recognized that pure oxygen or oxygen enriched air may be used in place of air in this burner. The equations determining duct sizes are based on air containing 20.99% oxygen and thus should any amount of 100% oxygen replace a portion of this air, the equations must reflect this change.

The basic difference between the present burner and that shown in my prior Patent No. 3,242,966 is that the latter has a reducing horizontal layer of burning gas with an oxidizing horizontal layer of burning oil above. The present improvement and invention has a circular reducing atmosphere with an oxidizing core. The patented burner is best suited to a cubical furnace whereas the present invention is best suited to a rotary furnace of klin such as one for melting an iron-silica slag required in the production of wrought iron.

While I have illustrated and described a single specific embodiment of my invention, it will be understood that this is by way of illustration only, and that various changes and modifications may be made within the contemplation of my invention and within the scope of the following claims.

I claim:

1. A furnace burner comprising a primary air duct of arcuate shape, a combustible gas source having inlet port means leading into said primary air duct, the terminal end of said primary air duct being in the form of a flow nozzle of progressively reduced diameter, a water jacket surrounding said nozzle, a secondary air duct of arcuate shape, a crude oil source having inlet port means extending through the walls of both of said ducts and leading into said secondary air duct up to said terminal end, a damper in the secondary air duct for controlling air flow therein which in conjunction of sizing the primary and secondary air ducts controls gas/air ratio and fuel oil/air ratio.

2. An industrial burner comprising a furnace wall, a primary duct terminating in said wall, an annular water jacket encircled by and encased within the terminal portion of said primary duct and being shaped to form a flow nozzle, a manifold surrounding an intermediate portion of said primary duct and having a plurality of outlets leading into said duct for introducing combustible gas into said duct, a secondary duct of arcuate shape extending through the center of the primary duct and having an outlet terminating at said wall, an oil burner extending longitudinally in said secondary duct on the center line axis of said primary duct, a damper in said secondary duct so as to control the gas/air and oil/air ratios while maintaining a substantially constant fuel to total air ratio.

3. A combination gas and oil furnace burner, comprising a cylindrical primary air duct of arcuate shape, a circular manifold surrounding said duct and having a plurality of spaced inlet ports throughout its entire circumference for introducing combustible gas into said duct including an outlet of progressively reduced diameter, forming a flow nozzle, a secondary cylindrical duct of smaller diameter and arcuate shape inserted in the center of said primary air duct, a furnace wall supporting the primary duct, a water jacket also supported by said furnace wall and surrounding the primary duct, an oil burner tube projecting through the walls of said primary and secondary air ducts and extending in said secondary duct and along the center line axis of said primary air duct to said water jacket.

References Cited

UNITED STATES PATENTS

1,983,927 12/1934 Bent et al. 158—11
2,862,545 12/1958 Soow et al. 158—11
3,223,136 12/1965 Mutchler 158—11
3,153,438 10/1964 Brzozowski 158—11

FREDERICK L. MATTESON, Jr., Primary Examiner.
EDWARD G. FAVORS, Assistant Examiner.

U.S. CI. X.R.

431—160