

[54] **COMBUSTION DEVICE FOR GASEOUS FUEL**

[72] Inventors: **Leonard P. Bagge**, Berkshire; **Robert W. Kear**, London, both of England

[73] Assignee: **Shell Oil Company**, New York, N.Y.

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[56]

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Primary Examiner—Carroll B. Dority, Jr.

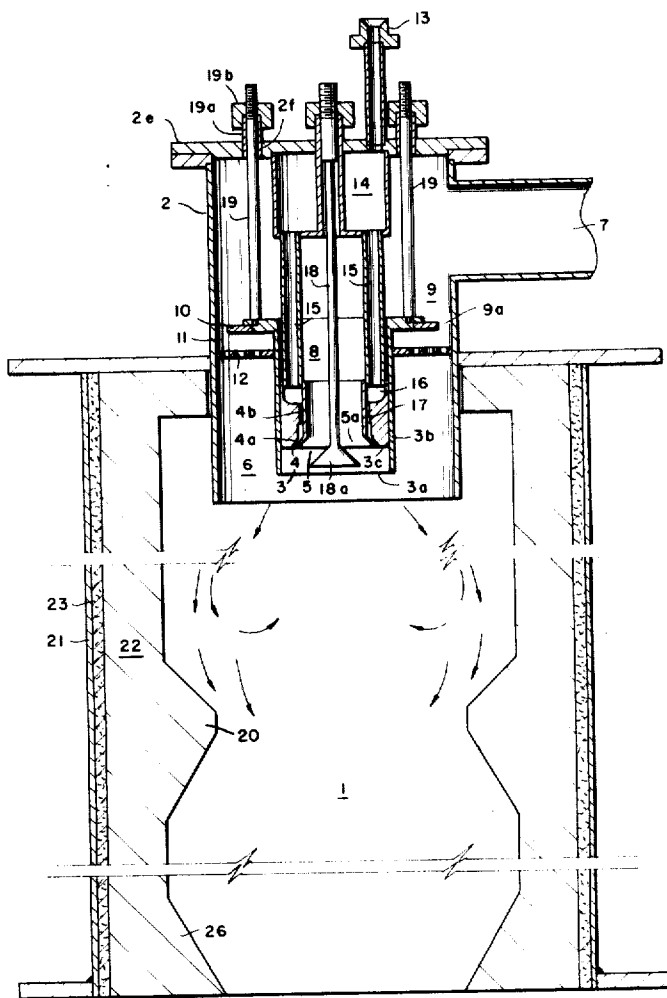
Attorney—Harold L. Denkler and Theodore E. Bieber

[57]

ABSTRACT

A combustion device for gaseous fuel, such as LPG, of the type having a coaxial burner opening into combustion chamber having an open downstream end. An annular supply for primary air and fuel issues into the bottom of flame chamber which is surrounded by an annular supply for secondary air. Means, such as a baffle are provided for subdividing the combustion air from a single source into determined proportions of primary and secondary air and means are providing for decreasing the velocity of the secondary air stream with respect to the velocity of the primary air stream.

9 Claims, 2 Drawing Figures



SHEET 1 OF 2

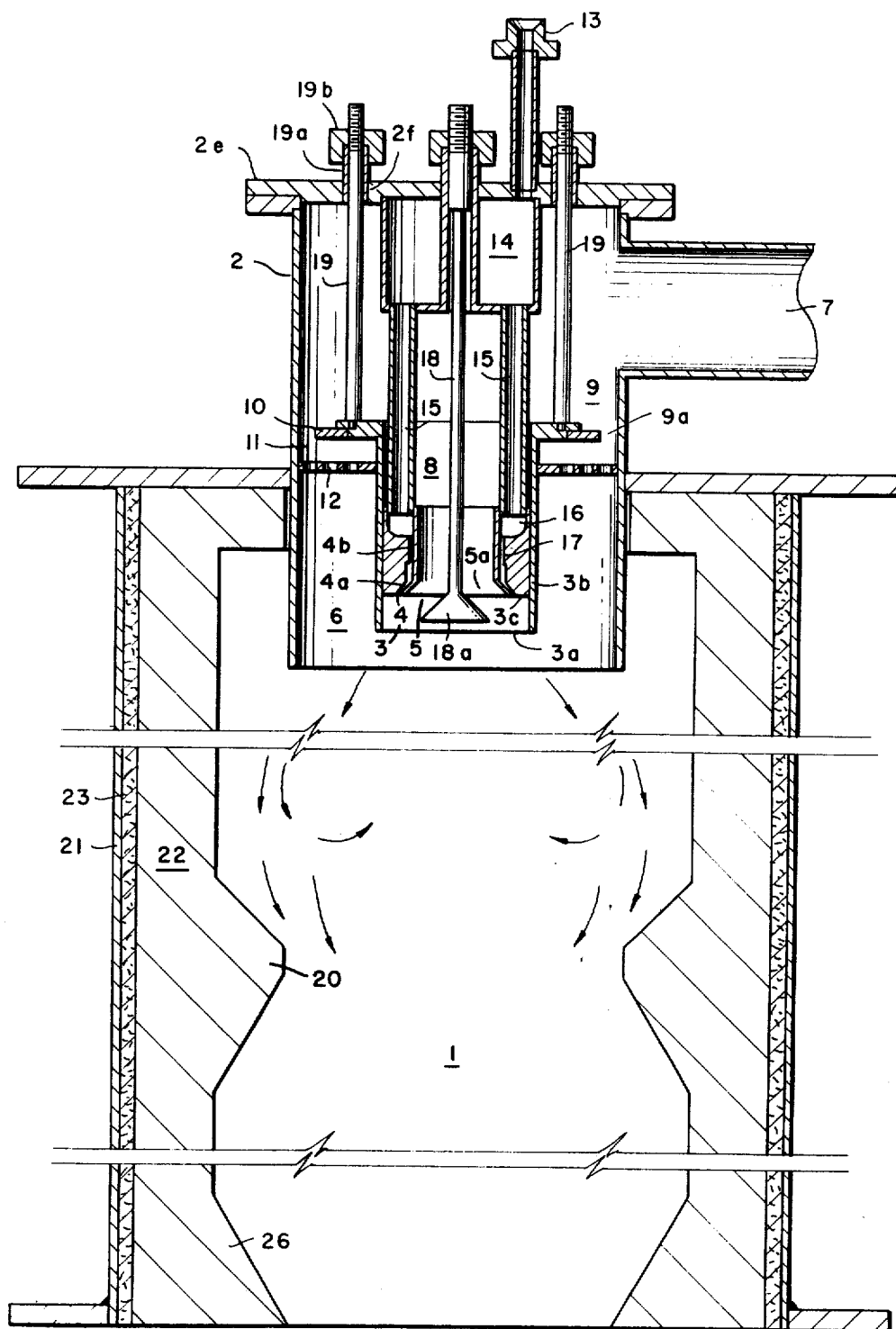


FIG. 1

INVENTORS:
L. P. BAGGE
R. W. KEAR

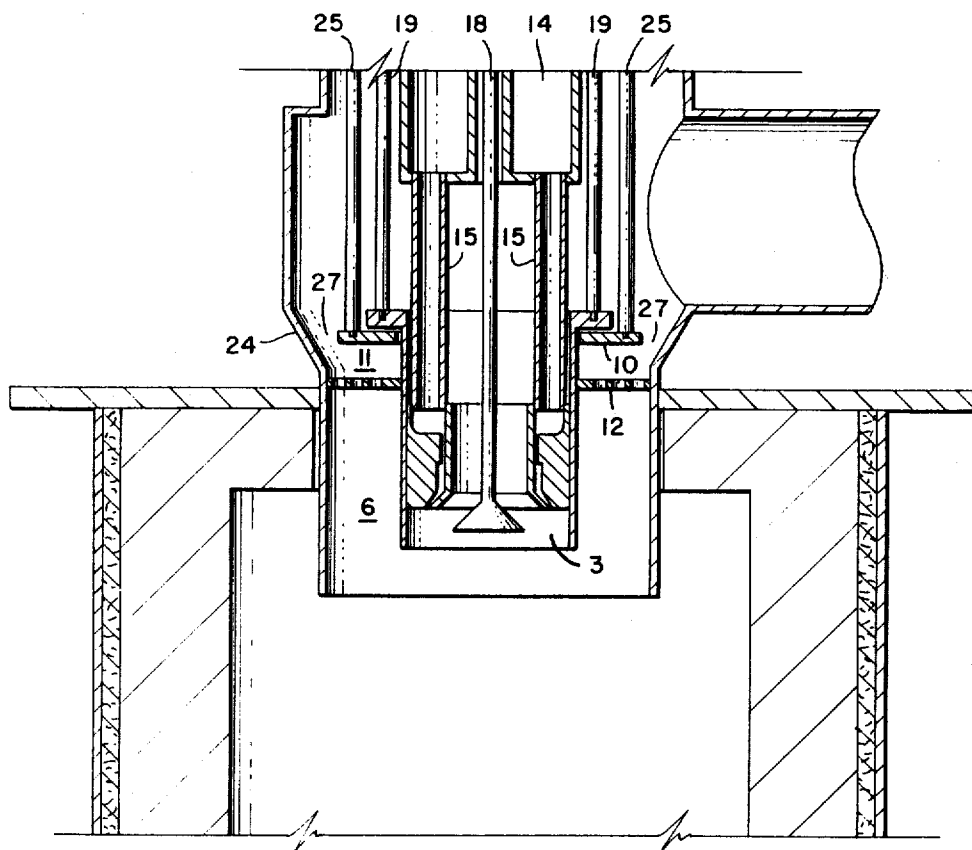


FIG. 2

INVENTORS:
L. P. BAGGE
R. W. KEAR

COMBUSTION DEVICE FOR GASEOUS FUEL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a combustion device adapted for operation with a gaseous fuel, such as LPG, comprising a combustion chamber substantially formed as a body of revolution and open at the downstream end and a coaxial burner, the fuel/air supply means thereof debouching at the upstream end into the combustion chamber. A combustion device of this type is known and will hereafter be referred to as a combustion device of the type specified.

The invention more particularly relates to a combustion device which is designed for use in industrial appliances such as, for instance, in steel works, and which is capable of being installed in an industrial furnace, such as a metallurgical furnace, e.g., a cupola furnace.

2. Description of the Prior Art

In such combustion devices, provisions have been made to ensure stable combustion over a certain operating range by creating stabilizing vortices in the hot combustion gases. Such vortices are achieved in different manners, for example, by a particular design of the end face of the burner nozzle part of the device and/or by a specially adapted flame chamber or combustion chamber.

A particular problem in such combustion devices, when installed in industrial furnaces, is the proper division and distribution of the oxidant and the intimate and staged mixing of the oxidant with the fuel to ensure a specific gas flow pattern so as to achieve optimal combustion conditions. An object of the invention is to provide a combustion device which ensures stable and complete combustion over a large operating range.

SUMMARY OF THE INVENTION

According to the invention, in a combustion device of the type specified an annular supply for primary air and fuel issues into the bottom of a flame chamber which is in communication with the combustion chamber. The flame chamber is surrounded by an annular supply for secondary air. Means are provided for subdividing the combustion air into two determined proportions of primary and secondary air, respectively, and means are provided for decreasing the velocity of the secondary air stream with respect to the velocity of the primary air stream.

Preferably, the combustion air is supplied from a common source, the means for subdividing the air comprising an adjustable baffle plate in the secondary air channel. The means for decreasing the velocity of the secondary air stream may comprise an annular expansion chamber in the secondary air supply downstream of the baffle plate.

In a particular embodiment, the downstream face of the baffle plate which extends substantially perpendicular to the axis of the secondary air channel, may constitute a boundary wall of the expansion chamber. Means may be provided for promoting uniform distribution of the secondary air stream. Such means may comprise a perforated plate arranged within the annular expansion chamber substantially perpendicular to the axis of the annular expansion chamber.

According to the invention, the supply for primary air and fuel may comprise an annular channel for supplying primary air surrounded by an annular channel for supplying fuel gas. Both channels may be conical at the downstream end, the cone diverging towards the outlet end of the channels. The passage of the primary air channel may be made adjustable by the axial displacement of a central barrel, the downstream terminal portion thereof being cone-shaped and constituting the inner lateral wall of the air channel.

So as to be able to obtain, during operation, a desired flame pattern, the bottom of the flame chamber may be made axially adjustable. Combustion can be kept stable by providing the combustion chamber with a mixing throat comprising a local restriction of the diameter of the combustion chamber downstream with regard to the flame chamber but at some

distance from the downstream end of the combustion chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a sectional view of one embodiment of a combustion device according to the invention and

FIG. 2 shows a sectional view of part of an alternative embodiment.

In the Figures, the same reference numbers are used for corresponding elements.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The combustion device shown in FIG. 1 comprises a combustion chamber 1 and a burner 2. The burner 2 is provided with a flame chamber 3 which is in communication with the combustion chamber at its open downstream end 3a. The bottom 3c of the flame chamber 3 comprises an annular fuel supply opening 4 which surrounds an annular opening 5 for primary air. Fuel and primary air supply openings 4 and 5 constitute the downstream terminal ends of fuel and air annular supply channels 4a and 5a, each annular channel 4a and 5a being in the shape of a cone which diverges towards the downstream end 3a of the flame chamber 3. Channels 4a and 5a may be of constant width or one or both may be narrow towards the respective openings 4 and 5 so as to accelerate the fluid stream during operation. In the present example, the fuel supply channel 4a decreases in cross-section towards the outlet 4 while the primary air channel 5a is of constant cross-section, the width thereof being adjustable, as will be explained below.

The burner 2 is provided with a common air inlet 7 for primary and secondary air. This air supply is connected to an air source, such as a fan (not shown) which is capable of supplying pressurized air up to a pressure of 40-inch water gauge.

The combustion air can be preheated, for example, by recuperation from the waste gases of the heating process to which the burner and combustion chamber are being applied (e.g., a cupola).

Alternatively, recuperation can be achieved within the combustor itself. The air can be fed through passages (not shown) which may be formed in the refractory lining 22 of the combustion chamber 2, or may be fed through an outer jacket (not shown) lined with the refractory, whereby the jacket's working life may be extended. The air may then pass through a passage (not shown) forming the end wall of the combustion chamber 1 (which can also be faced with refractory) and over the outer skin of the burner 2 (receiving heat from the flame and radiation from the combustion chamber 1) before entering at the rear of the burner 2. Only a portion of this path need be utilized if only a moderate degree of pre-heat is required.

Primary air is fed through a primary air channel 8, which is in communication with primary air supply opening 5. Secondary air is fed through an annular secondary air channel 9 into a secondary air supply 6. Within this channel 9 a baffle plate 10 is provided leaving a predetermined passage 9a for secondary air. The width of this passage 9a determines the proportion of the combustion air which is to be supplied as secondary air. In the embodiment shown, immediately downstream of the baffle plate 10 an expansion chamber 11 is present which decreases the velocity of the secondary air stream during operation. A perforated air distribution plate 12 ensures proper distribution of the air stream in the secondary air supply 6 downstream of the plate 12.

Fuel gas is supplied through fuel inlet 13 which is in communication with a fuel chamber 14. This fuel chamber is connected with an expansion chamber 16 by means of fuel supply pipes 15. In this embodiment, two of such pipes are present. The expansion chamber 16 is in communication with the fuel supply opening 4 by means of an annular connecting channel 4b. Swirl means 17 may be provided in this channel 4b.

During operation, the width of the primary air supply opening 5 can be varied. To this end, a central rod or barrel 18 is

provided which has a cone-shaped downstream end 18a which constitutes the inner lateral wall of the air channel 5a. By axial displacement of the barrel 18 in a rearward direction, the primary air channel 5a and its opening 5 will be narrowed. As a result of this narrowing, the primary air will be accelerated. This promotes more intimate mixing of the gases. If the barrel 18 is moved downstream with respect to the flow of fluid through the burner 2, the primary air channel 5 and its opening 5a will be widened and the primary air will be decelerated. The barrel 18 may be movably mounted in any conventional manner, for example, in the manner described below with respect to the rods 19.

The flame chamber 3 has a lateral wall 3b and a bottom 3c. The lateral wall 3b of the flame chamber 3 can be axially moved with regard to the bottom 3c by means of adjusting rods 19 which may be operatively connected to the lateral wall 3b of the flame chamber 3 by any suitable connector means such as, for example, welds or threaded connections. The axially movable rods 19 may be operatively connected to the burner 2 in any suitable conventional manner which allows axial movement. For example, the burner 2 may be provided with an end piece 2e having a number of openings such as opening 2f through which the rods 11 may pass. Cylindrical guide means 19a having a diameter such that slidable contact is maintained between guide means 19a and rod 19 may be operatively associated with opening 2f. Rods 19 may carry suitable lock means such as nuts 19b adapted to abut against guide means 19a. The rods 19 are manually slidable. When the rods 19 are properly positioned, nuts 19b may be adjusted to abut against guide means 19a to prevent inward movement of the rods 19 as might be caused by drag from air flowing through the secondary air chamber 6.

By adjusting the rods 19, the effective length of the flame chamber 3 can be adjusted, preferably between 0.1 and 0.8 of its diameter. By changing the length of the flame chamber 3, the flame shape can be influenced at will, from short wide-angled "umbrella" form flames to toroidal whirl type flames and also longer flames.

Combustion is completed within the combustion chamber 1. To ensure optimal combustion conditions, a mixing throat 20 is provided within the combustion chamber. The throat 20 acts as a return barrier for part of the hot gases in the chamber 1, thus ensuring more uniform heat distribution within the combustion chamber 1. As temperatures of about 1,800° C and higher may occur within the combustion chamber 1, it is provided with a refractory lining 22. The chamber 1 may also have a metal casing 21. A fiber insulation 23 may be provided between the casing 21 and lining 22.

An outflow throat 26 may be provided at the end of the combustion chamber 1 away from the burner 2. The effect of such throat 26 is to accelerate hot exit gases to a high velocity so as to be suitable to give high rates of convective heating (for example, to steel billets before forging) and/or to enable the exit gases to penetrate deeply into a furnace or shaft.

In the embodiment according to FIG. 2, a part 24 of the outer wall of the secondary air channel 6 is made conical, as a consequence whereof the amount of secondary air can be controlled by axial adjustment of the baffle plate 10. As can be seen from the drawing, the annular passage 27 will decrease upon forward movement of the baffle plate consequently decreasing the amount of secondary air passing through channel 6. To enable independent control of the amount of secondary air, separate adjusting rods 25 may be provided for the baffle plate 10. Alternatively, the conical part 24 may be diverging toward the downstream end of the channel 6. In this case, the most forward position of the baffle plate 10 corresponds with the maximum supply of secondary air.

During operation, the ratio between secondary and primary

air usually varies from 3:1 to 2:1, provided that no ambient air will be enabled to have access to the combustion space.

The embodiments as described above are by way of example only and consequently it will be clear that further alternatives falling within the scope of this invention will be included.

We claim as our invention:

1. In a combustion device for operation with a gaseous fuel of the type having a combustion chamber and an associated coaxial burner opening into the combustion chamber, the improvement comprising:

a flame chamber having walls and a bottom positioned in the burner and in communication with the combustion chamber,

annular primary air supply means opening into the bottom of the flame chamber,

annular fuel supply means opening into the bottom of the flame chamber,

annular secondary air supply means surrounding the flame chamber,

an air supply inlet in communication with the primary air supply means and the secondary air supply means, means operatively associated with the air supply inlet for subdividing air into selected proportions of primary and secondary air, and

means within the secondary air supply means for decreasing the velocity of the secondary air with respect to the velocity of the primary air.

2. A combustion device according to claim 1, wherein the primary air supply means comprises a first annular cone-shaped channel opening into the flame chamber and wherein the fuel supply means comprises a second annular cone-shaped channel surrounding the first cone-shaped channel and opening into the flame chamber.

3. A combustion device according to claim 2 wherein the primary air supply means comprises a central barrel slidably mounted in the burner, the barrel forming the inner lateral wall of the air supply means and the end of the barrel adjacent the flame chamber being cone-shaped, whereby the width of the opening of the primary air supply means into the flame chamber may be adjusted by axially sliding the central barrel.

4. A combustion device according to claim 1 including support means for supporting the walls of the flame chamber, the support means being affixed to the walls of the flame chamber and slidably mounted on the burner whereby the support means may be adjusted to regulate the distance the walls extend above the bottom of the flame chamber.

5. A combustion device according to claim 1, wherein the means for subdividing air comprises a baffle plate positioned in the secondary air channel.

6. A combustion device according to claim 5, wherein the means for decreasing the velocity of the secondary air comprises an annular expansion chamber in the secondary air supply means downstream of the baffle plate.

7. A combustion device according to claim 1, wherein a perforate air distribution plate is mounted in the secondary air supply means for promoting uniform distribution of air in the secondary air supply means.

8. A combustion device according to claim 1, wherein the combustion chamber is provided with a mixing throat comprising a local restriction of the diameter of the combustion chamber downstream with regard to the flame chamber but at some distance from the downstream end of the combustion chamber.

9. A combustion device according to claim 8, wherein the combustion chamber comprises a metal casing which is refractory-lined, a fiber insulation being provided between the lining and the casing.

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