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3,236,279

COMBUSTION APPARATUS FOR BOTH GASEOUS AND NON-GASEOUS FUELS

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2 Sheets-Sheet 1

Fig. 1.

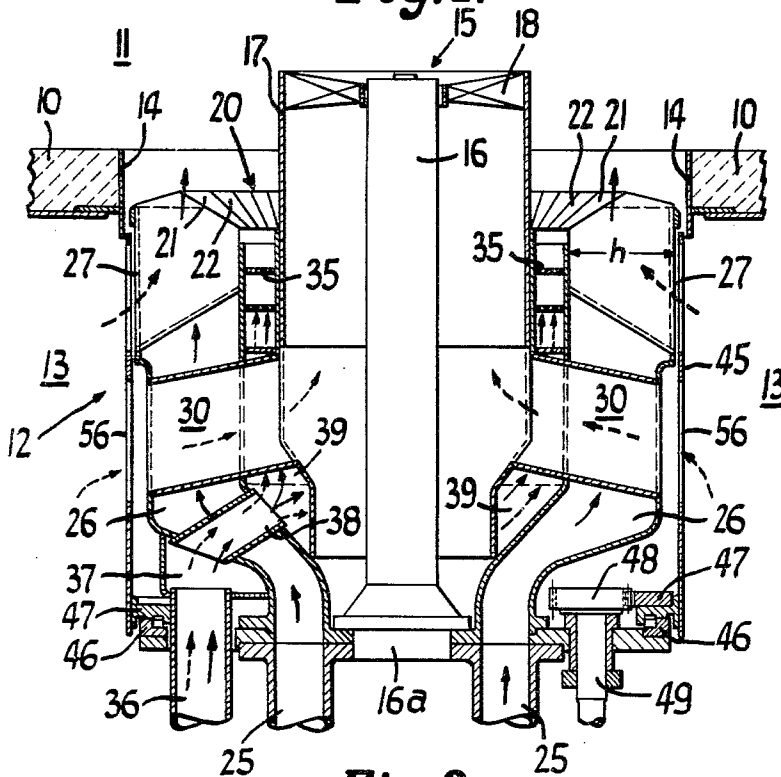
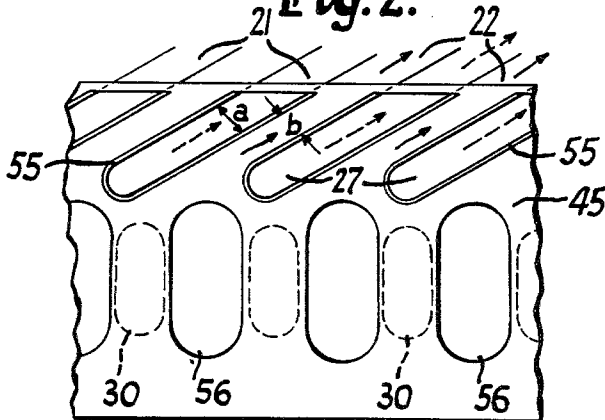


Fig. 2.



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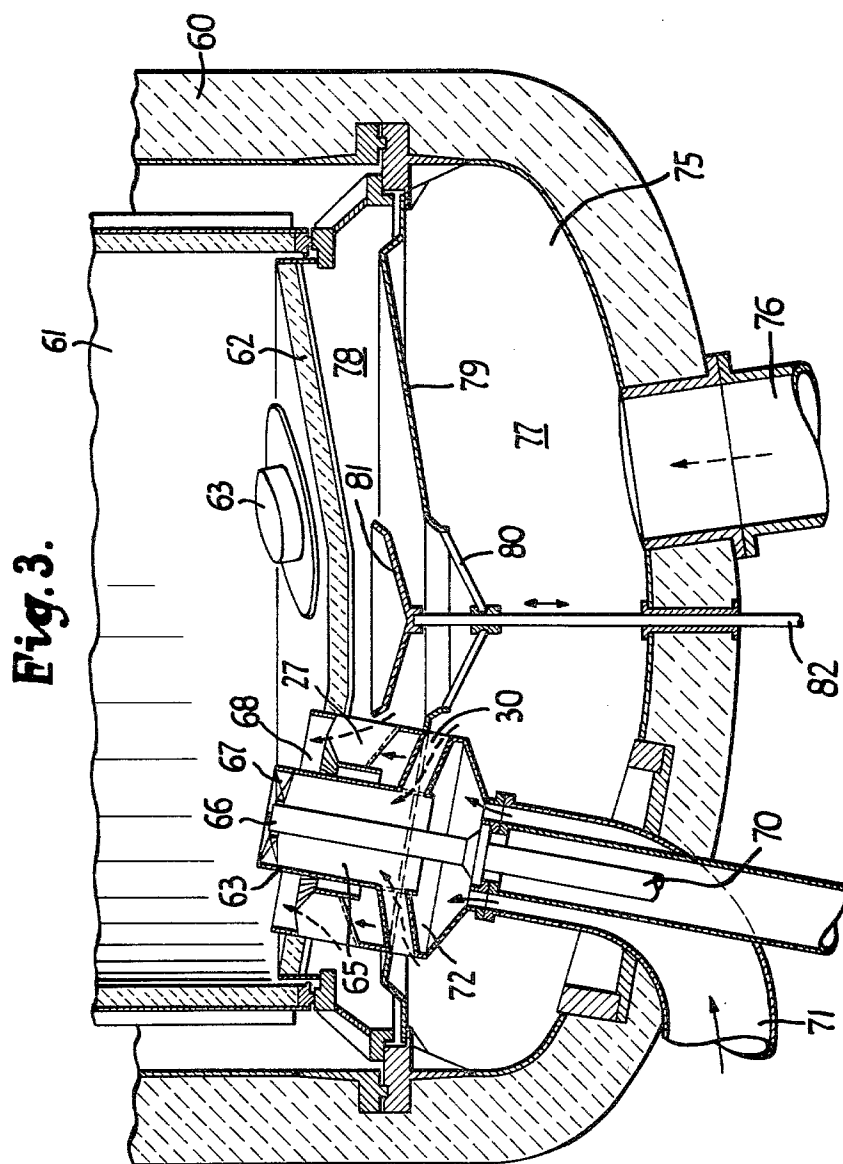
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COMBUSTION APPARATUS FOR BOTH GASEOUS AND NON-GASEOUS FUELS

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M 46,763

12 Claims. (Cl. 158—11)

This invention relates to combustion devices or burner apparatus for furnaces, gas turbine combustion chambers, and the like, for utilizing, simultaneously or alternatively, both gaseous and non-gaseous fuels and, more particularly, to such multiple fuel burner constructions for gas turbine combustion chambers using oil and gaseous fuels.

In various combustion devices for providing combustion or reacting heat for various heating or reaction furnaces and combustion chambers and the like, it may be desired to utilize a burner structure capable of accommodating, simultaneously or alternatively, different types of fuels such as for example, a liquid oil fuel and a gaseous fuel. Thus, a multiple fuel burner arrangement may be desired to operate generally by burning a gaseous fuel, but including means whereby an oil burner may be readily placed in operation as, for example, should the supply of gaseous fuel fail or diminish below operating levels. As will be understood, such a device may incorporate generally a gas burner arrangement in which a gaseous fuel and primary combustion air are admixed to form a combustible mixture for burning in the combustion space and also an oil burner device in which liquid fuel and primary combustion air are admixed as a combustible jet or stream for injection into the combustion space. In such a device, it may be desired to have the oil burner apparatus and the gas burner apparatus arranged together so that, for example, the flame originates at generally the same point in the combustion chamber regardless of which type of fuel is being used, and, if so, the construction may be complicated by having one or the other of the burners displaceable and/or constructed of special heat-resistant materials so as to avoid or withstand direct or close contact with the hot flame produced by the other burner.

In any event, if it is attempted to utilize different types of gaseous and non-gaseous fuels, having different heat contents or values, in a unitary multiple fuel burner device, some difficulty may be experienced from the fact that such different types of fuels may require for optimum efficient use widely varying quantities and velocities and proportions of primary combustion air for admixture therewith. Furthermore, such difficulties may arise with installations such as gas turbine combustion chambers where it is also desired to throttle or vary the amount of fuel being burned at various times, as under partial load operation, which variations require additional variation in the amount of primary air introduced through the burners.

For example, considerations of the pertinent pyrotechnics and fluid dynamics indicate widely varying and even inconsistent conditions of primary air supply for achieving optimum combustion efficiency or satisfactory operation with different types and varieties of fuels. A gaseous fuel such as blast furnace gas of low heat value may require relatively low velocities of both fuel and primary air, while satisfactory results with a non-gaseous fuel such as coal tar oil may be obtained only with much higher velocities for primary air supplied to or through a jet-type oil burner. Particularly with installations where the requirement for providing such widely differing velocity and supply conditions for the primary air for different fuels is further complicated by the additional desire of

also altering from time to time the amount or rate of both or either fuel supplied for combustion, difficulty or even impossibility may be experienced in attempting to design or provide air-fuel mixing arrangements providing both the inconsistent characteristics of large volume low velocity flow for one fuel and high velocity or variable flow for the other fuel in the same burner construction or from a single supply of primary air.

Thus, with a substantially constant quantity or pressure of primary air and without some special extra control, the large aggregate flow cross-sectional areas of alternate gas and air mixing ports for a gas burner may not offer enough throttling resistance to provide also desirably low air velocities for reduced or throttled operation, while, alternatively, if the primary air supply is redesigned to accommodate the foregoing considerations for throttled gas fuel operation, they may be inadequate for simultaneously or alternatively supplying sufficient quantities of high velocity air for satisfactory oil burner operation.

According to this invention, however, multiple fuel combustion apparatus is provided for accommodating or obviating the foregoing difficulties and inconsistent operating requirements not only for different types of fuel but also for operation at different consumption rates, as for full load and partial load operation, whereby the air discharge grid or aperture of the oil burner assures greater flow velocities than the air mixing ports of the gas burner and, accordingly, is provided with a substantially smaller effective air discharge cross-section than that of the gas burner; and a simple control element is provided for throttling or controlling the feed of primary air to one or both gas and non-gaseous burners for achieving optimum or satisfactory air supply and operating conditions in each notwithstanding the varying requirements of air supply and flow velocities for the different types of fuels. As a further feature of this invention such correlation of air discharge cross-sections for the gas burner and oil burner provide, at least for full load operation, sufficient throttling action and velocity control so that a separate air throttling member for air supply to the oil burner may normally be dispensed with, although such control is simply provided in accordance herewith for partial load operation; and the throttling control for primary air supplied to the gas burner includes provision of a small cooling air flow thereto during operation of the oil burner even when the gas burner is not operating; and, in accordance herewith, a construction is provided whereby both the oil burner and the gas burner are permanently oriented with respect to each other and in order to avoid undesired heating effects on either by direct impingement of flames from the other without requiring displacement of one with respect to the other or the use of special heat-resistant materials therefor.

With the foregoing and other objects in mind, this invention will now be described in more detail, and other objects and advantages thereof will be apparent from the following description, the accompanying drawings, and the appended claims.

In the drawing:

FIG. 1 is an axial section through a multiple fuel burner construction embodying and for practicing this invention and as mounted in a combustion chamber of a gas turbine;

FIG. 2 is a fragmentary view in elevation of a portion of the primary air flow control member of FIG. 1; and

FIG. 3 is a partial axial section through a combustion chamber having mounted therein a plurality of multiple fuel burner devices embodying and for practicing this invention and indicating a modification of control of primary air flow in accordance herewith.

Although it is to be understood that apparatus embodying and for practicing this invention is satisfactorily

applicable to a wide variety of furnace and combustion chamber constructions for accommodating a wide variety of different fuels, the following description relates, purely for illustrative purposes, to a gas turbine combustion arrangement for utilizing ordinary blast furnace gas and coal tar oil as, respectively, the gaseous and non-gaseous fuels for providing simultaneously or alternatively the desired combustion heat. Thus, referring to the drawings, in which like reference characters refer to like parts throughout the several views thereof, there is shown in FIG. 1 such a multiple fuel burner construction in accordance herewith and mounted through the end wall 10 of a combustion chamber which encloses a combustion space 11 into which the flames of the illustrated device are directed. The multiple burner construction, indicated generally by 12, is surrounded by a supply or storage space 13 for primary combustion air, and is mounted in an opening in wall 10 as by frame or casing 14.

The oil burner portion of the illustrated combustion device is indicated generally by 15 and comprises an oil injection nozzle assembly 16, supplied with fuel oil through the lower end 16a thereof, mounted centrally within a large pipe or air conduit 17, across the upper or discharge end of which is provided an air swirl grid 18, through which primary combustion air is discharged from pipe 17 into combustion space 11 and to form a combustible mixture therein with spray droplets of fuel oil being injected from the upper or discharge end of oil nozzle 16, all in known manner.

The gas burner portion of the illustrated structure is indicated generally by 20 as comprising a ring of alternating air discharge ports 21 and gas discharge ports 22 forming a burner ring around oil burner 15 and with the ports 21 and 22 being formed as elongated slots and being disposed to discharge air and gas into combustion space 11 and at an angle to the axis of burner construction 12 for forming a combustible mixture, in known manner fuel gas is supplied through pipes 25 into an annular gas channel or conduit 26, and flows therethrough upwardly and out the various gas ports 22. Primary combustion air for burning the gaseous fuel enters the combustion device from storage space 13 through a plurality of openings 27, each of which communicates with an air discharge port 21 in the gas burner ring 20 to form thereat a combustible mixture with gas from gas ports 22. Primary combustion air for the oil burner 15 enters the device from air space 13 through a plurality of radial conduits or channels 30, which traverse the annular gas conduit 26 and conduct air from storage space 13 into the pipe or conduit 17 of oil burner 15. Throughout the drawings, the flow of gaseous fuel is indicated by solid-line arrows, while the flow of primary combustion air is indicated by dotted-line arrows.

An annular ignition gas burner 35 is provided around the inner circumference of gas burner ring 20 and outside oil burner 15 for use in igniting the device in the first place, which ignition burner 35 is supplied with an ignitable gas-air mixture supplied through pipe 36 into chamber 37 and through conduit 38, traversing annular gas channel 26, into an annular conduit 39 leading to ignition burner 35.

As will be apparent from the foregoing, fuel gas and fuel oil are separately supplied, through pipes 25 and 16, to oil burner 15 and gas burner 20. Primary air, from a source 13 thereof under substantially constant pressure, is separately supplied through conduits 30 to oil burner 15 and through openings 27 to air ports 21 of gas burner 20. In such an arrangement, even for full load operation and particularly where a high heat production is demanded of the combustion chamber and the air storage space 13 is supplied under substantial pressure as with gas turbines, quite different quantities and flow rates of primary combustion air are required for optimum efficient operation of oil burner 15 and gas burner 20, and such varied conditions of primary air supply are accom-

modated in accordance herewith by providing different effective discharge cross-sections for primary air passing through grid 18 of oil burner 15 as compared with the effective discharge cross-sections of air discharge ports 21 in gas burner ring 20. Thus, the discharge cross-section of grid 18 is controlled by combined factors such as the internal diameter of conduit 17 and the height spacing and oblique angle of the various blades or partitions forming grid 18, as well known. The discharge cross-section of air ports 21 in gas burner 20 is controlled by the radial extension "h" (FIG. 1) and the width "a" (FIG. 2) thereof.

In accordance herewith, then, substantially higher discharge velocities are desired for the primary air passing through grid 18 of oil burner 15 to form a combustible mixture with droplets of oil fuel injected from nozzle 16, so grid 18 is provided with a substantially smaller effective discharge cross-section than that of air ports 21 in gas burner 20. As will be understood, the respective optimum flow velocities desired for the supplies of primary air to achieve desired combustion characteristics are readily determined or calculated with respect to various types of gaseous and non-gaseous fuels being used, and with due regard to the air pressure in air reservoir 13 and the relatively high flow velocities to be induced thereby. As illustrative, for the fuels blast furnace gas and coal tar oil, satisfactory results are obtained when the discharge velocity of primary air out of grid 18 into combustion space 11 is about five times the discharge velocity of primary air out of air ports 21 in gas burner 20, and, accordingly, the cross-section and construction of grid 18 is provided, with respect to that of air ports 21, so as to maintain approximately such ratio of air velocities, at least for full load (i.e., unthrottled) operation of the device.

There is also indicated in FIGS. 1 and 2 a control member for controlling or throttling the supply of primary air from air reservoir 13, which member is indicated as a movable sleeve 45 surrounding the device and mounted for rotation therearound as by bearings or rollers 46. An internally toothed ring 47 is provided near the bottom of sleeve 45 with a gear 48 in meshing engagement therewith and mounted for rotation on a control shaft 49 whereby, as will be understood, rotation of shaft 49 and gear 48 thereon causes the entire sleeve 45 to revolve around the outside of the burner construction. A plurality of slots 55 are provided in sleeve 45 for coinciding with openings 27 leading from air space 13 to various air ports 21 in burner ring 20, so that, as sleeve 45 is rotated, slots 55 will selectively open or close openings 27 for controlling the flow of air therethrough from air space 13. Similarly a plurality of openings 56 are also provided in sleeve 45 for coinciding with or closing off the outer ends of channels 30 to interrupt or control the flow of primary air therethrough from air space 13 to oil burner 15 depending upon the angular positioning of sleeve 45. Furthermore, the situation illustrated in FIG. 2 indicates the placement of slots 55 and openings 56 with respect to the air admission openings 27 and 30 to provide for operation of gas burner 20 only when oil burner 15 is not operating and vice versa, although, as will be understood, other operating conditions are satisfactorily provided in accordance herewith.

In order to protect gas burner 20 from the undesired heating effects of oil burner 15 when the latter is in operation, the discharge end of oil nozzle 16 and pipe 17 of oil burner 15 preferably extend axially from some distance beyond gas burner 20 into the combustion space 11 so as to avoid direct impingement of the flame from oil burner 15 on gas burner ring 20. Additionally, as indicated in FIG. 2, the width of slots 55 in sleeve 45 and the solid width "b" in the sleeve between slots 55 are preferably correlated so that, even when sleeve 45 is in an angular position closing openings 27 to the greatest possible extent, as during operation of oil burner

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15, still there will be a little open area through slots 55 and openings 27 for leakage or passage of sufficient air from storage space 13 through air ports 21 to maintain a cooling effect on gas burner 20 even when there is no flow of gas through gas ports 22. In this manner, the gas burner 20 can be satisfactorily constructed of ordinary sheet metal without the extra expense or difficulty of providing high heat resistance to withstand heating by oil burner 15 during operation thereof.

A further modification of structures embodying and for practicing this invention is indicated in FIG. 3 as a combustion device 60 including a combustion chamber 61 having mounted in the bottom 62 thereof a plurality of symmetrically arranged multiple fuel burners 63 in accordance herewith. Each of the burner constructions 63 is generally similar to that described above and includes an oil burner 65 with oil nozzle 66 and air discharge grid 67, as well as a gas burner ring arrangement 68 having alternate fuel gas and air ports as previously described. Oil fuel is supplied to nozzle 66 of oil burner 65 through oil pipe 70, and gaseous fuel is supplied to gas burner 68 through pipe 71 into an annular conduit or manifold 72, corresponding generally to annular conduit 26 in FIG. 1, and thence to the gas ports of gas burner 68 substantially as described with respect to FIG. 1. Primary air enters oil burner 65 through radial conduits 30, and also is led to air ports of gas burner 68 through openings 27 as previously described.

In the construction of FIG. 3, the space within the outer casing of combustion apparatus 60 and below or outside combustion chamber 61 therein forms a supply reservoir 75 for primary combustion air supplied thereto under pressure through conduit 76. Also air reservoir 75 is divided into two chambers 77 and 78 by a transverse partition 79 having a central opening 80 therein, which opening is controlled by a mushroom valve 81 operated as by a control rod 82 in known manner.

As will be understood from the foregoing, upper air chamber 78 above partition 79 communicates with openings 27 supplying primary air to gas burner 68, while lower air chamber 77 below partition 79 communicates with channels 30 supplying primary air to oil burner 65. Also, since all the primary air is initially supplied to reservoir 75 through pipe 76 below partition 79, the amount of air available for flow through openings 27 to gas burner 68 from upper chamber 78 is under the control of valve 81. Accordingly, during operation in which both gas and oil burners are used, the flow of primary air to gas burner 68 is under the control of mushroom valve 81 independently of any throttling of air from chamber 77 to oil burner 65 and, of course, in addition to the discharge flow ratios provided by correlating the discharge cross-section grid 67 of oil burner 55 with that of the air ports in gas burner 68. Similarly, in the case where operation is conducted solely by oil burner 65 and with fuel gas shut off in pipe 71 to gas burner 68, valve 81 is closed but not quite completely so as to provide some leakage through opening 80 in partition 79 of air to gas burner 68 for the above noted cooling effect thereof during operation of oil burner 65.

As will be apparent from the foregoing, there is provided according to this invention multiple fuel burner apparatus for use in a variety of furnaces or combustion chambers for the simultaneous or alternative combustion of various types of gaseous and non-gaseous fuels to provide heat for a wide variety of furnaces and combustion chambers and devices as may be used in industry, for metallurgical purposes, in chemical processing, coke oven plants, oil recovery, and similar operations, but particularly adapted to combustion chambers for gas turbines and similar applications where primary combustion air is supplied under pressure and with fairly high flow velocities and/or where optimum efficiency is desired for both full load and partial load operation with either or both of two different kinds of fuels. Furthermore, there is

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provided a construction for accommodating and controlling the different flow rates and quantities of primary air desired from a single source thereof to provide optimum operating conditions notwithstanding the fact that the gaseous and non-gaseous fuels demand widely different air discharge flow rates and velocities and quantities for efficient combustion.

Similarly, there is provided in accordance herewith such a multiple fuel burner apparatus as a substantially integrated and self-contained unit for mounting in a combustion chamber or other type of fire box or furnace, and including air throttling controls of extremely simple construction and operation, while the respective orientation of the burners for gaseous and non-gaseous fuels are arranged to avoid or obviate undesired or excessive heating of one burner during the operation of the other, and with the provision of cooling air flow through the gas burner even when it is not operating and during the operation of the burner for liquid or non-gaseous fuel, and with separate throttling control of combustion air to each or both of the two burners and/or for accommodating or selecting either simultaneous or alternative operation thereof.

While the forms of apparatus herein described constitute a preferred embodiment of the invention, it is to be understood that the invention is not limited to these precise forms of apparatus, that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. In a multiple fuel combustion device of the character described having separate gaseous fuel and non-gaseous fuel burners arranged together for discharging said fuels and combustion air into a combustion space for the mixing thereof and substantially complete combustion therein with an excess of air, said different fuels requiring different velocities and proportions of combustion air, the combination which comprises means providing a single source of air supply under pressure for both said gaseous and non-gaseous fuel burners for admixture with said fuels and including an excess amount of air for providing for substantially complete combustion of said fuels, air discharge means in said non-gaseous fuel burner for discharging air with said non-gaseous fuel into a combustion space for mixing and substantially complete combustion therein, separate and independent air discharge means in said gaseous fuel burner for discharging air with said gaseous fuel into said combustion space for mixing and substantially complete combustion therein, said gaseous fuel burner being disposed as a ring of alternating air and fuel ports around said non-gaseous fuel burner, said air discharge means in said non-gaseous fuel burner having a substantially smaller effective cross-sectional area than said air discharge means in said gaseous fuel burner for providing substantially higher air discharge velocities than said gaseous fuel burner, adjustable air control means for throttling the flow of air from said source of air supply to said gaseous fuel burner and concomitantly controlling said flow of air to said non-gaseous fuel burner, and means in said air control means for maintaining a small cooling flow of air to said gaseous fuel burner even in the fully throttled position of said control means and when said gaseous fuel burner is not operating for providing cooling thereof from the heat of said non-gaseous fuel burner.

2. A multiple fuel combustion device as recited in claim 1 in which said means providing a source of air supply under pressure for both said gaseous and non-gaseous fuel burners includes separate air reservoirs in flow communication separately with said gaseous and non-gaseous fuel burners, means for providing air under pressure into the one of said reservoirs which is in flow communication with said non-gaseous fuel burner, and means providing flow communication between said reservoirs, said adjustable air control means controlling the flow of air from

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said reservoir in communication with said non-gaseous fuel burner into said reservoir in communication with said gaseous fuel burner.

3. A multiple fuel combustion device as recited in claim 2 in which said air control means includes a valve controlling flow of air between said separate air supply reservoirs.

4. A multiple fuel combustion device as recited in claim 3 in which said valve includes means for maintaining a small cooling flow of air from said non-gaseous fuel air reservoir into said gaseous fuel air reservoir even in the closed position of said valve for providing a cooling flow of air to said gaseous fuel burner even when said burner is not operating.

5. A multiple fuel combustion device as recited in claim 3 in which a plurality of said gaseous fuel and non-gaseous fuel burners are mounted for discharging said combustible fuel-air mixtures into said combustion space at various points thereacross, and in which one of said air supply reservoirs is in flow communication with all of said gaseous fuel burners and the other of said air supply reservoirs is in flow communication with all of said non-gaseous fuel burners, whereby said control of said air supply to said gaseous fuel burner air reservoir simultaneously effects control of the air supply to all said gaseous fuel burners.

6. In a multiple fuel combustion device of the character described having separate gaseous fuel and non-gaseous fuel burners arranged together for discharging said fuels and combustion air into a combustion space for the mixing thereof and substantially complete combustion therein with an excess of air, said different fuels requiring different velocities and proportions of combustion air, the combination which comprises means providing a single source of air supply under pressure for both said gaseous and non-gaseous fuel burners for admixture with said fuels and including an excess amount of air for providing for substantially complete combustion of said fuels, separate means in each of said burners for discharging air for admixture with said fuels, said air discharge means in said non-gaseous fuel burner having a substantially smaller effective cross-sectional discharge area than said air discharge means in said gaseous fuel burner for accommodating substantially higher air discharge velocities than said gaseous fuel burner and being disposed in spaced relation to said non-gaseous fuel burner sufficiently to have substantially no effect upon the air fuel ratio discharge therefrom, single adjustable air control means for throttling the flow of air from said single source of air supply to said gaseous fuel burner and concomitantly controlling the flow of air from said source to said non-gaseous fuel burner, and means in said air control means for maintaining a small cooling flow of air to said gaseous fuel burner even in the fully throttled position thereof and when said gaseous fuel burner is not operating for providing cooling thereof from the heat of said non-gaseous fuel burner.

7. A multiple fuel combustion device as recited in claim 6 in which said adjustable air control means for said gaseous fuel and said non-gaseous fuel burners is a rotating valve sleeve interposed between said burners and said source of supply of air therefor.

8. A multiple fuel combustion device as recited in claim 7 in which said rotating valve sleeve includes separate air admission apertures intermittently disposed therearound for providing flow of air from said source of air supply separately to said gaseous and non-gaseous burners, and in which said intermittent air admission apertures are disposed on said valve sleeve to overlap at certain predetermined positions of said sleeve to control flow of air to said burners for selectively determining the alternative and simultaneous operation thereof.

9. In a multiple fuel combustion device of the character described having separate gaseous fuel and non-gaseous fuel burners arranged together for discharging said fuels and combustion air into a combustion space

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for the mixing thereof and substantially complete combustion therein with an excess of air, said different fuels requiring different velocities and proportions of combustion air, the combination which comprises means providing a source of air supply under pressure for both said gaseous and non-gaseous fuel burners for admixture with said fuels and including an excess amount of air for providing for substantially complete combustion of said fuels, separate and independent means at each of said burners for discharging air for admixture with said fuels separately at each of said burners for independently forming fuel-air mixtures, said air discharge means in said non-gaseous fuel burner having a smaller effective cross-sectional discharge area than said air discharge means in said gaseous fuel burner for providing higher air discharge velocities than said gaseous fuel burner and including an air swirl grid through which said air is discharged for mixture with a non-gaseous fuel in a combustion space, said gaseous fuel burner being disposed as a ring of alternating fuel and air slots positioned radially and at an acute angle around said non-gaseous fuel burner, said non-gaseous fuel burner extending into said combustion space axially beyond said gaseous fuel burner for discharging said air and non-gaseous fuel for mixing and combustion therein at a point spaced from said gaseous fuel burner for avoiding direct impingement of said non-gaseous fuel combustion on said gaseous fuel burner, single adjustable air control means for throttling the flow of air from said source of air supply to said gaseous fuel burner and concomitantly controlling the flow of air to said non-gaseous fuel burner, and means in said air control means for maintaining a small cooling flow of air to said gaseous fuel burner even in the fully throttle position of said air control means.

10. A multiple fuel combustion device as recited in claim 9 which additionally comprises an igniting burner device disposed between said non-gaseous fuel burner and said gaseous fuel burner, and means for supplying a combustible fuel mixture to said igniting burner separately from said fuel and air supplied to said gaseous fuel and non-gaseous fuel burners.

11. In a multiple fuel combustion device of the character described having separate gaseous fuel and non-gaseous fuel burners arranged together for discharging said fuels and combustion air into a combustion space for the mixing thereof and substantially complete combustion therein with an excess of air, said different fuels requiring different velocities and proportions of combustion air, the combination which comprises means providing a source of air under pressure for supplying air to both said gaseous and non-gaseous fuel burners for admixture with said fuels separately to form fuel-air mixtures for substantially complete combustion in a combustion space, air discharge means in said gaseous fuel burner for discharging air to form said combustible mixture with said gaseous fuel, separate air discharge means in said non-gaseous fuel burner having a substantially smaller effective cross-sectional discharge area than said air discharge means in said gaseous fuel burner providing a substantially higher air discharge velocity of about five times that of said air discharge at said gaseous fuel burner, and adjustable air control means for throttling the flows of air from said source of air supply to said gaseous fuel burner and including means for maintaining a small cooling flow of air to said gaseous fuel burner even in the fully throttled position of said air control means for cooling said gaseous fuel burner during operation of said non-gaseous fuel burner.

12. In a multiple fuel combustion device of the character described having gaseous fuel and non-gaseous fuel burners coaxially arranged to discharge separate fuels and air into a combustion chamber for substantially complete mixture and combustion therein and with separate discharges including substantially different excesses of air, said device being mounted in a wall of said combustion chamber, the combination which comprises means

comprising a source of air supply for said gaseous and non-gaseous fuel burners for admixture with said fuels separately to form separate combustible fuel-air mixtures, separate air ejection and admixing means in each of said burners for discharging said separate combustible fuels and air for admixture in said combustion chamber, said air ejection and admixing means in said non-gaseous fuel burner having a substantially smaller air ejecting cross-sectional area than said air ejection and admixing means in said gaseous fuel burner for accommodating substantially higher air ejection and discharge velocity than said gaseous fuel burner and including an air swirl grid through which said fuel-air mixture is discharged into said combustion chamber, with said air ejection and admixing means for said gaseous fuel burner including a ring of alternative fuel and air slots disposed radially around said non-gaseous fuel burner and at an acute angle to the axis thereof, adjustable air control means for adjusting the flow of air from said source of air supply to said gaseous fuel burner, means for maintaining a small cooling flow of air to said gaseous fuel burner providing cooling thereof from heat from said non-gaseous fuel burner when said gaseous fuel burner

is not operating, and said air ejection and admixing means for said non-gaseous fuel burner being axially spaced further into said combustion chamber from said wall than said air ejection and admixing means for said gaseous fuel burner whereby air ejected from either of said means has substantially no effect upon said completely combustible composition of said fuel and air discharge for mixture from the other of said means.

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