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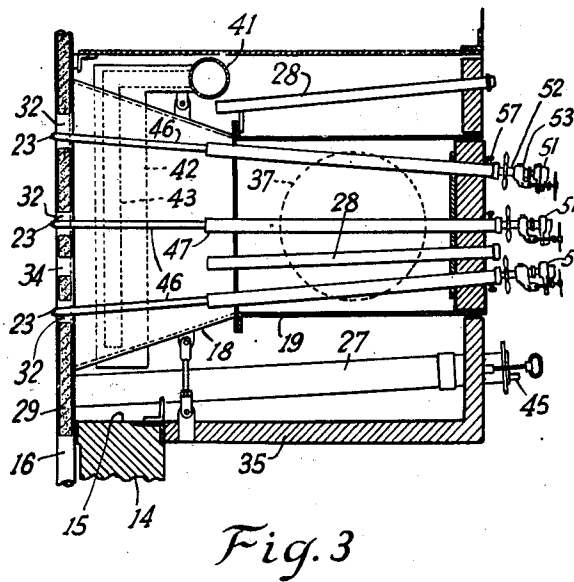
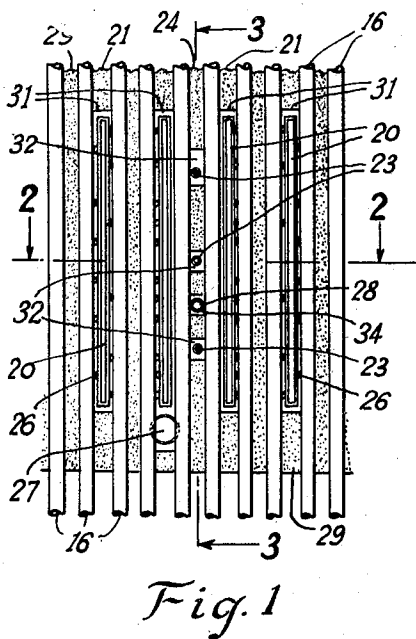
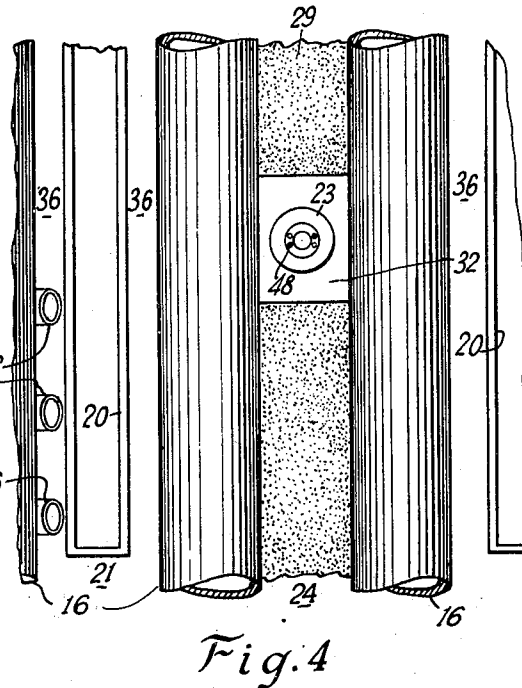
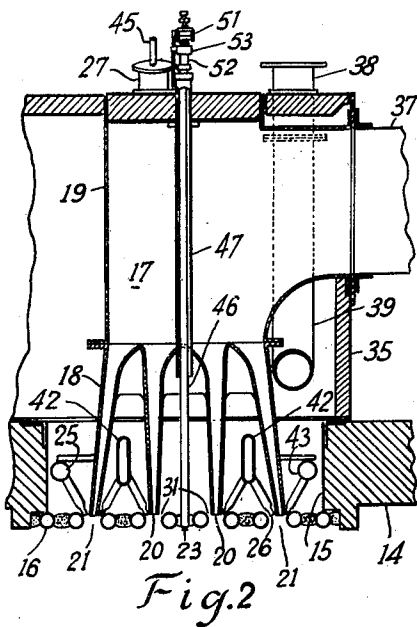
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2,480,459

FUEL BURNING APPARATUS WHEREIN AIR IS SUPPLIED IN
ONE OR MORE STREAMS OF ELONGATED CROSS SECTION

Filed Dec. 8, 1944

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

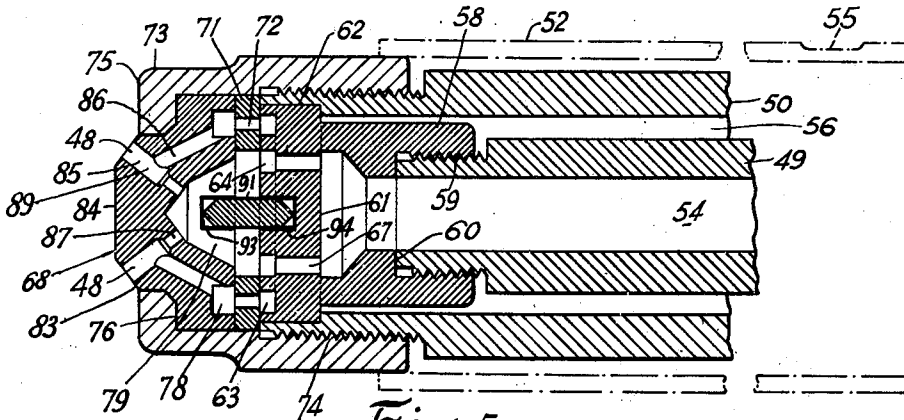


Fig. 5

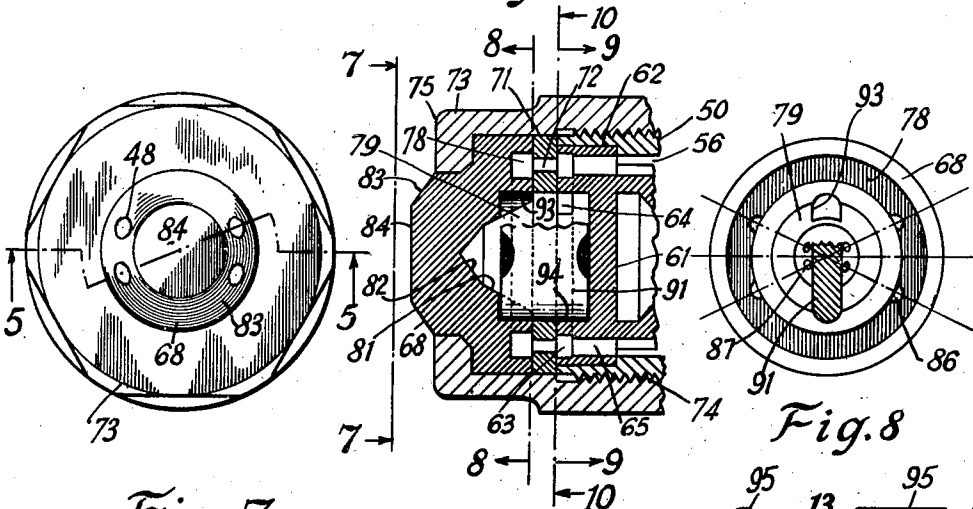


Fig. 7

Fig. 6

Fig. 8

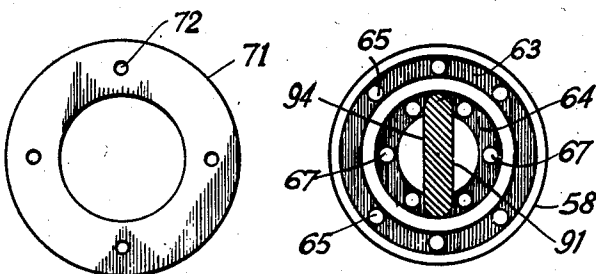


Fig. 10

Fig. 9

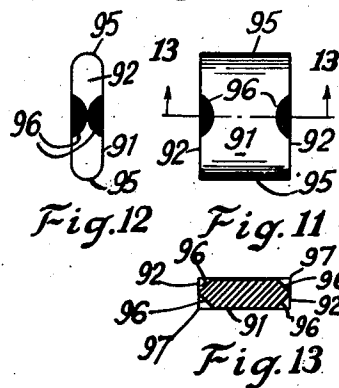


Fig. 12

Fig. 11

Fig. 13

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UNITED STATES PATENT OFFICE

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FUEL BURNING APPARATUS WHEREIN AIR IS SUPPLIED IN ONE OR MORE STREAMS OF ELONGATED CROSS SECTION

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12 Claims. (Cl. 158—11)

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The invention herein disclosed relates to the construction and operation of fuel burning apparatus wherein provision is made for the burning of one or more fuels. The invention features a novel form of liquid fuel burner particularly suited for installation with other burner apparatus utilizing a fuel or fuels of different character.

The invention is especially adapted for use in furnace installations having provision for burning a fuel or fuels of gaseous character for a given period of time and requiring provision for burning a fuel of different character for another period. In some instances where blast furnace gas, for example, is normally used, the supply of such fuel may at times be inadequate or totally unavailable, in which case it is desirable to provide means for burning an auxiliary or alternate fuel, such as oil, in order to maintain the desired heat input into the furnace.

Where the burner wall of the furnace is fluid cooled, it is customary to install spaced fluid carrying tubes in a row adjacent the inner face of the wall, and to position the gas burner tips between selected pairs of tubes. Such tips are desirably formed to discharge the gas in streams of relatively narrow elongated cross section, or in a plurality of longitudinally distributed smaller streams, to present a large area of surface to the combustion air which is suitably supplied in one or more streams closely adjacent each burner tip or series of tips.

In such an installation the provision of auxiliary or alternate fuel burning equipment therefore presents a problem particularly when the location of the heat source must remain substantially unchanged, and economy of installation is desired by utilizing as much as possible of the existing structure required for burning the gaseous fuel or fuels.

An object of the invention is to provide burners discharging separate fuel streams in mixing relation to a common discharge of combustion air.

A more specific object is to provide burners arranged to discharge different fuels in different directions while independently or simultaneously utilizing combustion air introduced through a given set of ports.

An additional object is to provide a liquid fuel atomizer adapted to discharge atomized fuel laterally of a series of spaced furnace wall tubes in transverse relation to streams of combustion air discharged from between tubes of the series.

A further object is to provide a liquid fuel burn-

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er arranged to spray atomized fuel in a narrow band transversely of oppositely disposed air streams of elongated cross section.

Another object is to provide a liquid fuel burner arranged to discharge atomized fuel in jets diverging therefrom in opposite directions.

Among other objects is to provide a liquid fuel atomizer formed of separable internal parts suitably indexed for assembly in predetermined relative arrangement.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a preferred embodiment of my invention.

Fig. 1 of the drawings is a fragmentary front elevational view, from within the furnace, of a furnace wall having burner apparatus associated therewith in accordance with the invention;

Fig. 2 is a sectional plan view of Fig. 1, taken along line 2—2;

Fig. 3 is a sectional side view of Fig. 1, taken along line 3—3;

Fig. 4 is a front elevational view showing an enlargement of a portion of Fig. 1;

Fig. 5 is an enlarged fragmentary view, in longitudinal section, showing details of an oil burner atomizer included in each of the foregoing figures;

Fig. 6 is an enlarged fragmentary view, similar to Fig. 5, showing a section of the atomizer in a plane normal to the plane of Fig. 5;

Fig. 7 is an end projection of the atomizer, as viewed at line 7—7 of Fig. 6;

Figs. 8, 9, and 10 are partial transverse sections of Fig. 6, taken along lines 8—8, 9—9, and 10—10 respectively;

Figs. 11 and 12 are front and end views respectively of a detail part of the atomizer; and

Fig. 13 is a transverse section of Fig. 11, taken along line 13—13.

Figs. 1, 2 and 3 of the drawings show a furnace wall 14 formed with a rectangular burner opening 15 therein across which at the inner side thereof are disposed fluid-carrying wall cooling tubes 16 in horizontally spaced relation, such tubes being connected, for example, into the circulatory system of a vapor generating unit, not shown.

The fuel burning apparatus associated with the opening 15 includes an intertube burner 17 for blast furnace gas comprising a burner tip section 18 connected to a gas inlet section 19, the tip section 18 being formed with elongated burner tips or nozzles 20 terminating at alternate spaces 21 between the wall tubes 16; a series of oil burner atomizers 23 extending through the gas burner sections 18 and 19 and terminating at an intertube space 24 located centrally of the group of blast furnace gas nozzles 20; and a burner 25 for coke oven gas having nozzles 26 terminating adjacent the blast furnace gas nozzles 19 at the same alternate intertube spaces 21. In addition to the foregoing principal burner equipment, the arrangement includes a gas pilot lighter 27 for igniting the gas from burners 17 and 25, and lighter pipes 28 through which a suitable torch may be inserted for igniting the atomized oil from burners 23.

Certain portions of the intertube spaces 21 and 24 are blocked off by suitably applied heat refractory material 29 while other portions are left open to provide spaces for insertion of the burner nozzles or lighter devices, or for the passage of fuel therefrom, together with an adjoining space for the passage of combustion air. The open intertube spaces thus provided include the elongated air opening 31 adjacent to and surrounding the tip of each blast furnace gas nozzle 20; the rectangular opening 32 for accommodation of each oil atomizer 23, the top opening 32 having its upper portion in alignment with the upper lighter pipe 28 for insertion of the oil-lighting torch; and an additional opening 34 in alignment with the lower lighter pipe 28 for a similar purpose. One of the openings 31 is extended at its lower end to provide an additional open space for the flame from the gas pilot lighter 27.

A windbox 35 is provided for delivering heated combustion air to the burner opening 15 from a suitable source, the air passing into the furnace through the described open intertube spaces, particularly the spaces 31 which provide relatively long and narrow air ports or passages 36 at opposite sides of each blast furnace gas nozzle 20, between each nozzle and the adjacent wall tube 16, through which the major flow of combustion air into the furnace takes place.

The gas burners 17 and 25 have suitable fuel inlet connections exteriorly of the windbox 35; the blast furnace gas inlet for burner 17 being provided by conduit 37 which is connected to the gas inlet section 19 of the burner; and the coke oven gas inlet for burner 25 being provided by the conduit 38 which is connected to the internal distributing pipe 39 having an upper horizontal portion 41 from which connections are made to the downwardly extending nozzle manifolds 42 and 43. The gas inlet to the pilot lighter 27 is indicated at 45.

The oil atomizers 23 are of the fluid atomizing type and comprise elongated tubular portions 46 which are supported within stationary sleeves 47, in alignment with the respective intertube spaces 32, each sleeve 47 extending across the gas burner inlet section 19 from a point exteriorly of the windbox 35 and having its inner end positioned between two of the gas burner tips 20. The fuel is discharged from each atomizer 23 in diverging streams through a group of outlet ports 48 arranged substantially as shown in Fig. 4, the resultant spray being projected transversely of the tubes 16 a sufficient distance at

each side of the atomizer to extend across and into the streams of combustion air entering through all laterally positioned ports 36. The tubular portion 46 of each atomizer assembly comprises an internal tube 49 and an outer tube 50 having their outer ends connected to the atomizer body 51, together with an exterior tube or casing 52 having its outer end connected to and secured against rotation in the atomizer coupling 53 through which permanent connections may be made to suitable sources of a liquid fuel and a fuel atomizing fluid; the atomizer body having a quick-detachable connection with the atomizer coupling and both having internal passages by which the two fluids are supplied to the passages 54 and 56 provided by the internal and outer tubes 49 and 50 respectively; such parts being constructed and arranged, for example, substantially as disclosed in U. S. Patent 2,143,843, H. Cowan, issued January 17, 1939. Each atomizer 23 may be held in position, axially of the supporting sleeve 47, by means such as the thumb screw 57 which engages the tubular casing or distance piece 52, suitably against a flat area 55 to prevent angular displacement of the atomizer 23 about its longitudinal axis.

The constructional details of each atomizer 23 adjacent its discharge end are illustrated in Figs. 5 to 13 inclusive. For convenience of description, the central passage 54 will be identified throughout as a supply passage for steam as the atomizing fluid and the annular passage 56 as the supply passage for oil as the liquid fuel. It is to be understood however that other fluids than those specifically named may be used for the fuel and for the atomizing medium, and that if necessary or desirable the central passage 54 may be utilized for the fuel and the annular passage 56 for the atomizing fluid.

A sprayer head or nozzle 58 is formed with a tubular portion at one end in threaded engagement with the adjacent end of tube 49 as at 59, the nozzle including a transverse sealing surface 60 against which the end of tube 49 is stationarily seated, and a transverse end plate 61 at its opposite end providing a flange 62 which is received within a counterbore in the adjacent end of the outer tube 50.

Concentric annular recesses 63 and 64 are formed in the outer face of the nozzle plate 61 and a series of circumferentially spaced holes 65 extending through the flange 62 connect the outer recess 63 with the annular fuel space 56, while a series of circumferentially spaced holes 67 extending through the central portion of the plate connect the inner recess 64 with the central steam space 54.

The sprayer plate 68 providing the discharge openings 48 is in this embodiment positioned a short distance from the end of the sprayer head 58 to provide for the assembly of an annular resistor plate 71 therebetween, the resistor plate having a limited number of holes 72 there-through, of smaller number and diameter than the holes 65 through the sprayer head 58, to reduce the pressure of oil delivered to the sprayer plate 68 to an appreciably lower value than is carried on the oil line and thus within the fuel supply passage 56.

A cap 73 having a threaded connection 74 with the outer tube 50 is formed with an inwardly extending flange portion 75 engaging a conforming shoulder portion 76 of the sprayer plate 68, to thereby maintain the sprayer plate 68, the resistor plate 71, and the sprayer head 58 in their

proper fluid-tight relation adjacent the counter-bored end of the outer tube 50.

The sprayer plate 68 is machined from a solid block of metal to include an annular recess 78 in its base surface opposite the resistor plate holes 72, and a central recess 79 opposite the circle of sprayer head holes 67, the latter recess 79 having successive conical wall portions 81 and 82 of different angularity. The outer face of the sprayer plate is beveled as at 83 to provide a conical surface area for the location of the outlet openings 48, the area 83 being concentric with the inner surfaces 81 and 82 and of substantially the same inclination as the inner surface 82, the central area 84 of the face being imperforate and substantially normal to the central axis.

The sprayer plate 68 is drilled with two sets of circumferentially spaced passages 85 and 86 which intersect within the body of the plate in substantially Y-formation; the passages 85 having their inlet ends 87 at the central recess 79 and extending entirely through the plate normal to the inner and outer surfaces 82 and 83 respectively; the passages 85 thus being inclined outwardly from the central axis in the direction of flow and their enlarged outer ends 89 providing the discharge openings 48; the passages 86 extending partially through the plate from their inlet ends at the annular recess 78 and being inclined inwardly toward the central axis to intersect and form junctures with the passages 85. The longitudinal axes of cooperating cylindrically-walled passages or ports 85 and 86 lie in a plane common to the central axis of the sprayer plate 68. Further details concerning the formation of individual passages 85 and 86, and their intersections within the body of the sprayer plate 68, may be had by reference to my copending application Serial No. 520,012, filed January 28, 1944, now U. S. Patent 2,414,459, patented January 21, 1947, wherein the specific advantages and operation of such a construction are also discussed.

According to the present invention each atomizer 23 may be positioned intermediate a group of air ports 36, and the discharge ports 48 for atomized fuel may be arranged at opposite sides of a line or plane through the central axis of the atomizer parallel to the air ports. In the illustrated embodiment, the four discharge ports 48 form the outlets from passages 85 and 86 which have their common planes of intersection unequally spaced about the central axis to provide the desired transversely elongated pattern of spray. Each discharge port 48 is at the corner of a rectangle of greater dimension transversely of the tubes 16 than longitudinally, in a ratio greater than 2:1 for example; and, as seen in Fig. 8, with the central axis of the atomizer assumed to be horizontal, each plane of intersection may be displaced 22½ degrees from the horizontal, above or below, thereby providing alternating angular spacings of 45 degrees and 135 degrees. In the form shown, the angle of divergence between diametrically opposite passages 85 which provide outlet ports 48 is approximately 75 degrees, and the angle of convergence between diametrically opposite passages 86 approximately 55 degrees. These values have been found desirable with gas burner tips 20 horizontally spaced at approximately thirteen inches center-to-center, with combustion air supplied through the narrow ports 36 between the respective tips 20 and the adjacent wall tubes 16 as above described.

The oil and steam mixture is discharged in jets

from each atomizer 23 in directions oblique to the plane of the wall tubes 16 and to the lengths of such tubes, the jets thus being directed across longitudinally elongated air ports 36 at opposite sides and forming a spray pattern of generally butterfly form occupying a relatively narrow band extending transversely of the lengths of the ports. The provision of a plurality of atomizers 23 in a line paralleling the lengths of the air ports 36 provides a composite spray pattern distributed over an area of approximately rectangular outline extending across a sufficiently large portion of the total area of all ports 36 to enable the combustion air and atomized oil to become thoroughly mingled.

It should be noted that in the operation of an atomizer such as described, the spray formation differs from that resulting from the operation of other constructions wherein the total oil and steam mixture is discharged from a single passage or orifice and the spray is circumferentially continuous from its origin at the atomizer outlet. In the operation of an atomizer of the present invention, the total oil and steam mixture is discharged in a plurality of circumferentially spaced jets, each jet from an individual port 48 tending to maintain its identity as a separate stream for an appreciable distance from the sprayer plate 68 and adjacent jets merging upon expansion at a position spaced therefrom. The combustion air is thus enabled to envelope the jets close to their points of origin and to contact a greater peripheral surface of individual jets than is possible with a spray presenting a continuous wall throughout. Furthermore, with the outlet ports 48 arranged to provide a butterfly pattern of spray, as described, and with two or more atomizers projecting such sprays in bands transversely of the air ports 36, the separation between successive bands adjacent the line of atomizers affords an increased exposure of spray surface to the discharging streams of combustion air.

Each sprayer plate 68 is held in predetermined angular relation to the nozzle 58 by means of a flat rectangular positioning plate or key 91 extending through the central opening in the resistor plate 71; the key having its opposite front and rear ends 92 received in keyways 93 and 94 diametrically disposed in the adjacent end surfaces of the sprayer plate and nozzle respectively; the sprayer plate keyway 93 being interrupted by the central recess 79 and thus comprising separate diametrically opposed portions; the keyways 93 and 94 having rounded ends to which the lateral portions 95 of the key are made to conform. The sprayer plate keyway 93 is positioned to bisect the wider angle of separation between the entrances to the four passages 87, and the nozzle keyway 94 being positioned to divide the passages 67 into two groups of three each of equal flow areas.

The key 91 is formed at its forward end 92 with a pair of segmental grooves 96 converging toward the central axis of the sprayer plate 68 to define a flow path of minimum flow resistance for fluid approaching the inlet passages 87; such a flow path contributing to improved distribution of fluid to the passages. The key may be formed as an integral part of one of the members 58 or 68, or be otherwise fixed in relation thereto, and project into the other of the members. However, when the key is a separate removable member as shown, both ends 92 are preferably formed alike, including grooves 96, to avoid error in assembly. The grooves 96 at each end of the key are sym-

metrically inclined in opposite directions from a point midway of the plate thickness and cut across the marginal edges 97 which lie between the flat sides and flat ends 92 of the key; the grooves having their axes preferably in a plane normal to the plate edges 97 and containing the central axis of the atomizer assembly.

The provision of key 91 between the sprayer plate 68 and nozzle 58 assures the maintenance of a fixed angular relation between the group of outlet ports 48 and the elongated air ports 36, for a given angular position of the atomizer coupling 53. This results from the fixed assembled relation between the nozzle 58 and the atomizer body 51, and the fixed assembled relation between the body 51 and coupling 53; the angular position of coupling 53 being suitably determined by the position in which the set screw 57 holds the connected tubular member 52.

The construction thus enables the assembled key 91 to be maintained in a vertical position, for example, as shown in Fig. 9, so as to maintain the discharge ports 48 in the desired position relative to the air ports 36 as shown in Fig. 4. The construction also permits removal of the barrel assembly comprising tubes 49, 50, and associated parts from within the tubular casing 52 for purposes of inspection, cleaning or repair, for example, with the assurance that when such parts are reassembled and the barrel assembly is reinserted, the same relative position of ports 48 will be automatically restored.

I claim:

1. The combination with a furnace wall having a fuel burner opening therein, which comprises, fuel burner means within said opening having elongated fuel discharge tips terminating in spaced relation in a row adjacent the furnace end of said opening, said tips being elongated in a direction transverse to said row, means defining a relatively narrow combustion air passage paralleling each of said tips, and fuel burner means having outlets positioned between tips in said row at locations displaced from air passages associated with said tips, said outlets being arranged to discharge fuel in jets directed across the furnace end outlets of said combustion air passages.

2. In combination with a furnace wall having a fuel burner opening therein, fuel burner means within said opening having vertically elongated gas discharge tips terminating adjacent the furnace end of said opening in horizontally spaced relation, means defining a relatively narrow elongated combustion air passage adjacently paralleling each of said tips, and liquid fuel burner means positioned intermediate two of said air passages and constructed and arranged to discharge liquid fuel in sprays directed transversely of said air passages disposed at opposite sides of said last named fuel burner means.

3. In combination with a furnace wall having a rectangular burner opening therein with upright wall cooling tubes horizontally spaced in a row across the furnace side of said opening, a gas burner having vertically elongated discharge tips positioned at alternate intertube spaces of said row, said burner tips having horizontal width dimensions less than the respective intertube spaces at which said tips are positioned to define a pair of relatively narrow elongated air passages between each tip and the adjacent wall tubes, and a fluid fuel burner positioned at the intertube space intermediate two of said tips and the associated pairs of combustion air passages, said fluid

fuel burner having outlet ports arranged to discharge diverging jets of atomized fuel in horizontally opposite directions across the furnace ends of said combustion air passages, said outlet ports diverging from a common axis and comprising pairs of ports at opposite sides of a plane parallel to said tubes and containing said axis, said pairs of ports being angularly spaced about said axis to a greater extent than ports forming any of said pairs.

4. Liquid fuel burning apparatus comprising an atomizer having outlet ports arranged to discharge atomized fuel in jets diverging at equal angles with respect to a common central axis, said ports being unequally spaced about said axis in an arrangement providing a port at each of the four corners of a rectangle having its base dimension at least double its height, and means for discharging combustion air into mixing relation with the discharging atomized fuel comprising means defining passages at opposite sides of said atomizer for discharging said air in parallel streams substantially parallel to said central axis, said passages being relatively narrow in the direction parallel to the base of said rectangle and being elongated in the direction parallel to the height of said rectangle.

5. In a burner wall having an opening therein with a row of substantially parallel fluid heating tubes spaced across the inner end of said opening, a gas burner having a gas inlet conduit section disposed adjacent the outer end of said opening and terminating in an even number of gas discharge tips positioned at intertube spaces in said row, said tips being elongated in substantially parallel relationship to said tubes and defining with adjacent tubes a row of elongated combustion air passages spaced across said opening, and fluid fuel nozzles arranged in a row paralleling said tubes and extending through said gas inlet section into an intertube space centrally of said row of air passages, each of said nozzles terminating in outlet ports arranged to discharge fuel in circumferentially spaced jets diverging from a common axis and directed transversely of said air passages disposed at opposite sides of said row of nozzles.

6. In combination with a furnace wall having a row of passages therein arranged to discharge combustion air into the furnace in relatively narrow streams elongated in a direction transverse to said row, liquid fuel atomizers having fuel outlet ends in spaced alignment transversely of said row of passages at a location intermediate the ends of said row, each of said atomizers having its fuel outlet end formed with ports arranged to discharge atomized fuel in a spray pattern of generally butterfly form limited to a relatively narrow band extending across the outlet ends of said passages, said individually formed spray bands diverging in opposite directions from their origins at said outlet ends and collectively forming a composite pattern of spray overlying furnace wall area included between the outermost combustion air passages in said row.

7. In combination with a furnace wall having a row of passages therein arranged to discharge combustion air into the furnace in relatively narrow streams elongated in a direction transverse to said row, liquid fuel atomizers having fuel outlet ends in spaced alignment transversely of said row of passages at a location intermediate the ends of said row, each of said atomizers having its fuel outlet end formed with ports arranged

to discharge atomized fuel in jets defining a spray pattern of generally butterfly form limited to a relatively narrow band extending across the outlet ends of said passages, each said band diverging in opposite directions from its origin at one of said outlet ends and having its portions adjacent said origin spaced from corresponding portions of the next adjacent band, said individually formed spray bands collectively forming a composite pattern of spray of substantially rectangular outline overlying furnace wall area included between the outermost combustion air passages in said row.

8. In combination with a furnace wall having a row of passages therein arranged to discharge combustion air into the furnace in relatively narrow streams elongated in a direction transverse to said row, a liquid fuel spraying means disposed beyond one end of said row and having its fuel outlet end spaced from all of said passages, said fuel outlet end being formed with ports arranged to discharge fuel in jets defining a substantially flat pattern of spray extending across the outlet ends of said passages, said ports having straight line axes of flow diverging from said fuel outlet end in a plane transverse to the direction of air discharge into said furnace.

9. In combination with a furnace wall having a row of passages therein arranged to discharge combustion air into the furnace in relatively narrow streams elongated in a direction transverse to said row, a liquid fuel spraying means disposed beyond one end of said row and having its fuel outlet end spaced from all of said passages, said fuel outlet end being formed with ports arranged to discharge fuel in jets defining a substantially flat pattern of spray extending across the outlet ends of said passages at an inclination to the furnace side of said wall, said ports having straight line axes of flow diverging from said fuel outlet end in a plane diverging inwardly from said furnace wall side in the direction of fuel jet discharge.

10. Fuel burning apparatus comprising a fluid fuel nozzle having outlet ports arranged to discharge fuel in diverging jets angularly spaced about a common axis and defining an elongated pattern of fuel discharge in planes oppositely inclined to said axis, and means for causing combustion air to enter into mixing relation with the discharging fuel comprising means forming

passages at opposite sides of said axis for directing said air in streams across the longer dimension of said elongated fuel discharge pattern, said passages being relatively narrow in a direction paralleling said longer dimension and being elongated in a direction transverse to said dimension.

11. In a furnace wall comprising transversely spaced wall cooling tubes, fluid fuel burner means terminating in elongated fuel discharge tips disposed between spaced pairs of said tubes and spaced from said tubes so as to constitute means defining therewith relatively narrow combustion air passages elongated parallel to said tubes, and liquid fuel burner means positioned intermediate said air passages associated respectively with tubes of said pairs and constructed and arranged to discharge liquid fuel in sprays directed transversely of said air passages disposed at opposite sides of said liquid fuel burner means.

12. Fuel burning apparatus comprising a liquid fuel nozzle having outlet ports arranged to discharge fuel in diverging jets angularly spaced about a common axis and defining an elongated pattern of fuel discharge substantially in a plane intersecting said axis, and means for causing combustion air to enter into mixing relation with the discharging fuel comprising means forming a passage at one side of said axis for directing said air in a stream across the longer dimension of said elongated fuel discharge pattern, said passage being relatively narrow in a direction paralleling said longer dimension and being elongated in a direction transverse to said dimension.

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