March 12, 1935. E. G. BAILEY 1,994,444

FLUID FUEL BURNER

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Fig. 2

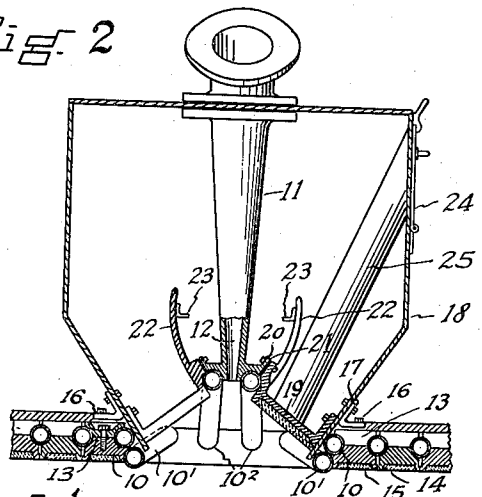

Fig. 3

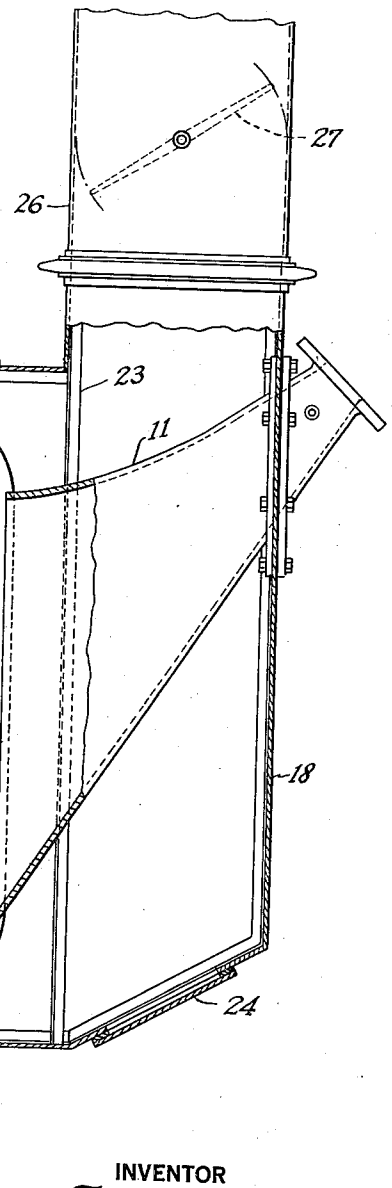

Fig. 1

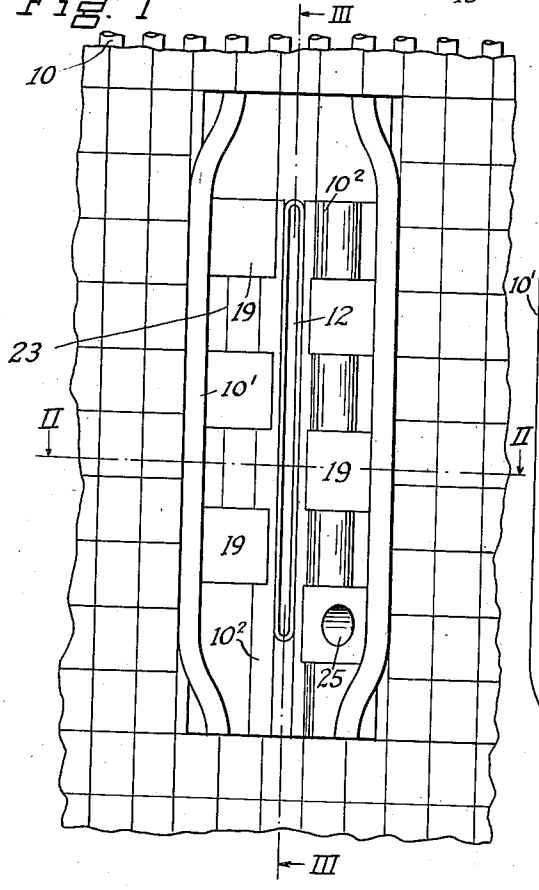

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Fig. 5

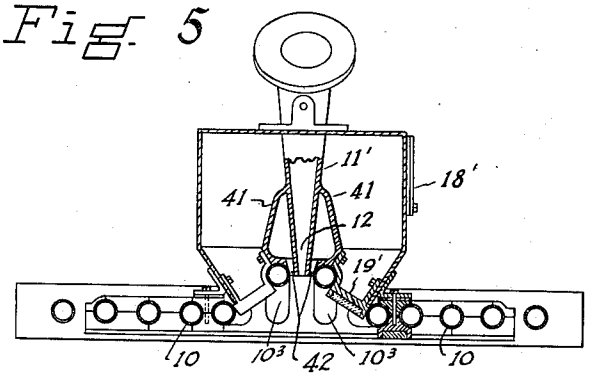


Fig. 4

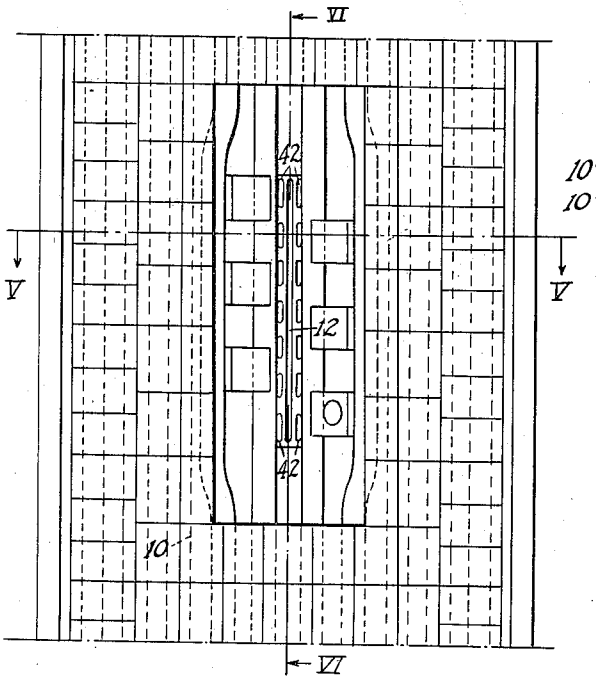
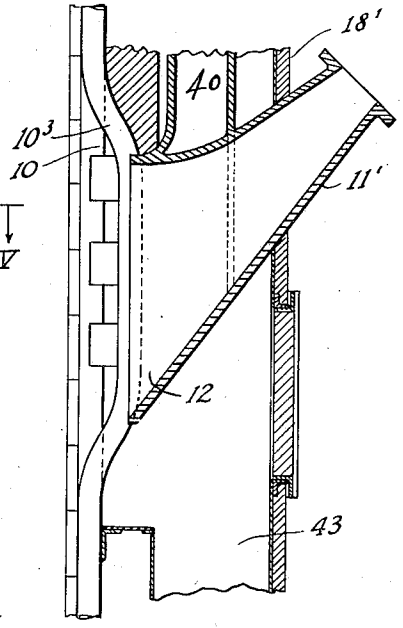


Fig. 6



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FLUID FUEL BURNER

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Fig. 8

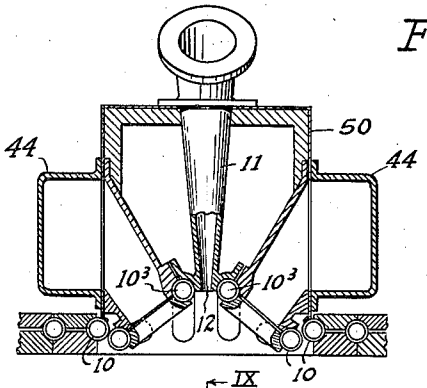


Fig. 9

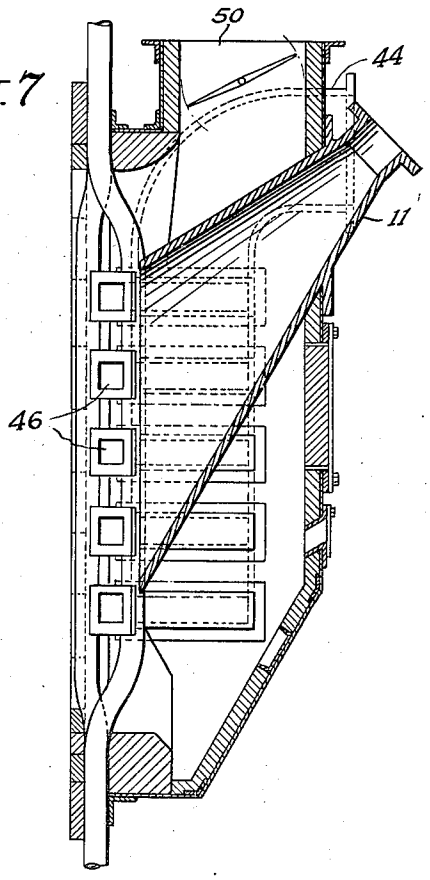
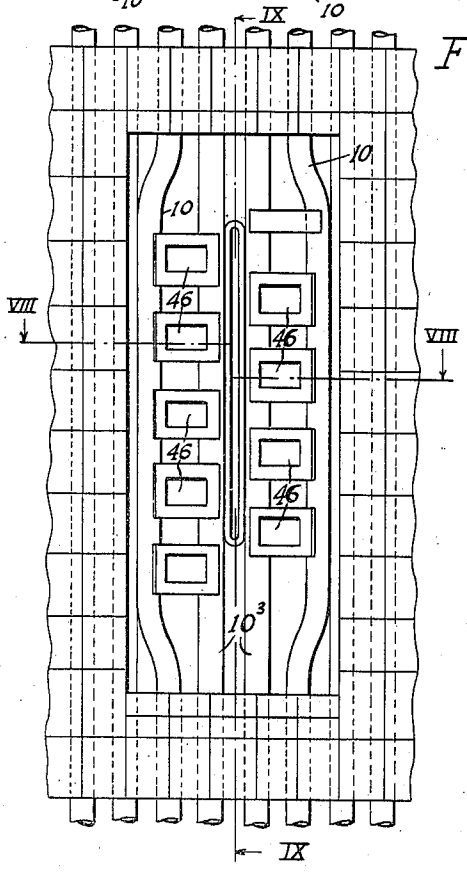


Fig. 7



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Patented Mar. 12, 1935 1,994,444

UNITED STATES PATENT OFFICE

1,994,444

FLUID FUEL BURNER

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Continuation of application Serial No. 127,791, August 7, 1926. This application July 20, 1932, Serial No. 623,519

32 Claims. (Cl. 122—235)

My invention relates to a fluid fuel burner which will more thoroughly mix the fluid fuel and the combustion air. It is especially intended for use in connection with boiler furnaces having water-cooled walls.

The present application is a continuation of my copending application Serial No. 127,791, filed August 7, 1926, for Fuel burner, and is related to my copending patent application filed of even date herewith, Serial No. 623,520, which is directed to a method of burning fuel.

One object of the present invention lies in providing a burner which will produce a shorter, more intense flame and more rapid combustion than has heretofore been possible. A further object is to enlarge the flame filled space and to reduce the amount of excess air required. Another object is to provide a burner and a mounting therefor in a form which will permit it to be adequately cooled by means of fluid cooling tubes in the wall. Other objects will appear upon further consideration of this specification.

One preferred form of the burner and associated parts is shown in the accompanying drawings wherein—

Figure 1 is an elevation of a burner constructed in accordance with the invention, showing a portion of the furnace wall as viewed from within the furnace,

Fig. 2 is a horizontal section on the line II—II of Figure 1,

Fig. 3 is a vertical midsection of the burner taken on the line III—III of Figure 1,

Figs. 4, 5, and 6 are views similar to Figs. 1, 2, and 3 respectively showing a modified form of the invention, and

Figs. 7, 8, and 9 are views similar to Figs. 1, 2, and 3 showing another modified form of the invention.

By the words "fluid fuel" I intend to include any fuel which is or may be employed in fluid form whether admixed with primary air or not before emerging from the fuel opening of the burner. It is intended, for example, to include as fuel, either gas, oil in spray or finely divided form, vaporized liquid fuels, pulverized coal or other carbonaceous material admixed with primary air to form a preliminary fluid fuel mixture, or any combination of such fuels.

Beside the thorough mixing of fluid fuel and air, more fully described hereinafter, a second important feature of the invention lies in properly supporting and protecting the burner. Especially where pulverized coal is used as a combustible, the general burner opening is likely to become heated to a point at which the fuel will become partly fused and sticky in character, tending to clog the burner opening. This difficulty is overcome by protecting and water-cooling the burner. In overcoming this difficulty provision is also made for suitably supporting the burner on the water-cooled furnace wall so that the burner may move with the furnace wall in any expansion or contraction thereof.

A third important feature of my invention lies in combining a furnace, having water-cooling tubes, with a burner or burners of the improved type which may be located at any desirable point or points therein or in connection therewith.

Referring more particularly to the drawings, the form of the invention illustrated in Figs. 1, 2, and 3 shows a boiler furnace wall having spaced vertically extending water tubes 10 forming at least a portion thereof. Water is circulated through these tubes to cool the furnace wall, and also for heating the water or generating steam, the resulting hot water or steam being used for any desired purpose. In this form the spaces between the water tubes 10 are closed by rows of blocks, the outside blocks being marked 13, and the inside blocks being marked 14. Each row of blocks has recesses formed therein which fit partly around adjacent tubes, and the rows may be clamped in place by means of bolts 16. The inside blocks 14 are preferably of metal in the portion seating against the tubes and are shown as having portions 15 of refractory material facing the furnace chamber. Heat conducting cement of any known or desired composition may be interposed between the curved recessed portions of the blocks of the water tubes in order to provide closely fitting joints through which the furnace heat may be readily conveyed.

In this form of the invention two adjacent water tubes 10^2 are bent directly outwardly of the furnace and parallel to each other to support and cool the elongated outlet 12 of a fuel nozzle 11. This outlet is preferably in the form of a long narrow slot, as best shown in Figure 1. Each water tube 10^1 adjacent each of the water tubes 10^2 is bent inwardly toward the furnace chamber and sidewise away from the adjacent water tube 10^2 and toward the adjacent unbent tube, to provide the general burner opening or port. (See Fig. 2.)

The fuel nozzle 11, through which a rich mixture of pulverized fuel and primary air or other suitable fluid fuel is fed to the furnace, extends through a box-like casing 18 containing secondary air under pressure. This casing 18 is shown

as having inwardly converging sides bolted to angle irons 17 attached to the outside blocks 13. The fuel nozzle 11 which extends through the air chamber has its outlet portion 12 flanged and provided with concave recesses which fit against and are in intimate heat-conductive relation with the tubes 10^2. Bolts 20 pass through the flanges on the outlet portion 12 and also through lugs on spaced blocks 19, which are likewise recessed to fit snugly upon the tubes 10^2. Heat conducting cement is preferably used between the concave recesses in the outlet portion 12 of the fuel nozzle 11 and the tubes 10^2 and also between the blocks 19 and these tubes in order to assist the transfer of heat from the flanges and the blocks to the tubes.

Lugs or extensions 21 are preferably provided on the outside of the blocks 19, and these lugs or extensions may carry air-directing wings 22 extending outwardly of the blocks 19 into the air-box and preferably secured to vertical angle irons 23 which form vertical braces or supports. The blocks 19 are preferably composite in character, their outer portions being of metal, and the portions facing the furnace being of refractory material. These blocks 19 are fastened to the supports 23, as just described, and also to the walls of the air housing 18. The blocks 19 are here shown as spaced (see Figure 1) to provide air openings from the air-box into the furnace, these openings being shown (see Figure 1) as staggered on opposite sides of the outlet portion 12 of the fuel nozzle 11.

It is preferred to provide an access door 24 in the side of the air housing 18 and to construct a tubular port 25 leading from the access door 24 into the burner opening through which a torch for lighting the fuel may be thrust. An inlet 26 is provided for feeding air from any convenient source to the casing 18, and a damper 27 is preferably disposed in the inlet 26 to control the air admission.

In operation the fluid fuel, in this case pulverized coal and primary air, is introduced into the furnace through the fuel nozzle 11, passing the outlet portion 12 in the form of a thin vertically extending sheet. The mixture passing through the nozzle contains insufficient air for combustion, and additional or secondary air passes into the furnace from the inlet 26 past the damper 27 into the box-like casing 18 and thence through the staggered openings between the blocks 19 at inwardly converging angles on opposite sides of the fuel stream. In this form, therefore, the incoming secondary air streams are staggered on opposite sides of the central sheet.

Applying the term "fluid" to the rich coal and air mixture, which has been referred to as the fuel passing through the nozzle 11, it will be noted that at least one of the fluids is admitted through multiple ports in order to assist in the intermixing of the fuels and the spreading and shortening of the flame. The angular impingement and deflecting of the coacting streams occur after the streams have left their respective openings, at least one of the fluids passing into the furnace through several ports. If these ports are positioned on opposite sides, the flame from the multi-ported burner is deflected in opposite directions in different portions thereof. Thus, it will be noted that the secondary air streams enter the furnace at angles to the fuel stream and impinge on the fuel stream after the latter has emerged from its outlet 12. Consequently the angular impingement of the staggered air streams on the central thin fuel stream tends to deflect portions thereof in opposite directions. Further, such angular impingement not only causes thorough admixture of air and fuel, but also shortens the flame, and by forcing it sidewise in opposite directions, causes the flame to fill a much greater volume of the furnace space than would otherwise be possible. Finally, it will be noted that such angular impingement of the combustion air against the thin sheet of the fuel stream causes great turbulence, rapid admixture of fuel and air and shortening of the flame.

Referring now to the second set of features of my invention, namely, the proper supporting and protecting of the burner, it will be noted that the burner, as a whole, has its burner opening into the furnace partly screened from radiant heat by water tubes; that the unscreened portion is cooled by water tubes in close heat-contacting relation with metallic parts of the burner; and that the burner is fitted to be attached to and supported by the water tube wall structure. The sidewise bent tubes 10^1 and the adjacent tubes 10 partially screen the burner from the radiant heat of the furnace, while the outwardly bent tubes 10^2 serve to water-cool the nozzle portions of the burner, as well as also partially screen them. It will be noted that the fuel enters between water tubes—in the case shown, the tubes 10^2 while the supplemental air enters the several ports between each tube 10^2 and the adjacent tube 10^1. Consequently, the tubes 10^1 and 10^2 serve to partially protect and also water-cool both the fuel and air-ports.

The burner is thus kept below such temperatures as would cause stickiness and clogging where pulverized coal is used as the combustible. This water-cooling of the partially exposed inner part of the burner, as a whole, is an important feature of my invention. Furthermore, by the construction shown, the burner or burners are supported on and may move with the water-cooled wall structure. Consequently, any expansion or contraction of the wall, as a whole, will cause a similar movement of the burner or burners, thus avoiding strains, etc. between them. Hence, overheating of the burner is prevented; and no separate supporting system is needed for the burner or burners.

In the construction illustrated, the burner does not project inside the furnace from the plane of the furnace wall and is preferably outside such plane, as shown, thus decreasing the heat to which it is subjected, while such heat as is received by the burner is rapidly conducted to and absorbed by the water in the tubes having intimate heat conductive contact with the burner and its connections. Further, the burner has its opening into the furnace partly screened from radiant heat by water tubes, the sidewise bent tubes 10^1 partially screening the burner from radiant heat.

The outwardly bent tubes 10^2 serve not only to cool the nozzle but also to support it, the burner being fitted for fastening to these tubes. Thus, the fuel enters between water tubes—in the case shown, the tubes 10^2—while the secondary air passes through the several ports between each tube 10^2 and the adjacent tubes 10^1. Consequently the tubes 10^1 and 10^2 serve to partly protect and also water-cool both the fuel and the air-ports.

An important feature of the invention, to which general reference has been made above, is that the spaces between the water tubes are closed

by blocks which are secured in place upon the tubes, and that the multi-ported burners may be placed wherever desirable and in any necessary number in the wall, all parts being carried by the water tube wall structure. In this manner an economical, simple and effective wall and burner structure is provided in which the burners may be positioned as desired in the wall, while the heat absorbed by the water tubes may be utilized for useful work.

In Figures 4, 5, and 6, there is shown a form generally similar to that of Figures 1, 2, and 3, except that provision is made for introducing gas along with the pulverized fuel and air. The burner 11' extends through the housing 18', the tubes and connections being substantially the same as in the first form. The opposite blocks 19' provide the angular inwardly converging air outlet ports which are preferably staggered, as in the first form; and a gas outlet conduit 40 extends into the air-box and is split and passes down on each side of the fuel nozzle, the two branches 41 having spaced ports or openings 42 between the fuel outlet and the adjacent tubes 10^3. In this case, the angular secondary air jets impinge upon and bend successive portions of the fuel stream of pulverized coal, gas, and primary air and cause a thorough admixture, giving the spreading action, turbulence and shortening of the flame.

In the further form of Figures 7, 8 and 9, another arrangement is shown for introducing gas in connection with the primary fuel, which may be a rich mixture of pulverized coal and air, and in connection with the multi-ported angular air outlets. The wall, water tubes, burner connections and general assembly are about the same as in Figures 1, 2 and 3; but in this modification, gas conduits 44 are secured at the sides of the air-box having spaced outlets 46 which are shown as staggered on opposite sides of the pair of tubes 10^3, so that gas for combustion purposes passes out of the openings 46. The secondary air for combustion purposes is supplied to the upper end of the air-box 50 and passes downwardly through the air-box on both sides of the fuel nozzle 11. The air enters the furnace at both sizes of the nozzle 11 through the spaces between the gas outlets 46 and above and below the nozzle 11. In this manner, both the air and the gas enter in an angular relation to the thin sheet of primary fluid fuel, there being two rows of ports on each side thereof feeding in alternate air and gas. In this case, both the compressed air jets and the compressed gas jets serve to impinge upon the thin sheet of primary fluid fuel and deflect the same sidewise in opposite directions, thus further shortening and spreading the flame, while effecting a thorough and intimate mixture of all the combustion components.

The advantages of my invention result from the three general features above described, and will be claimed both separately and in combination with one another.

In actual practice, it has been proven that the burner greatly improves the mixing of the fluid fuel and air, reduces the length of flame and spreads the flame into large volume; also that it greatly reduces the amount of excess air required and thus enables a high furnace temperature to be maintained. The heat-conducting metallic contacts between the burners and water tubes, especially in connection with the partial screening from radiant heat and arranging the burners so that they do not project inside the water wall and are preferably exterior thereof, are found to give the burners a long life, prevent clogging, and avoid injury by strains between the burners and water wall on which they are carried. The blocks close in substantially all the side walls of the furnace chamber and enclose it except as to the burners, which fill the remainder of the wall space.

The structure can be economically and easily constructed and applied, and is especially well adapted for fluid fuels, such as those mentioned above.

The water tubes may extend either vertically or horizontally or in inclined positions, and many changes may be made in the burner, the fuel used and the form and arrangement of the parts, without departing from my invention.

I claim:

1. A furnace having spaced water tubes forming part of a vertically extending wall thereof and a fluid fuel burner nozzle arranged to discharge between a pair of said water tubes and a plurality of air ports between another pair of said water tubes and arranged to discharge towards the discharge from said burner nozzle.

2. In a furnace, a vertically extending wall having spaced water tubes, means for closing the spaces between the tubes, and a multi-ported fluid fuel burner in the wall projecting inwardly no further than the inner face of the water tubes and having separate fuel and air outlets arranged to respectively discharge fuel and air jets impinging upon one another.

3. A furnace having a wall with spaced water tubes, means for closing the spaces between the tubes, and a fuel burner arranged to discharge through said wall and having metallic parts closely fitting and in heat-conductive relation with said water tubes.

4. In combination, a burner having an elongated opening for introducing a stream of fuel into a furnace, and means to project air in staggered streams on opposite sides against the stream of fuel near where it issues from said opening.

5. In combination, a burner having an elongated opening for introducing fuel and air into a furnace, auxiliary air ports on each side of and in proximity to and directed towards said fuel and air opening, and means to introduce gas into said furnace between said opening and ports.

6. In combination, a burner having an elongated opening for introducing fuel and air into a furnace, and spaced water tubes in the wall of said furnace, said burner being recessed to receive and engage some of said tubes and being attached thereto.

7. In combination, a burner having an elongated opening for introducing a stream of fuel and air into a furnace, spaced water tubes in the wall of said furnace, said furnace wall having certain outwardly bent tubes upon which said burner is supported, said bent tubes providing air inlet openings on opposite sides of said burner opening directed towards the stream of fuel and air from said burner.

8. In combination, a burner, water tubes to which said burner is attached, said burner being recessed to receive and engage some of said tubes and having an outlet elongated longitudinally of said tubes, and having curved surfaces in contact with some of said tubes and air ports on each side of said outlet.

9. In combination, a burner, a furnace comprising a wall having vertically disposed out-

wardly bent water tubes to which said burner is attached, said burner having an elongated opening parallel to said tubes and being recessed to receive and engage some of said tubes and being attached thereto, and means to introduce air into said furnace at an angle to the axis of said burner.

10. In combination, a furnace, means for discharging fuel into said furnace in a fuel stream tending to produce a flame elongated transversely of the direction of fuel discharge, and means for discharging a plurality of high velocity air jets towards opposite sides of said fuel stream and deflecting adjacent portions of said fuel stream in opposite directions at substantially the same distance from the point of fuel discharge.

11. In combination, a furnace wall having a series of spaced vertically extending cooling fluid tubes, a fuel burner port formed in said wall, a fuel nozzle arranged to discharge a downwardly directed fuel stream between adjacent tubes extending across said burner port, and means for discharging a high velocity air jet through said burner port below said fuel stream and contacting therewith adjacent said wall.

12. In combination, a furnace wall having a fuel burner port formed therein, an elongated fuel nozzle arranged to discharge a relatively thin sheet of fuel through said burner port, and a plurality of air passages extending into said burner port at opposite sides of said fuel nozzle and arranged to provide a plurality of staggered air jets inclined towards said sheet of fuel and impinging on different portions thereof adjacent said wall.

13. In combination, a furnace wall having a fuel burner port formed therein, a fuel burner nozzle arranged to discharge a fuel jet through said burner port, means for discharging a high velocity air jet through said burner port in a direction inclined to said fuel jet and impinging thereon adjacent said wall, and spaced cooling fluid tubes extending across said burner port in position to shield the discharge end of said burner nozzle from radiant heat.

14. In a fuel burner, a narrow elongated inlet for primary air and fuel, staggered secondary air inlets on opposite sides of said primary air and fuel inlet, and means to cause the secondary air to enter at an angle to the direction of entry of the primary air and fuel.

15. In combination, a furnace, means for discharging fluid fuel into said furnace in a plurality of staggered streams, and means for separately discharging air for combustion into the furnace in a plurality of staggered streams intermediate said fuel streams.

16. In combination, a furnace, means for discharging fluid fuel into said furnace in a plurality of staggered streams, and means for separately discharging air for combustion into the furnace in a plurality of staggered streams intermediate said fuel streams and each directed to impinge on a corresponding fuel stream.

17. In combination, a furnace, means for discharging fluid fuel into said furnace in a plurality of staggered streams with the points of fuel discharge arranged in substantially parallel planes, and means for separately discharging air for combustion into the furnace in a plurality of staggered streams with the points of discharge thereof substantially in alignment with and intermediate said fuel streams.

18. In combination, a furnace having a wall, means for discharging a fluid fuel into the furnace in a plurality of staggered streams projected at oblique angles to said wall, and means for separately discharging air for combustion into the furnace in a plurality of staggered streams at points intermediate said staggered fuel streams and projected at oblique angles to said wall to cause corresponding fuel and air streams to impinge upon one another.

19. In combination, a furnace having a wall, means for discharging a fluid fuel in a plurality of streams entering the furnace at points staggered in substantially parallel planes, and means for separately discharging air for combustion into the furnace in a plurality of staggered streams at points intermediate and in the planes of the points of discharge of said staggered fuel streams and at oblique angles to said wall to cause each air stream to impinge upon a corresponding fuel stream.

20. In combination, a furnace having a wall including a series of spaced vertically extending cooling fluid tubes, means for discharging a fluid fuel into the furnace in a plurality of staggered streams passing between pairs of adjacent wall tubes, and means for separately discharging air for combustion into the furnace in a plurality of staggered streams at points between said wall tubes and intermediate said staggered fuel streams.

21. In combination, a furnace having a wall including a series of spaced vertically extending cooling fluid tubes, means for discharging a fluid fuel into the furnace in a plurality of staggered streams passing between pairs of adjacent wall tubes at oblique angles to said wall, and means for separately discharging air for combustion into the furnace in a plurality of staggered streams projected at points between said wall tubes and intermediate said staggered fuel streams and at oblique angles to said wall to cause corresponding fuel and air streams to impinge upon one another adjacent their points of discharge.

22. In combination, a substantially vertical furnace wall having a series of spaced vertically extending cooling fluid tubes, a fuel nozzle arranged to discharge a downwardly inclined fuel stream between a pair of said tubes, and means for discharging a high velocity air jet between said pair of tubes below the point of fuel discharge therebetween and commingling with the fuel stream adjacent said wall.

23. In combination, a furnace wall having a fuel burner port therein, a fuel burner arranged to discharge a fluid fuel through said port, a series of tiles adjacent said port, and a pair of cooling tubes having bent portions embracing said port at the furnace end thereof and arranged in heat transfer relation to said tiles.

24. In combination, a furnace wall having a fuel burner port therein, a fuel burner arranged to discharge a fluid fuel through said port, a series of tile pieces adjacent said port, and a pair of vertically arranged water tubes having portions above and below said fuel port arranged substantially parallel and intermediate portions bent laterally to embrace said fuel port, said intermediate portions being arranged to hold said tile pieces in position and in heat transfer relation therewith.

25. In a furnace, a wall comprising water cooled tubes, certain of said tubes being displaced outwardly from the line of the furnace wall to form a recess in said wall, said wall having an air box opening into the recess therein,

and a pulverized fuel nozzle extending through said wall at the recess in proximity to said air box, in combination with a gaseous fuel nozzle extending within said air box and opening into said recess.

26. In a furnace for burning fuel in suspension, means for discharging pulverized fuel into the furnace in a stream tending to produce a flame elongated transversely of the direction of fuel discharge, and means for supplying a gaseous fuel to the furnace in a plurality of high velocity jets at opposite sides of the pulverized fuel stream and mixing therewith adjacent the point of pulverized fuel discharge.

27. In a furnace for burning fuel in suspension, means for discharging pulverized fuel into the furnace in a stream tending to produce a flame elongated transversely of the direction of fuel discharge, means for supplying a gaseous fuel to the furnace in a plurality of high velocity jets at opposite sides of the pulverized fuel stream and mixing therewith adjacent the point of pulverized fuel discharge, and means for supplying air for combustion in a plurality of high velocity streams at opposite sides of the pulverized fuel stream and intermediate the jets of gaseous fuel.

28. In combination, a furnace wall having a fuel burner port formed therein, a pulverized fuel burner nozzle arranged to discharge a stream of pulverized fuel through said burner port, a gaseous fuel burner nozzle arranged to discharge a high velocity gaseous fuel jet through said burner port in a direction inclined to said pulverized fuel stream and mixing therewith adjacent said wall, and spaced cooling fluid tubes extending across said burner port in cooling relation to one of said burner nozzles.

29. In combination, a furnace wall having a fuel burner port formed therein, a pulverized fuel burner nozzle arranged to discharge a stream of pulverized fuel through said burner port, a gaseous fuel burner nozzle arranged to discharge a high velocity gaseous fuel jet through said burner port in a direction inclined to said pulverized fuel stream and impinging thereon adjacent said wall, and spaced cooling fluid tubes extending across said burner port in cooling relation to said pulverized fuel burner nozzle, and means for passing air for combustion through said burner port in cooling relation to said gaseous fuel burner nozzle.

30. In combination, a furnace wall having a series of transversely spaced cooling fluid tubes, a fuel nozzle arranged to discharge a fuel stream between a pair of said tubes, an air box surrounding said fuel nozzle, means for discharging combustion air from said air box between a pair of said tubes adjacent the point of fuel discharge and in a direction to commingle with the fuel stream adjacent said wall, and a lighting torch conduit extending through said air box and opening between a pair of said tubes adjacent the point of fuel discharge.

31. In combination, a furnace wall having a series of spaced cooling fluid tubes, a fuel burner having nozzle means arranged to discharge fuel between adjacent tubes in a plurality of streams alternately oppositely directed, air inlet ports adjacent said fuel burner nozzle means and opening to the furnace between adjacent tubes, and means for supplying air for combustion to the furnace through said air inlet ports in high velocity jets impinging on and commingling with corresponding oppositely directed fuel streams.

32. In combination, a furnace wall having a series of spaced vertically extending cooling fluid tubes, a fuel burner port in said wall, a fuel burner having nozzle means arranged to discharge fuel through said port and between adjacent tubes in a plurality of streams alternately oppositely directed, air inlet ports opening to the furnace between similarly directed fuel streams, and means for supplying air for combustion to the furnace through each of said air inlet ports in a high velocity jet impinging on and commingling with an oppositely directed fuel stream.

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