

Jan. 21, 1941.

M. FRISCH

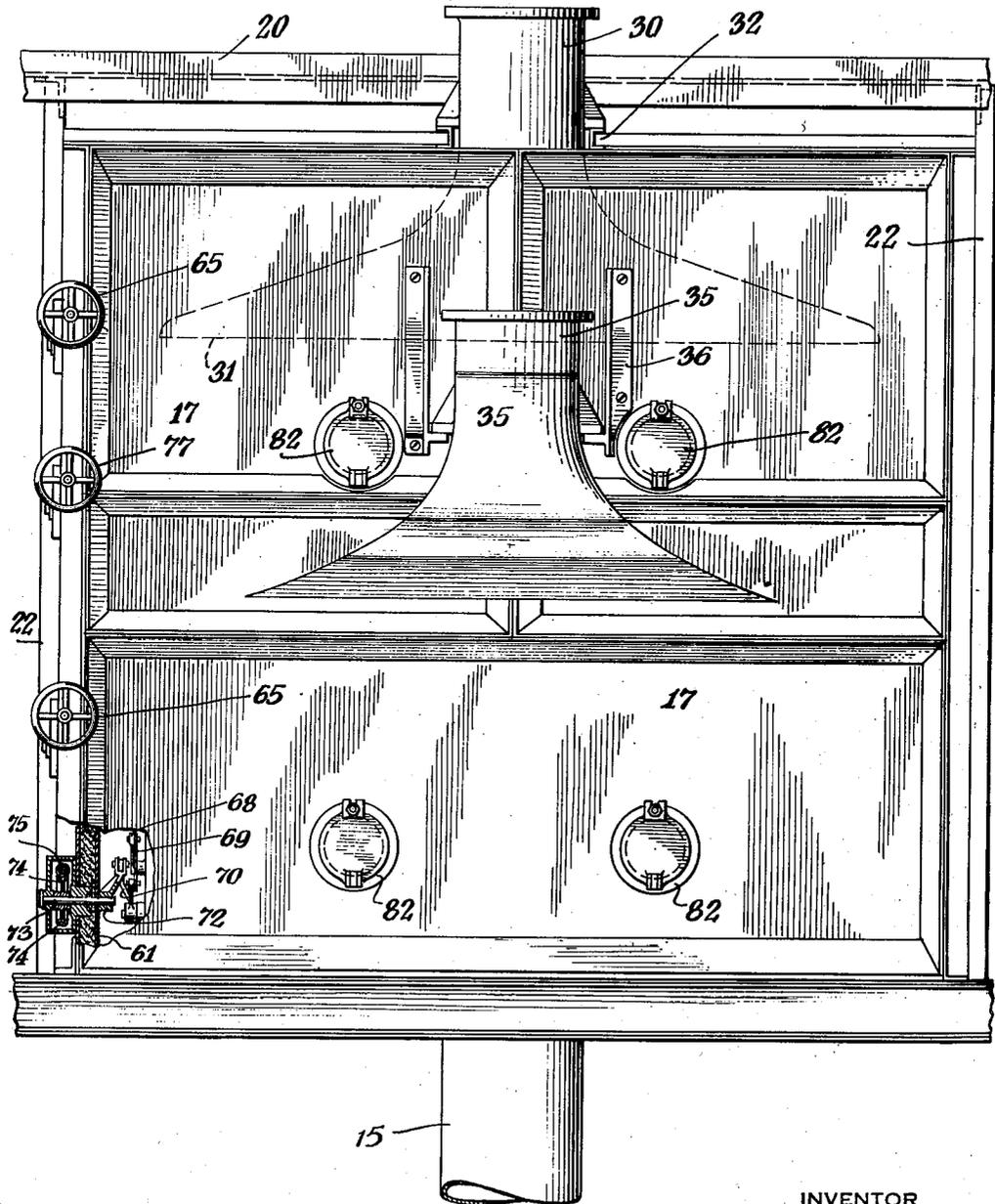
2,229,068

BURNER

Original Filed April 17, 1930

4 Sheets-Sheet 1

Fig. 1



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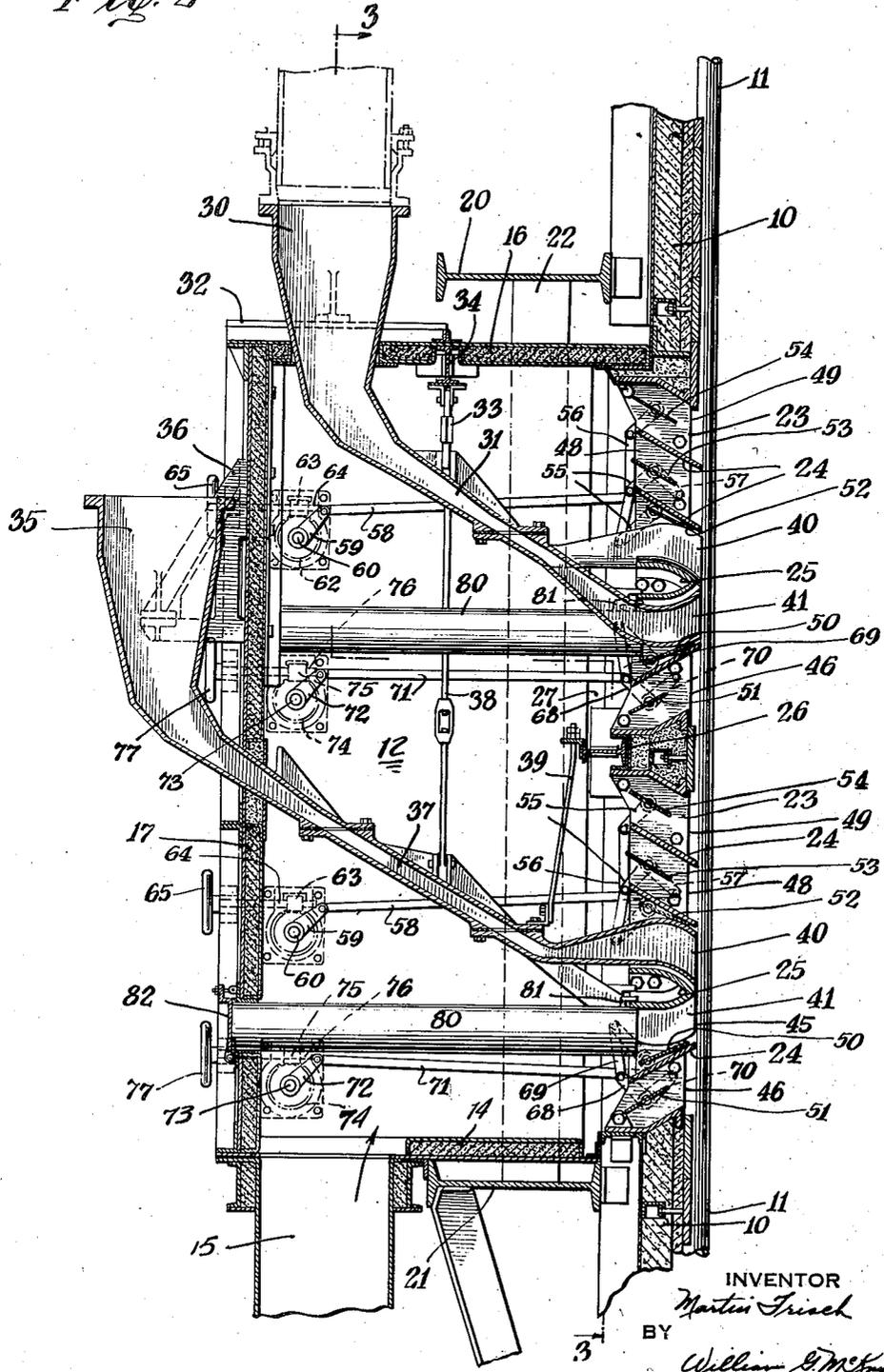
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BURNER

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4 Sheets-Sheet 2

Fig. 2



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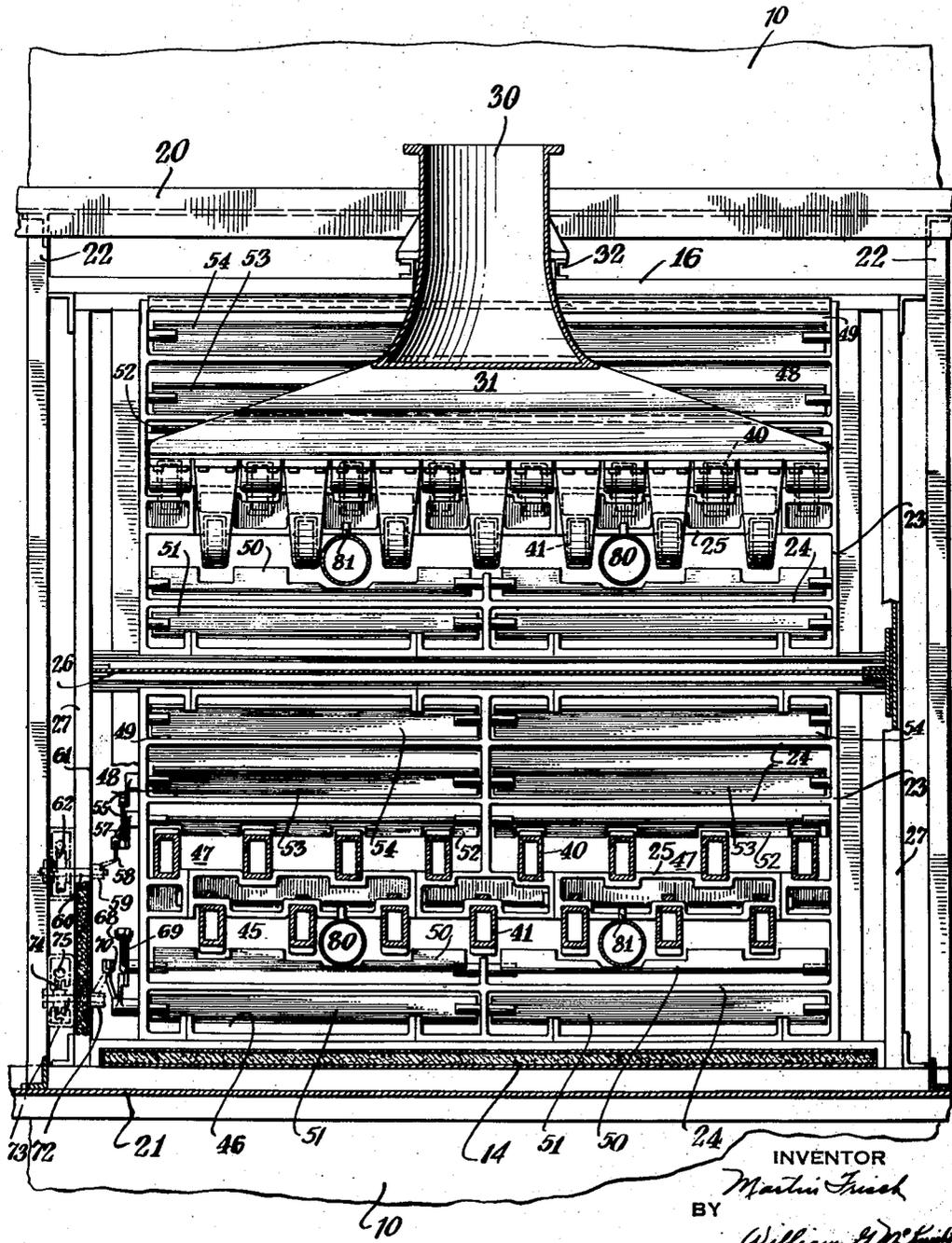
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BURNER

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4 Sheets—Sheet 3

Fig. 3



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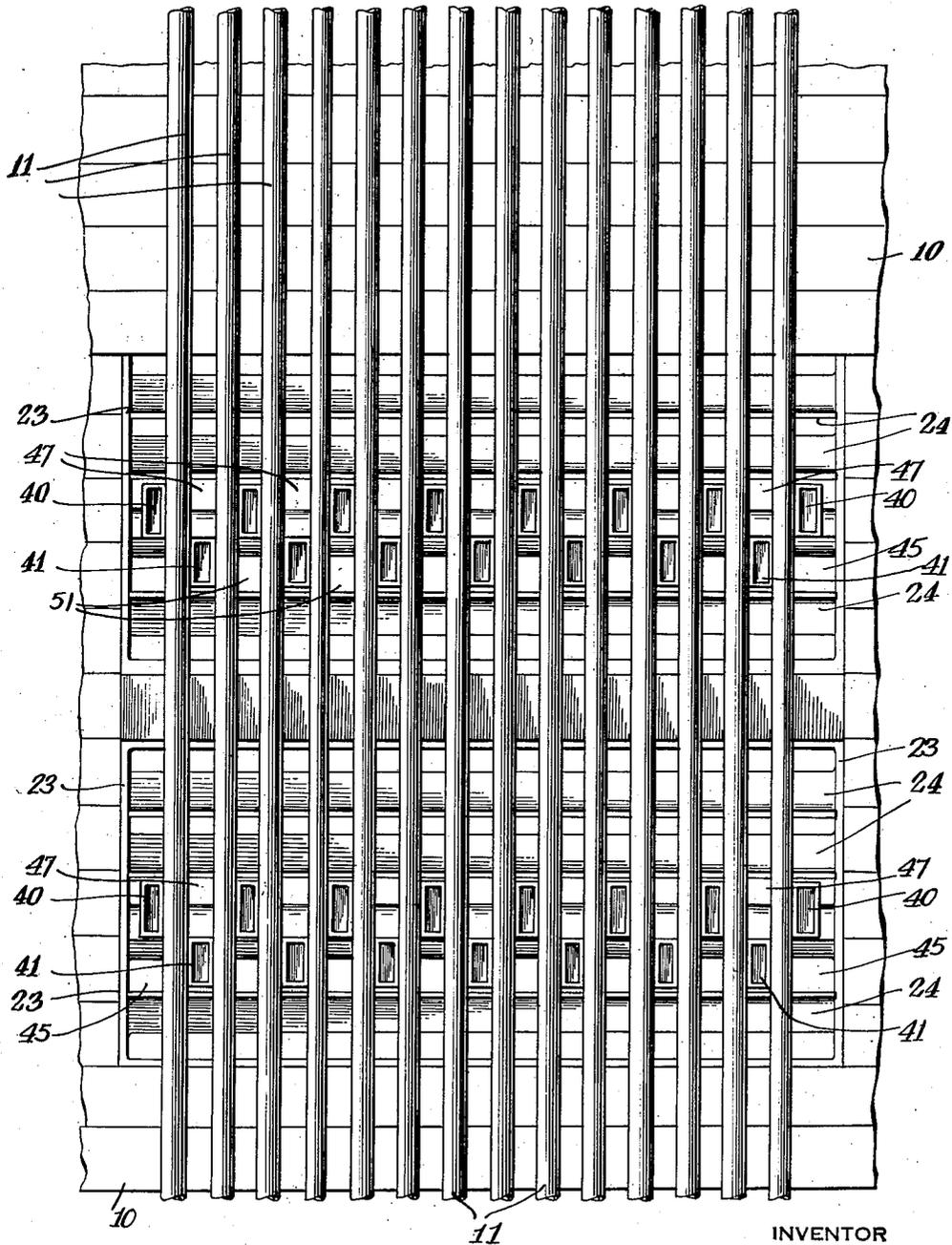
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BURNER

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4 Sheets-Sheet 4

Fig. 4



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UNITED STATES PATENT OFFICE

2,229,068

BURNER

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Application April 17, 1930, Serial No. 444,906
Renewed June 16, 1938

35 Claims. (Cl. 122—235)

This invention relates to burners, more particularly to pulverize fuel burners adapted to fire steam boilers or the like.

The invention provides a burner in which the fuel, such as pulverized coal, is injected into the furnace through a wall thereof by means of a plurality of nozzles which are so arranged as not to interfere with the normal construction of the furnace wall, nor to require bending or displacement of any water tubes, where the firing is done through a water wall. The invention further provides a burner which may be readily adapted to any desired fuel capacity and in which the mixing of the fuel and air and the shape of the burner flame and the direction thereof may be readily controlled.

In accordance with the present invention, the fuel is introduced into the furnace through a wall thereof by means of a plurality of nozzles which are arranged to project alternate fuel jets in converging planes. An air jet which is convergent to each of the fuel jets is caused to impinge thereon in such manner that the direction and shape of the flame is dependent upon the relative velocities of the air and the fuel jets. Additional air for combustion is also supplied from above and below the fuel nozzles in directions which are inclined toward the nozzles. Controllable dampers are provided for regulating each of the air jets so that the direction of the flame may be controlled at will. The arrangement is such that the flame may be projected horizontally into the furnace or it may be caused to assume an upwardly or downwardly inclined direction or to impinge upon the floor of the furnace, dependent upon the regulation of the various air dampers.

The invention also consists in certain new and original features of construction and combinations of parts hereinafter set forth and claimed.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, the mode of its operation and the manner of its organization may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof, in which:

Fig. 1 is a front elevation of a burner constructed in accordance with the present invention;

Fig. 2 is a vertical sectional view of the burner showing the arrangement of the various parts;

Fig. 3 is a section taken on the line 3—3 of Fig. 2; and

Fig. 4 is a broken elevation of a water-cooled furnace wall taken from inside the furnace and showing the arrangement of the air ports and fuel nozzles with respect thereto.

Like reference characters denote like parts throughout the several figures of the drawings.

In the following description and in the claims, the various parts will be identified by specific names for convenience, but such names are intended to be as generic in their application to similar parts as the art will permit.

Referring to the drawings, a burner constructed in accordance with the present invention is shown as applied to a boiler furnace wall constructed of suitable refractory material and having a plurality of water tubes associated therewith.

As shown, the burner is provided with an air casing 12 having a bottom wall 14 provided with an air inlet 15, and top and rear walls 16 and 17 respectively, each of the walls being preferably constructed of heat-insulating material and being joined together in any desired manner.

The air casing 12 is suitably supported by the boiler framework by means of I beams 20 and 21 located below and above the casing, and upright members 22.

A pair of housings 23 having air baffles 24 mounted therein and spacing members 25 are also supported by the framework, together with a beam 26 which extends along the furnace wall between the housings 23 and is secured to uprights 27.

The fuel inlet for the upper set of nozzles preferably comprises a duct 30 which is formed with an elongated fan-tail-shaped distributing nozzle 31. The duct 30 is carried by framework 32 secured to the boiler framework and distributing nozzle 31 is supported by means of rods 33 from a transverse beam 34. The fuel for the lower set of nozzles is supplied through a duct 35 which extends through the rear wall 17 and is secured in position by framework 36 or other suitable means. Associated with duct 35 is an elongated fan-tailed distributing nozzle 37, which is supported by rods 38 from the beam 34. An additional support is provided by rods 39 which extend from the lower end of distributing nozzle 37 to a transverse beam 26.

The upper and lower sets of fuel nozzles are preferably identical in construction, hence only the lower nozzles and the mechanism associated therewith will be described in detail. It is to be understood that the description applies to the upper set as well and that any desired number of sets may be employed. These fuel nozzles preferably comprise a series of upper nozzles 40 and a series of lower nozzles 41 which are bolted or otherwise secured to the fan-tailed distributing nozzle 37. A spacing member 25, forming a part of housing 23, is located between the series of nozzles 40 and 41 and is adapted to prevent the passage of air therebetween. The upper nozzles 40 are designed to project jets of fuel in a

downwardly inclined direction and the lower nozzles 41 project fuel jets in an upwardly inclined direction. It is to be noted that the nozzles 40 and 41 are arranged to project the fuel jets into the furnace between the water tubes 11 and that the jets are alternately arranged above and below spacing member 25.

Air is supplied to the burner from air casing 12 through passages in the housing 23 and the velocity of the air through these passages is controlled by means of dampers mounted in the passages. Passages 45 and 46, located below spacing member 25, are adapted to direct the air flowing therethrough in an upwardly inclined direction, and passages 47, 48 and 49 located above spacing member 25, are adapted to direct the air flowing therethrough in a downwardly inclined direction. It is to be noted that passages 45 supply air to the burner between adjacent fuel nozzles 41 of the lower series and below each nozzle 40 of the upper series, and that passages 47 supply air between adjacent nozzles 40 of the upper series and above each nozzle 41 of the lower series. The direction of the air jets from passages 45, for example, is parallel to the direction of the fuel jets from nozzles 41 and is convergent to the fuel jets from nozzles 40. The air jets from passages 45 and the fuel jets from nozzles 40 accordingly impinge at an angle and produce a flame, the direction of which is determined by the relative velocities of the air and fuel jets. The flame direction may be further controlled by means of the air admitted through passages 46, 48 and 49. It is to be understood that the air jets from passages 47 and the fuel jets from nozzles 41 operate in a similar manner.

A plurality of dampers 50 and 51 are pivotally mounted in air passages 45 and 46 respectively and dampers 52, 53 and 54 are mounted pivotally in passages 47, 48 and 49, respectively. It is to be noted that dampers 50 and 52 are suitably recessed (Fig. 3) to cooperate with nozzles 41 and 40 respectively in controlling the air flow through the passages in which they are mounted.

The position of the upper dampers 52, 53 and 54 is controlled by a plurality of arms 55 which are connected by links 56. An arm 57 is associated with damper 53 and is pivoted to rod 58 which is connected to a crank 59. This crank is mounted on a shaft 60 which extends through side wall 61 of the air casing (Fig. 3) and carries a worm wheel 62. Worm 63 meshes with worm wheel 62 and is mounted on a shaft 64 (Fig. 2) which extends through the rear wall 17 of the air casing and is provided with an operating hand-wheel 65.

Dampers 50 and 51 are controlled by arms 68 which are interconnected by a link 69 and arm 70 which is connected to a rod 71. Rod 71 is connected to a crank 72 mounted on shaft 73 which extends through side wall 61 of the air casing and carries a worm wheel 74. A worm 75 meshes with wheel 74 and is carried on a shaft 76 which extends through the rear wall 17 of the air casing and carries a hand-wheel 77.

As shown, ignition tubes 80 extend from the rear wall 17 of the air casing to a point adjacent the fuel nozzles 41. The inner end of each of the tubes 80 is supported by means of a lug 81 which engages the spacing members 25 and the outer end of each tube is closed by a suitable ignition door 82.

It is to be understood that the upper set of nozzles connected to distributing nozzle 31 and the air passages and dampers associated there-

with are similar in construction and operation to those above described. Furthermore, the number of sets of nozzles and the number of air passages may be varied to meet the requirements of any particular furnace. A particular embodiment of the invention has been disclosed by way of illustration only.

In the operation of the burner shown, fuel, such as pulverized coal, is passed through the fuel ducts 30 and 35 to the distributing nozzles 31 and 37, whence it is supplied to the fuel nozzles 40 and 41. The fuel is discharged from the nozzles 40 and 41 into the furnace between the water tubes 11 in alternate upwardly and downwardly directed jets which pass each other at an angle but do not impinge. Air is supplied to the burner through the various air passages in quantities and at velocities which are controlled by the positions of dampers 50 to 54 inclusive. Each fuel jet impinges on an oppositely inclined air jet in the manner above pointed out, while additional air for combustion is admitted through the remaining passages, both above and below the fuel nozzles, in a direction inclined toward the nozzles. By varying the velocity of the combustion air admitted through the passages above and below the fuel nozzles by varying the positions of the dampers in the air passages, the direction of the burner flame may be directed either horizontally, upwardly or downwardly. This ready means for controlling the direction of the burner flame is particularly advantageous in slagging furnaces, for the reason that it provides means for impinging the flame onto the furnace floor without moving the burners.

It is to be noted that in accordance with this invention, the capacity of the burner may be readily varied merely by the addition or removal of jet units and without disturbing the construction of the furnace wall in any way or bending or changing the spacing of the water tubes where the burner is used to fire through a water wall. Each nozzle unit could, for example, have a capacity of one thousand pounds of coal per hour and a burner having a capacity of fifteen thousand pounds of coal per hour could be built up by using fifteen nozzle units.

It is to be understood that the constructional details of the burner, such as the supports and mechanical arrangement, may be varied as desired. Only so much of a furnace wall and supporting mechanism therefor have been disclosed as is necessary to an understanding of the invention.

While certain novel features of the invention have been shown and described and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit or scope of the invention.

What I claim is:

1. A burner for pulverized fuel comprising a plurality of fuel nozzles spaced along a furnace wall, some of said nozzles being inclined downwardly with respect to the horizontal and intermediate nozzles being inclined upwardly with respect to the horizontal to provide adjacent oppositely inclined fuel jets.

2. A burner for pulverized fuel comprising a plurality of fuel nozzles spaced along a furnace wall, some of said nozzles being inclined downwardly with respect to the horizontal and intermediate nozzles being inclined upwardly with re-

spect to the horizontal to provide adjacent oppositely inclined fuel jets, the downwardly inclined nozzles being mounted above the upwardly inclined nozzles, whereby the fuel jets cross.

5 3. A burner for pulverized fuel comprising a plurality of fuel nozzles spaced along a furnace wall, some of said nozzles being inclined downwardly with respect to the horizontal and intermediate nozzles being inclined upwardly with respect to the horizontal to provide adjacent oppositely inclined fuel jets, and means forming an air passage associated with each of said nozzles and arranged to provide an air jet which is oppositely inclined to the corresponding fuel jet and impinges thereon.

10 4. A burner for pulverized fuel comprising a plurality of fuel nozzles along a furnace wall, some of said nozzles being inclined downwardly with respect to the horizontal and intermediate nozzles being inclined upwardly with respect to the horizontal to provide adjacent oppositely inclined fuel jets, means forming an air passage associated with each of said nozzles and arranged to provide an air jet which is oppositely inclined to the corresponding fuel jet and impinges thereon, and means for selectively controlling the velocity of the upwardly and downwardly inclined air jets, whereby the direction of the burner flame may be varied.

20 5. A burner for pulverized fuel comprising a plurality of fuel nozzles spaced along a furnace wall, some of said nozzles being inclined downwardly with respect to the horizontal and intermediate nozzles being inclined upwardly with respect to the horizontal to provide adjacent oppositely inclined fuel jets, means forming an air passage associated with each of said nozzles and arranged to provide an air jet which is oppositely inclined to the corresponding fuel jet and impinges thereon, and means forming additional air passages above and below said fuel nozzles and arranged to direct air jets which are inclined toward said nozzles.

30 6. A burner for pulverized fuel comprising a plurality of fuel nozzles spaced along a furnace wall, some of said nozzles being inclined downwardly with respect to the horizontal and intermediate nozzles being inclined upwardly with respect to the horizontal to provide adjacent oppositely inclined fuel jets, means forming an air passage associated with each of said nozzles and arranged to provide an air jet which is oppositely inclined to the corresponding fuel jet and impinges thereon, means forming additional air passages above and below said fuel nozzles and arranged to direct air jets inclined toward said nozzles, and means for selectively controlling the velocity of air admitted through the upper and lower passages, whereby the direction of the burner flame may be varied.

40 7. A burner for pulverized fuel comprising a plurality of fuel nozzles spaced along a furnace wall, some of said nozzles being inclined downwardly with respect to the horizontal and intermediate nozzles being inclined upwardly with respect to the horizontal to provide adjacent oppositely inclined fuel jets, the downwardly inclined nozzles being mounted above the upwardly inclined nozzles whereby the fuel jets cross, and means for providing an air jet between alternate nozzles in a direction to impinge upon said fuel jets.

50 8. A burner for pulverized fuel comprising a plurality of fuel nozzles spaced along a furnace wall, some of said nozzles being inclined downwardly with respect to the horizontal and intermediate nozzles being inclined upwardly with respect to the horizontal to provide adjacent oppositely inclined fuel jets, the downwardly inclined nozzles being mounted above the upwardly inclined nozzles whereby the fuel jets cross, means for providing an air jet between alternate nozzles in a direction to impinge upon said fuel jets, and means for controlling the velocity of the air admitted between the upper and lower nozzles.

wardly with respect to the horizontal and intermediate nozzles being inclined upwardly with respect to the horizontal to provide adjacent oppositely inclined fuel jets, the downwardly inclined nozzles being mounted above the upwardly inclined nozzles whereby the fuel jets cross, means for providing an air jet between alternate nozzles in a direction to impinge upon said fuel jets, and means for controlling the velocity of the air admitted between the upper and lower nozzles.

10 9. A burner for pulverized fuel comprising a plurality of fuel nozzles spaced along a furnace wall, some of said nozzles being inclined downwardly with respect to the horizontal and intermediate nozzles being inclined upwardly with respect to the horizontal to provide adjacent oppositely inclined fuel jets, the downwardly inclined nozzles being mounted above the upwardly inclined nozzles whereby the fuel jets cross, means for providing an air jet between alternate nozzles in a direction to impinge upon said fuel jets, and means for supplying additional air jets above and below said nozzles in a direction to impinge upon said fuel jets.

20 10. A burner for pulverized fuel comprising a plurality of fuel nozzles spaced along a furnace wall, some of said nozzles being inclined downwardly with respect to the horizontal and intermediate nozzles being inclined upwardly with respect to the horizontal to provide adjacent oppositely inclined fuel jets, the downwardly inclined nozzles being mounted above the upwardly inclined nozzles whereby the fuel jets cross, means for providing an air jet between alternate nozzles in a direction to impinge upon said fuel jets, means for supplying additional air jets above and below said nozzles in a direction to impinge upon said fuel jets, and means for controlling the velocity of the air admitted above and below said nozzles whereby the direction of the burner flame may be varied.

30 11. In combination with a water-cooled furnace wall having a plurality of spaced water tubes, a burner comprising a plurality of nozzles disposed between said tubes and adapted to discharge jets of fuel, alternate nozzles being directed upwardly and the others of said nozzles being directed downwardly, and means for discharging jets of air in oppositely inclined directions so that a jet of air impinges against each jet of fuel.

40 12. In combination with a furnace wall, a burner for pulverized fuel comprising a fuel duct having a distributing nozzle extending substantially across said burner, a series of fuel nozzles associated with said distributing nozzle and extending through said furnace wall, and a spacing member, alternate fuel nozzles being disposed above and below said spacing member, the upper nozzles being downwardly inclined and the lower nozzles being upwardly inclined.

50 13. In combination with a furnace wall, a burner for pulverized fuel comprising a fuel duct having a distributing nozzle extending substantially across said burner, a series of fuel nozzles associated with said distributing nozzle and extending through said furnace wall, a spacing member, alternate fuel nozzles being disposed above and below said spacing member, the upper nozzles being downwardly inclined and the lower nozzles being upwardly inclined, means forming air passages adjacent said lower nozzles and between said upper nozzles and means forming additional air passages adjacent said upper nozzles and between said lower nozzles, said passages being

adapted to project air jets which impinge upon the fuel jets discharged from adjacent nozzles.

14. In combination with a furnace wall, a burner for pulverized fuel comprising a fuel duct having a distributing nozzle extending substantially across said burner, a series of fuel nozzles associated with said distributing nozzle and extending through said furnace wall, a spacing member, alternate fuel nozzles being disposed above and below said spacing member, the upper nozzles being downwardly inclined and the lower nozzles being upwardly inclined, means forming air passages adjacent said lower nozzle and between said upper nozzles and means forming additional air passages adjacent said upper nozzles and between said lower nozzles, said passages being adapted to project air jets which impinge upon the fuel jets discharged from adjacent nozzles, dampers for the upper and lower air passages, and means for independently adjusting said dampers.

15. In combination with a furnace wall, a burner for pulverized fuel comprising a fuel duct having a distributing nozzle extending substantially across said burner, a series of fuel nozzles associated with said distributing nozzle and extending through said furnace wall, a spacing member, alternate fuel nozzles being disposed above and below said spacing member, the upper nozzles being downwardly inclined and the lower nozzles being upwardly inclined, means forming a plurality of air passages above and below said spacing member, the upper air passages being downwardly inclined and the lower air passages being upwardly inclined, dampers for controlling the discharge of air therefrom, and means for selectively controlling the positions of the upper and lower dampers.

16. A burner for pulverized fuel comprising a fuel duct having a distributing nozzle extending substantially across said burner and a series of fuel nozzles associated with said distributing nozzle, a spacing member, alternate fuel nozzles being disposed above and below said spacing member, the upper nozzles being downwardly inclined and the lower nozzles being upwardly inclined, means forming a plurality of air passages above and below said spacing member, the upper air passages being downwardly inclined and the lower air passages being upwardly inclined, dampers for controlling the discharge of air therefrom, means for controlling the position of the upper dampers as a unit, and means for controlling the lower dampers as a unit.

17. A burner for pulverized fuel comprising a fuel duct having a distributing nozzle extending substantially across said burner and a series of fuel nozzles associated with said distributing nozzle, a spacing member, alternate fuel nozzles being disposed above and below said spacing member, the upper nozzles being downwardly inclined and the lower nozzles being upwardly inclined, means forming a plurality of air passages above and below said spacing member, the upper air passages being downwardly inclined and the lower air passages being upwardly inclined, dampers for controlling the discharge of air therefrom, means for controlling the position of the upper dampers as a unit and means for controlling the lower dampers as a unit, said last mentioned means comprising arms associated with said dampers, links interconnecting said arms, control rods for said links, and means located without the burner for independently operating said control rods.

18. A device for introducing pulverized fuel and

air through a furnace wall which comprises a plurality of fuel nozzle units, the nozzles of each unit being spaced along said wall, the alternate nozzles of each unit being oppositely inclined to the horizontal, and means forming air passages for directing inclined air jets through said wall in directions to impinge on the fuel jets discharged from said nozzles.

19. A device for introducing pulverized fuel and air through a furnace wall which comprises a plurality of nozzle units, the nozzles of each unit being spaced along said wall, the alternate nozzles of each unit being oppositely inclined to the horizontal, and means forming air passages for directing inclined air jets through said wall in directions to impinge on the fuel jets discharged from said nozzles, and means for controlling the velocity of air through said passages for varying the direction of the burner flame.

20. A burner for pulverized fuel comprising a row of spaced inclined fuel nozzles and inclined air ports between said fuel nozzles, and a second row of spaced inclined fuel nozzles and inclined air ports, the fuel nozzles and air ports of both rows terminating in a common surface, the air ports of one row being in vertical alignment with the fuel nozzles of the other row, said aligned ports and nozzles in the respective rows being inclined toward each other so that the air and fuel streams discharged therefrom intersect.

21. A burner for pulverized fuel comprising a row of spaced inclined fuel nozzles and inclined air ports between said fuel nozzles, a second row of spaced inclined fuel nozzles and inclined air ports, the fuel nozzles and air ports of both rows terminating in a common surface, the air ports of one row being in vertical alignment with the fuel nozzles of the other row, said aligned ports and nozzles in the respective rows being inclined toward each other so that the air and fuel streams discharged therefrom intersect, and additional air ports adjacent each of said rows and inclined toward said rows.

22. In combination with a water-cooled furnace wall having a plurality of spaced water tubes, a burner comprising a plurality of nozzles disposed between said tubes and adapted to discharge jets of fuel, some of said nozzles being inclined downwardly with respect to the horizontal and intermediate nozzles being inclined upwardly with respect to the horizontal to provide adjacent oppositely inclined fuel jets.

23. In combination with a furnace wall having a fuel burner port formed therein and a row of cooling fluid tubes uniformly spaced across said burner port to form transversely spaced discharge openings therebetween, a fluid fuel burner comprising a series of transversely spaced nozzles adjacent said cooling tubes and discharging through said discharge openings, a combustion air casing at the outer side of said furnace wall and surrounding said burner port, and means for passing air from said casing through said burner port between the streams of fuel discharged from said nozzles.

24. In combination with a furnace wall having a row of cooling fluid tubes spaced therealong to form spaced discharge openings therebetween, a fuel burner comprising a series of transversely spaced nozzles arranged to discharge through said discharge openings, means for supplying air to the burner, and means for passing air through said discharge openings between the streams of fuel discharged from said nozzles.

25. In combination with a furnace wall hav-

ing a fuel burner port formed therein, a fuel burner comprising a fluid fuel conduit having a fan-shaped distributing section terminating in a series of spaced nozzles arranged to discharge through said burner port, a combustion air casing at the outer side of said furnace wall and surrounding said burner port, and means for passing air from said casing through said burner port between and above and below the streams of fuel discharged from said nozzles.

26. In combination with a furnace wall having a fuel burner port formed therein and a row of cooling fluid tubes spaced across said burner port to form transversely spaced discharge openings therebetween, a fluid fuel burner comprising a fluid fuel conduit terminating in a series of transversely spaced nozzles adjacent said cooling tubes and discharging through said discharge openings, a combustion air casing at the outer side of said furnace wall and surrounding said burner port, and means for passing air from said casing through said burner port between and at opposite sides of the streams of fuel discharged from said nozzles.

27. In combination with a furnace wall having a fuel burner port formed therein and a row of cooling fluid tubes spaced across said burner port to form transversely spaced discharge openings therebetween, a fluid fuel burner comprising a fluid fuel conduit terminating in a series of transversely spaced nozzles adjacent said cooling tubes and discharging through said discharge openings, a combustion air casing at the outer side of said furnace wall and surrounding said burner port, and means for passing air from said casing through said burner port between and above and below the streams of fuel discharged from said nozzles.

28. In combination with a furnace wall having a fuel burner port formed therein and a row of cooling fluid tubes spaced across said burner port to form transversely spaced discharge openings therebetween, a fuel burner comprising a fluid fuel conduit terminating in a series of transversely spaced nozzles elongated longitudinally of said cooling tubes and discharging through said discharge openings, a combustion air casing at the outer side of said furnace wall and surrounding said burner port, and means for passing air from said casing through said discharge openings between the streams of fuel discharged from said nozzles.

29. In combination with a furnace wall having a fuel burner port formed therein and a row of cooling fluid tubes uniformly spaced across said burner port to form transversely spaced discharge openings therebetween, a fuel burner comprising a fluid fuel conduit having a fan-shaped distributing section terminating in a series of transversely spaced nozzles positioned between said cooling tubes and discharging through said discharge openings, a combustion air casing at the outer side of said furnace wall and surrounding said burner port, and means for passing air from said casing through said burner port between the streams of fuel discharged from said nozzles.

30. A fuel burner comprising a plurality of fuel nozzles spaced along a furnace wall, some of said nozzles being inclined to the plane of the wall in one direction and intermediate nozzles being in-

clined in another direction to provide adjacent oppositely inclined fuel jets, and means forming an air passage associated with each of said nozzles and arranged to provide an air jet which is inclined to the plane of the wall and is oppositely inclined to the corresponding fuel jet and impinges thereon.

31. A fuel burner comprising a plurality of fuel nozzles spaced along a furnace wall, some of said nozzles being inclined to the plane of the wall in one direction and intermediate nozzles being inclined in another direction to provide adjacent oppositely inclined fuel jets, means forming an air passage associated with each of said nozzles and arranged to provide an air jet which is oppositely inclined to the corresponding fuel jet and impinges thereon, and means for selectively controlling the velocity of the air jets to thereby vary the direction of the burner flame.

32. In combination with a furnace wall having a row of cooling fluid tubes spaced therealong to form spaced discharge openings therebetween, a fuel burner comprising a series of transversely spaced nozzles arranged to discharge through said discharge openings, some of said nozzles being inclined to the plane of the wall in one direction and intermediate nozzles being inclined in another direction to provide adjacent oppositely inclined fuel jets.

33. In combination with a furnace wall having a row of cooling fluid tubes spaced therealong to form spaced discharge openings therebetween, a fuel burner comprising a series of transversely spaced nozzles arranged to discharge through said discharge openings, some of said nozzles being inclined to the plane of the wall in one direction and intermediate nozzles being inclined in another direction to provide adjacent oppositely inclined fuel jets, and means forming an air passage associated with each of said nozzles and arranged to provide an air jet which is oppositely inclined to the corresponding fuel jet and impinges thereon.

34. In combination with a furnace wall having a row of cooling fluid tubes spaced therealong to form spaced discharge openings therebetween, a fuel burner comprising a series of transversely spaced nozzles arranged to discharge through said discharge openings, some of said nozzles being inclined to the plane of the wall in one direction and intermediate nozzles being inclined in another direction to provide adjacent oppositely inclined fuel jets, means forming an air passage associated with each of said nozzles and arranged to provide an air jet which is oppositely inclined to the corresponding fuel jet and impinges thereon, and means for selectively controlling the velocity of the air jets to thereby vary the direction of the burner flame.

35. In combination with a furnace wall having a fuel burner port and fluid tubes spaced across the port to form spaced openings therebetween, a fuel burner comprising a series of transversely spaced nozzles arranged to discharge through said openings, a combustion air casing at the outer side of said furnace wall and surrounding said port, and means for passing air from said casing through said discharge openings between the streams of fuel discharged from said nozzles.

MARTIN FRISCH.

CERTIFICATE OF CORRECTION.

Patent No. 2,229,068.

January 21, 1941.

MARTIN FRISCH.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, first column, line 2, for the word "pulverize" read --pulverized--; page 4, first column, line 27; claim 15, for "will" read --wall--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 18th day of February, A. D. 1941.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.