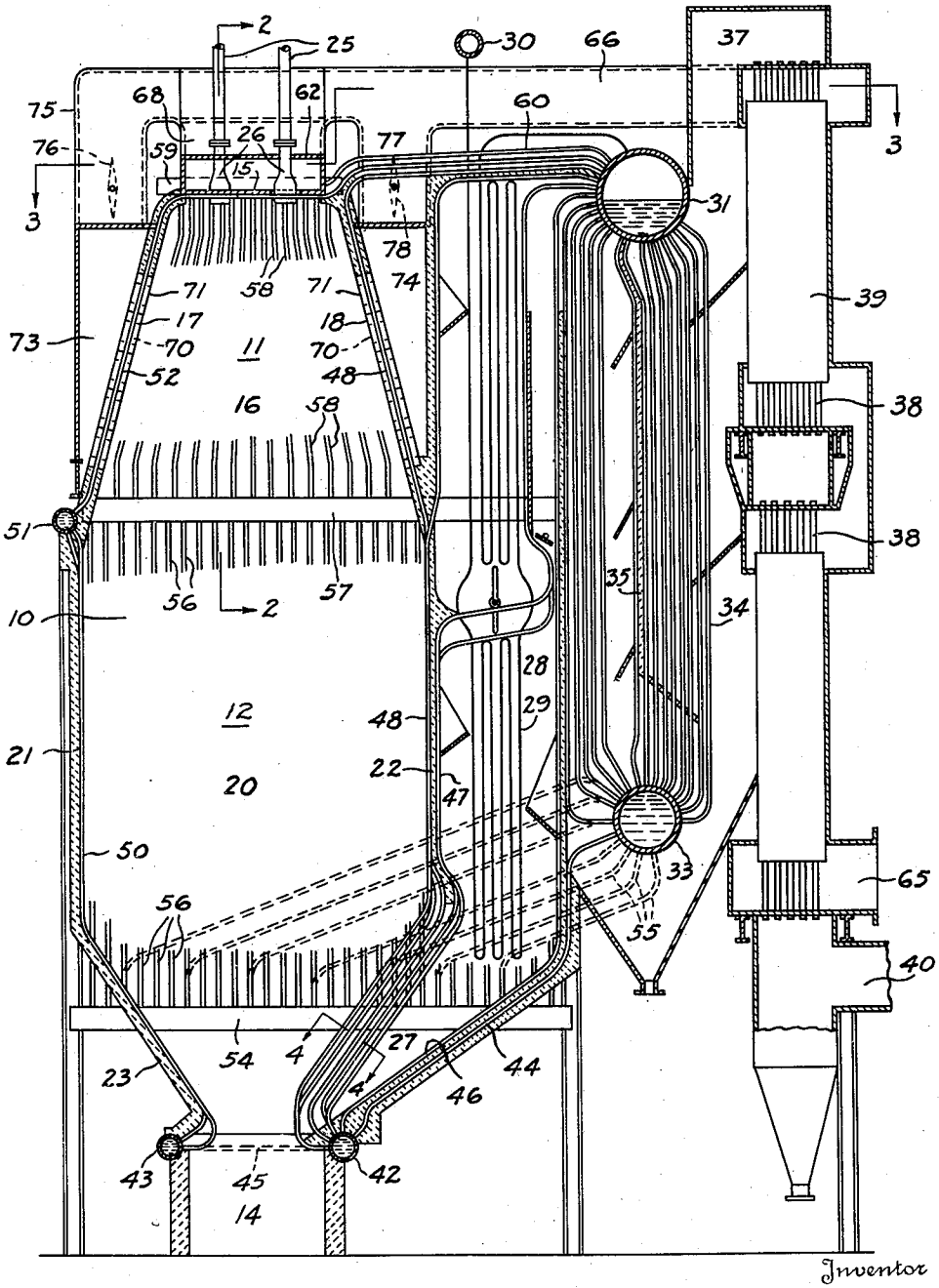
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FUEL BURNING APPARATUS

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Fig. 1

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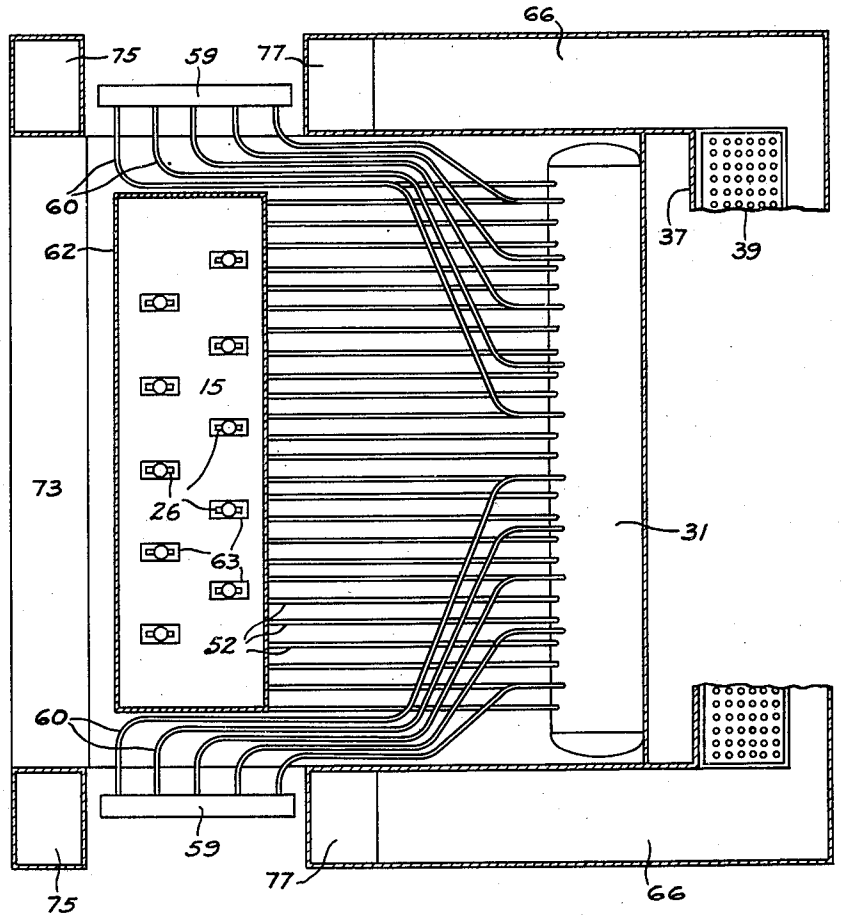


Fig. 3

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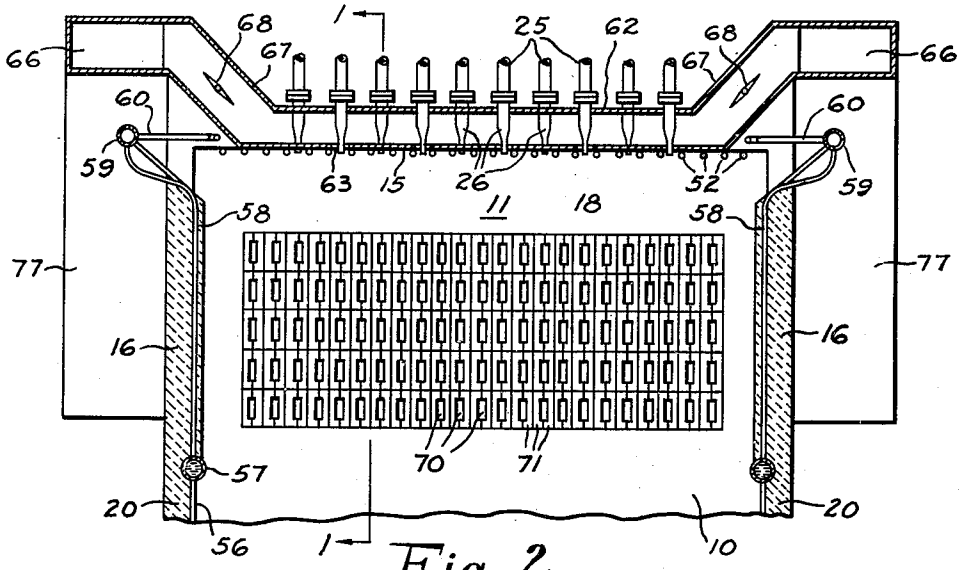


Fig. 2

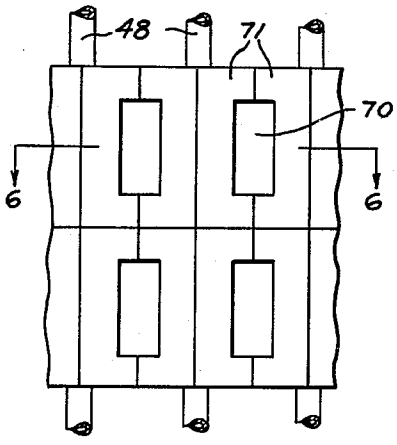


Fig. 5

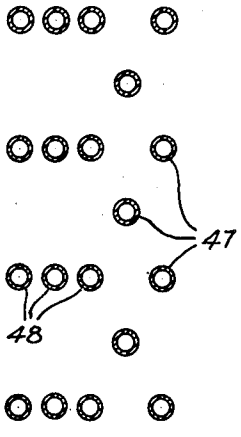


Fig. 4

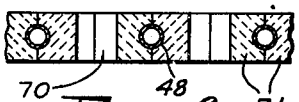


Fig. 6

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UNITED STATES PATENT OFFICE

2,498,761

FUEL BURNING APPARATUS

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Application March 21, 1945, Serial No. 583,959

4 Claims. (Cl. 122—235)

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This invention relates to fuel burning apparatus, and more particularly to apparatus arranged to produce steam by burning pulverized fuel in suspension.

It has been proposed heretofore to project pulverized fuel downwardly into the upper portion of a furnace chamber, and to conduct the hot gases from the lower portion of the furnace chamber rearwardly into contact with suitable heat absorbing surfaces, such as water tubes, for the generation of steam. This method of burning fuel is known as "down-shot firing." Some of the air required for combustion enters the furnace with the fuel, but the major part of the necessary air has been supplied through openings in the front wall of the furnace. In these prior steam generators many difficulties have been encountered in obtaining dependable ignition and complete combusion of the fuel. Considerable combustible material is deposited with the ash in the bottom of the furnace, and unburned carbon particles are carried out of the furnace by the hot gases. These troubles are particularly serious when burning pulverized anthracite.

It is accordingly one object of the invention to overcome these various difficulties and to provide a fuel burning apparatus arranged for the down-shot firing of pulverized fuel and capable of maintaining steady ignition and efficient combustion.

It is a further object of the invention to provide a fuel burning apparatus particularly suitable for the down-shot firing of pulverized anthracite and capable of burning such fuel in a dependable and efficient manner.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

Referring to the drawings illustrated one embodiment of the invention, and in which like reference numerals indicate like parts,

Fig. 1 is a vertical longitudinal section through a steam generator, taken on the line 1—1 of Fig. 2;

Fig. 2 is a section taken on the line 2—2 of Fig. 1;

Fig. 3 is a section taken on the line 3—3 of Fig. 1;

Fig. 4 is an enlarged fragmentary section taken on the line 4—4 of Fig. 1;

Fig. 5 is an enlarged fragmentary elevation showing the construction employed for the front and rear walls of the ignition chamber; and

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Fig. 6 is a section taken on the line 6—6 of Fig. 5.

The embodiment illustrated comprises a fuel burning furnace 10 which includes an ignition chamber 11, a combustion chamber 12 directly beneath the ignition chamber, and an ash pit 14 directly beneath the combustion chamber. The ignition chamber 11 is provided with a roof 15, side walls 16, a front wall 17, and a rear wall 18. The front wall 17 slopes downwardly and forwardly, and the rear wall 18 slopes downwardly and rearwardly, so that the ignition chamber flares downwardly. The combustion chamber 12 is provided with side walls 20, a front wall 21, and a rear wall 22. The lower portion 23 of the front wall 21 slopes downwardly and rearwardly to the ash-pit 14. A suitable fuel, such as pulverized anthracite, is transported in a current of primary air through pipes 25 to burners 26, which project the fuel downwardly through the roof 15 of the ignition chamber 11. These burners are arranged in two transverse rows in a staggered formation, and they are of the well-known "fish-tail" type with the larger dimension extending in a front to rear direction.

The hot gases escape rearwardly from the lower portion of the combustion chamber 12 through an outlet opening 27 located beneath the lower edge of the rear wall 22 and immediately above the ash pit 14. This opening 27 has an appreciable height and it extends throughout substantially the entire width of the combustion chamber, so that a large area is provided for the flow of gases at a comparatively low velocity. The opening 27 leads directly into the lower portion of an upright passage 28 located immediately to the rear of the furnace 10 and containing a superheater 29 formed of vertically looped tubes each of which is connected at one end to a discharge header 30 and at the other end to a transverse steam-and-water drum 31. This drum is located behind the upper portion of the passages 28. A transverse water drum 33 is provided beneath the drum 31, and these drums are connected by a bank of upright water tubes 34. A transverse baffle 35 extends downwardly from the upper drum 31, and the parts are so arranged that the gases will flow rearwardly from the upper end of the passage 28, then downwardly in contact with the water tubes in front of the baffle 35, and then upwardly in contact with the water tubes behind the baffle to a duct 37. From this duct 37 the gases travel downwardly through the tubes 38 of an air heater 39 and escape through a

duct 40 leading to a suitable induced draft fan or stack (not shown).

Water wall tubes are provided adjacent the various walls of the furnace 10 and of the passage 28. These tubes not only form efficient steam generating devices, but they also protect the walls from excessive heat and they aid in supporting the walls. For this purpose a transverse header 42 is provided adjacent the top of the rear wall of the ashpit 14, and a transverse header 43 is provided adjacent the top of the front wall of the ashpit. A row of downcomer tubes 44 connect the lower water drum 33 with the header 42. Tubes 45 connect the two headers 42 and 43, so that both headers are supplied with water in ample quantities.

A row of water tubes 46 extend upwardly and rearwardly from the rear header 42 along the bottom wall of the passage 28 and thence upwardly along the rear wall of the said passage to the upper drum 31. Water tubes 47 extend upwardly and rearwardly from the rear header 42 across the furnace outlet 27, along the rear side of the wall 22 and then upwardly through the passage 26 to the drum 31. Water tubes 48 extend upwardly and rearwardly from the rear header 42 across the furnace outlet 27 and along the front side of the wall 22, whereupon the tubes are divided so that some of them extend along the rear wall 18 of the ignition chamber 11 and others extend along the front wall of the passage 28, the upper ends of all these tubes being connected to the drum 31. The tubes 47 and 48 extend across the outlet 27 in the form of an upwardly and rearwardly inclined bank containing several rows of tubes, the tubes in each row being widely spaced (see Fig. 4) to provide a comparatively open screen through which the gases travel. A row of water tubes 50 extend upwardly from the front header 43, and along the sloping wall 23 and the upright front wall 21 of the combustion chamber to a transverse header 51 located adjacent the junction of the walls 21 and 17. A row of water tubes 52 extend upwardly from this header 51 adjacent the wall 17, thence rearwardly beneath the roof 15, and thence still further rearwardly to connect with the drum 31. Adjacent each side of the furnace there is provided a longitudinally extending lower header 54 which is supplied with water from the end portions of the lower drum 33 by means of feeder tubes 55. Water wall tubes 56 extend upwardly from each header 54 to an intermediate header 57 near the top of the wall 20, and from this intermediate header other water wall tubes 58 extend upwardly adjacent the wall 16 to an upper header 59. The upper headers 59 are connected to the drum 31 by means of releaser tubes 60. As shown in Fig. 2, the water wall tubes 58 are preferably covered with refractory material in order to avoid undue cooling of the ignition chamber 11, but for clearness of illustration the end portions of these tubes have been shown in full in Fig. 1. The portions of the tubes 48 and 52 associated with the front and rear walls 17 and 18 of the ignition chamber are likewise covered with refractory material.

The air for combustion of the fuel is supplied in a new and highly advantageous manner. The burners 26 are enclosed in an air pressure chamber 62, the roof 15 forming the bottom wall of this chamber, and this roof is provided with openings 63, generally rectangular in shape, through which the burner nozzles extend. These openings 63 are somewhat larger than the nozzles so that air may be blown downwardly around the fuel jets. This air may be described as secondary air, and the air which carries the fuel through the pipes 25 to the burners may be described as primary air. Air may be supplied under pressure from a suitable forced draft fan (not shown) to the inlet 65 of the air heater 39, and after traveling upwardly through the air heater this air will flow forwardly through two ducts 66 extending along opposite sides of the furnace. Branch ducts 67 (Fig. 2), provided with dampers 68, connect the ducts 66 with the ends of the air chamber 62. The front and rear walls 17 and 18 of the ignition chamber 11 are provided with a multiplicity of openings 70 through which air may enter to complete the combustion of the fuel, and this air may be described as tertiary air. These air openings are distributed both vertically and horizontally over a considerable area of each of the sloping walls 17 and 18. Preferably these openings 70 are formed by special blocks 71 of refractory material which interlock with the adjacent water tubes, as shown particularly in Figs. 5 and 6. In order to supply air to these openings 70, an air chamber 73 is provided directly in front of the wall 17, and an air chamber 74 is provided directly behind the wall 18, between the said wall and the gas passage 28. The chamber 73 is connected to the air ducts 66 by branch ducts 75 provided with dampers 76, and the chamber 74 is connected to the air ducts 66 by branch ducts 77 provided with dampers 78.

The operation of the invention will now be apparent from the above disclosure. Streams of pulverized fuel and primary air flow through the pipes 25 and are discharged downwardly from the burner nozzles 26 into the ignition chamber 11. Since the walls of this chamber are lined with refractory material, a comparatively high temperature will be maintained and ignition will take place promptly. Ignition will also be facilitated by the fact that a relatively small portion of the total air required for combustion enters with the fuel. Air from the preheater 39 flows forwardly through the ducts 66 and thence through the branch ducts 67 (under the control of the dampers 68) into the chamber 62, whence it is discharged downwardly as secondary air through the openings 63 around the burners. Air also flows from the ducts 66 through the branch ducts 75 and 77 (under control of the dampers 76 and 78) to the chambers 73 and 74 respectively. From these chambers this air enters the ignition chamber as tertiary air through the openings 70 in the front and rear walls of the ignition chamber, and mixes with the fuel to complete its combustion during the flow downwardly through the combustion chamber 12. This mixing is facilitated by reason of the staggered burner arrangement, since this allows air to flow into direct contact with both the front and the rear portions of each fuel jet, in addition to the lateral portions thereof. Most of the ash is deposited directly in the ash pit 14. The hot gases travel rearwardly at a relatively low velocity past the lower portions of the water tubes 46 and 47 and through the opening 27 into the passage 28. Some of the ash will be carried out of the combustion chamber by the gases, and a large part of this so-called "fly ash" will be deposited on the inclined floor of the passage 28 and slide forwardly along this floor into the ash pit. As the gases travel upwardly through the passage 28 they will make contact with the super-

heater 29. The gases will then make one downward pass and one upward pass in contact with the water tube bank 34, after which they will travel downwardly through the air heater tubes 38 and escape through the outlet 40. Steam will be generated in the water tubes 46, 47, 48, 50, 52, 56 and 58, and this steam will be delivered to the drum 31 and thence to the superheater 29. An ample supply of water will be delivered from the drum 33 to the lower ends of the steam generating tubes through the down-comer tubes 44, 45 and 55.

Since air is supplied through both the front wall 17 and the rear wall 18, both the front portion and the rear portion of the flame envelope are in contact with air. This is of the greatest importance, since it makes possible the completion of combustion during the downward travel of the fuel and before the gases pass through the opening 27 into the passage 28. Consequently the losses resulting from unburned carbon will be very low. Furthermore, there will be no danger of injuring the superheater 29 by reason of delayed combustion in the passage 28. The ignition chamber 11, with its refractory lined walls, acts as a heat-reflecting retort which maintains a very high temperature and greatly facilitates prompt ignition of the fuel. The invention is accordingly well adapted for burning low volatile fuels, such as anthracite.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. Fuel burning apparatus comprising walls forming an ignition chamber and including a front wall and a rear wall, and means to project fuel downwardly into the ignition chamber for combustion in suspension, the front wall sloping downwardly and forwardly and the rear wall sloping downwardly and rearwardly, the said front and rear walls including water tubes and

blocks of refractory material mounted on the water tubes to shield them from the heat of the combustion, and the said blocks being shaped to provide openings for the admission of air to the fuel from opposing directions.

2. Fuel burning apparatus as set forth in claim 1, in which the fuel projecting means is in the form of two transverse rows of burners extending along the top of the ignition chamber, the burners in one row being staggered relative to the burners in the other row, so that the air admitted through the specified air openings may have direct access to each fuel jet from both the front and the rear.

3. Fuel burning apparatus as set forth in claim 1, in which the specified water tubes extend upwardly along the sloping front and rear walls, and the tubes in each of said walls are spaced apart with the refractory blocks located between them.

4. Fuel burning apparatus as set forth in claim 1, in which the specified air openings are distributed both vertically and horizontally over a considerable area of each of the front and rear walls.

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