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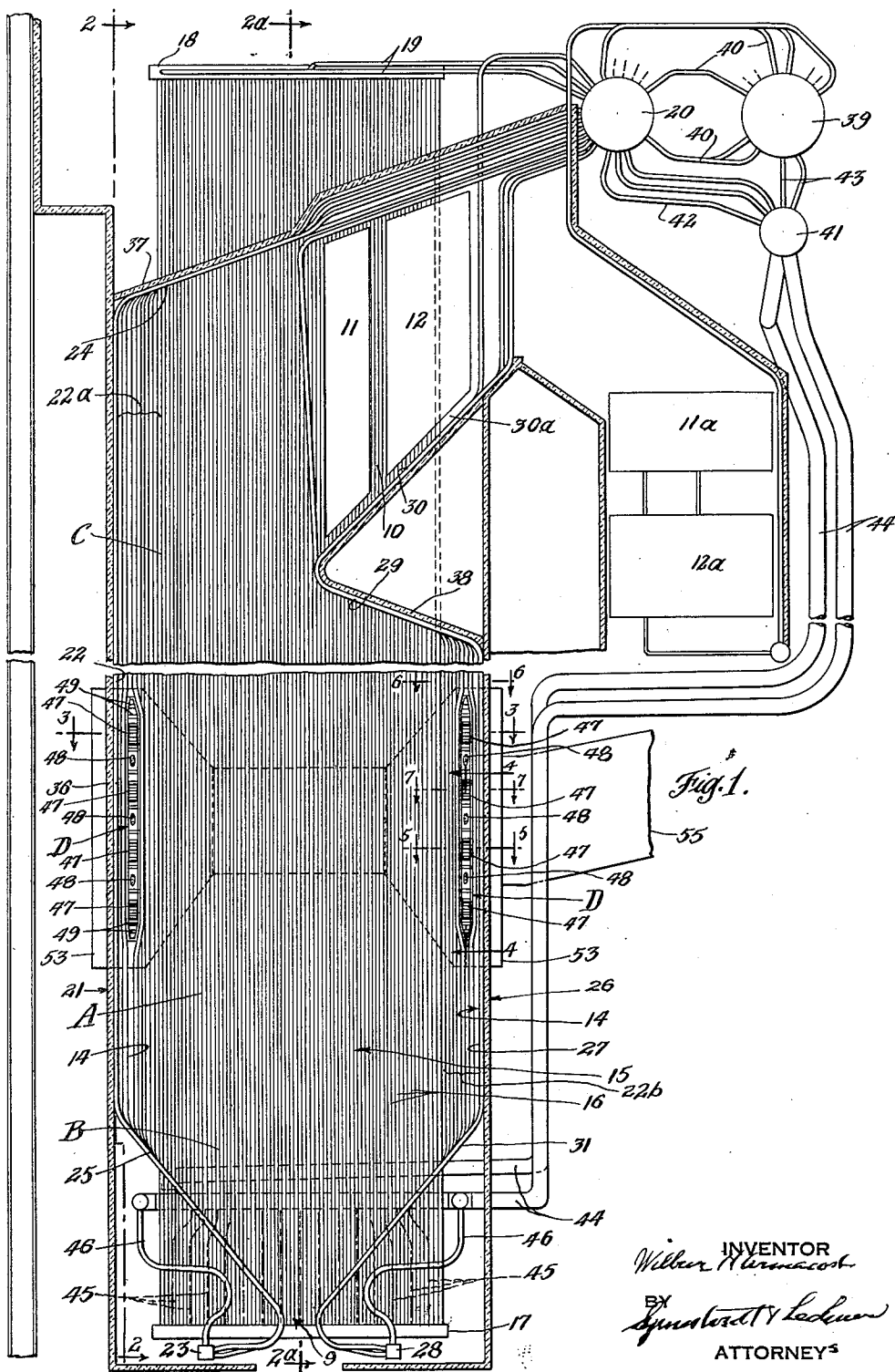
W. H. ARMACOST

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BOILER FURNACE

Filed March 16, 1950

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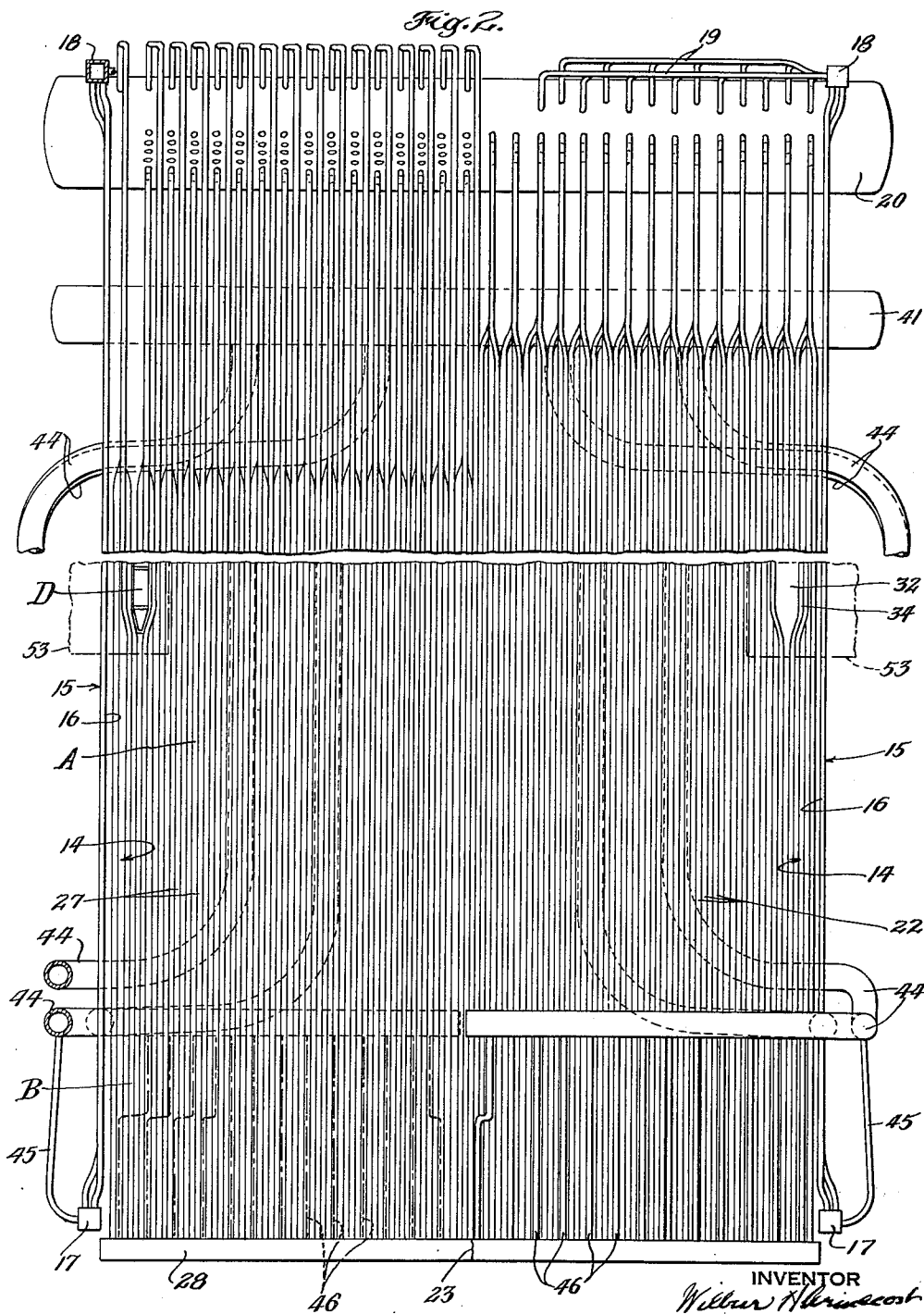
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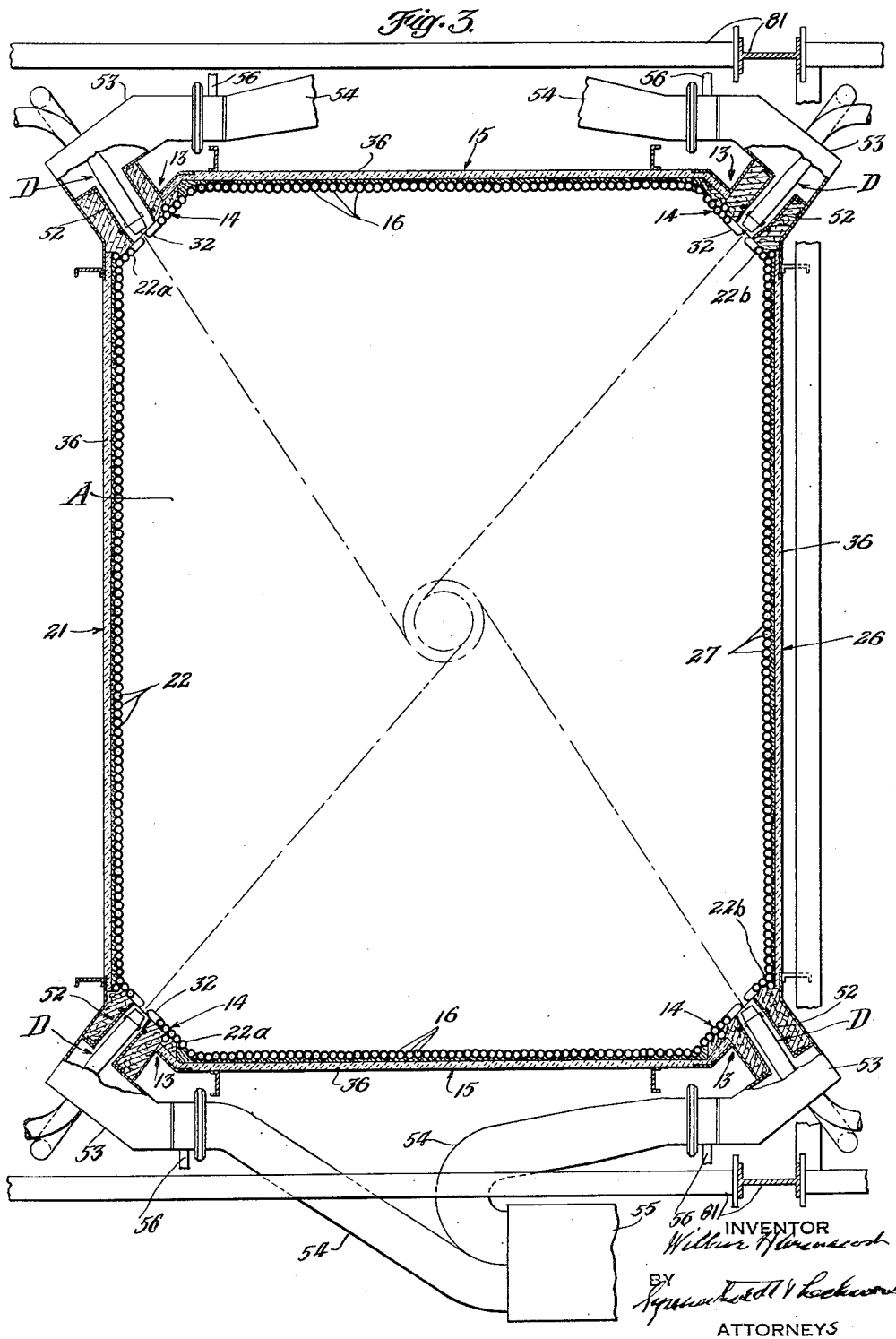
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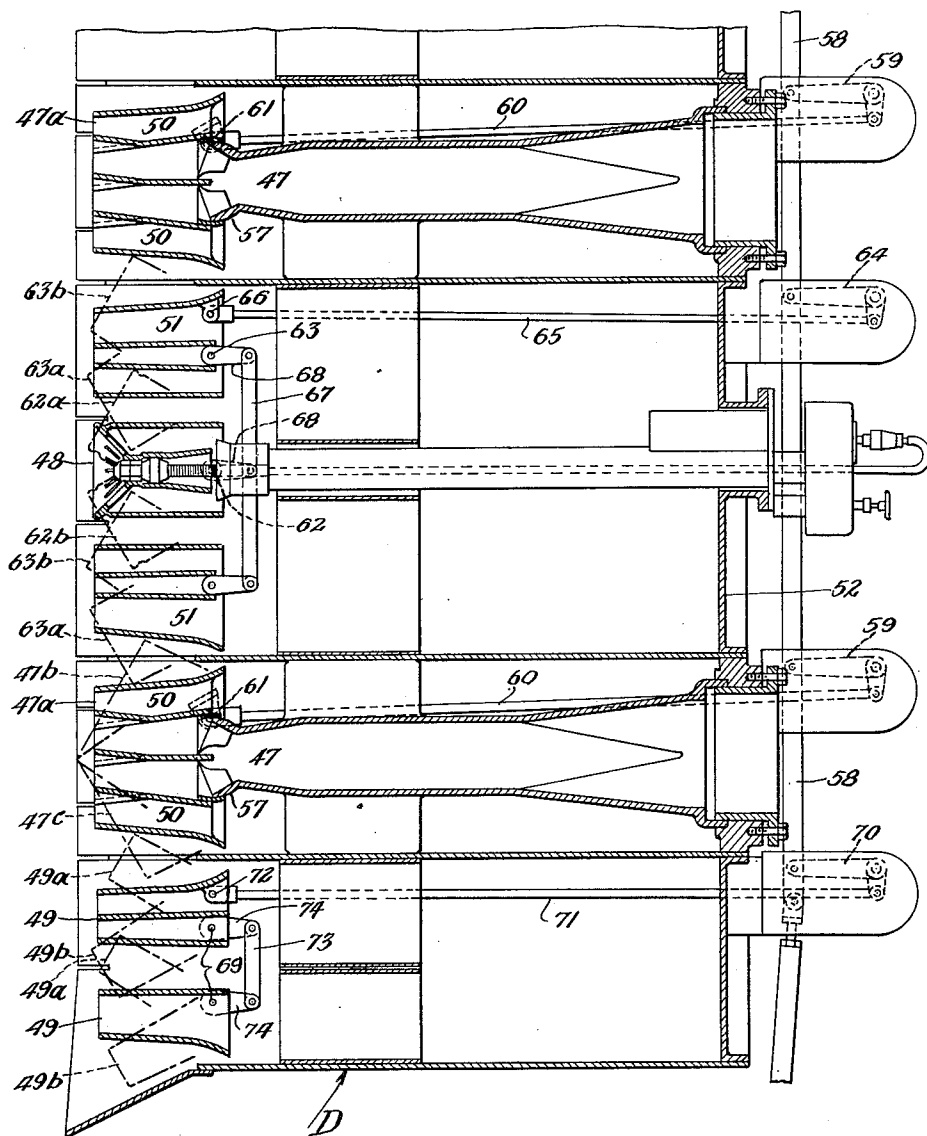
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Fig. 4.



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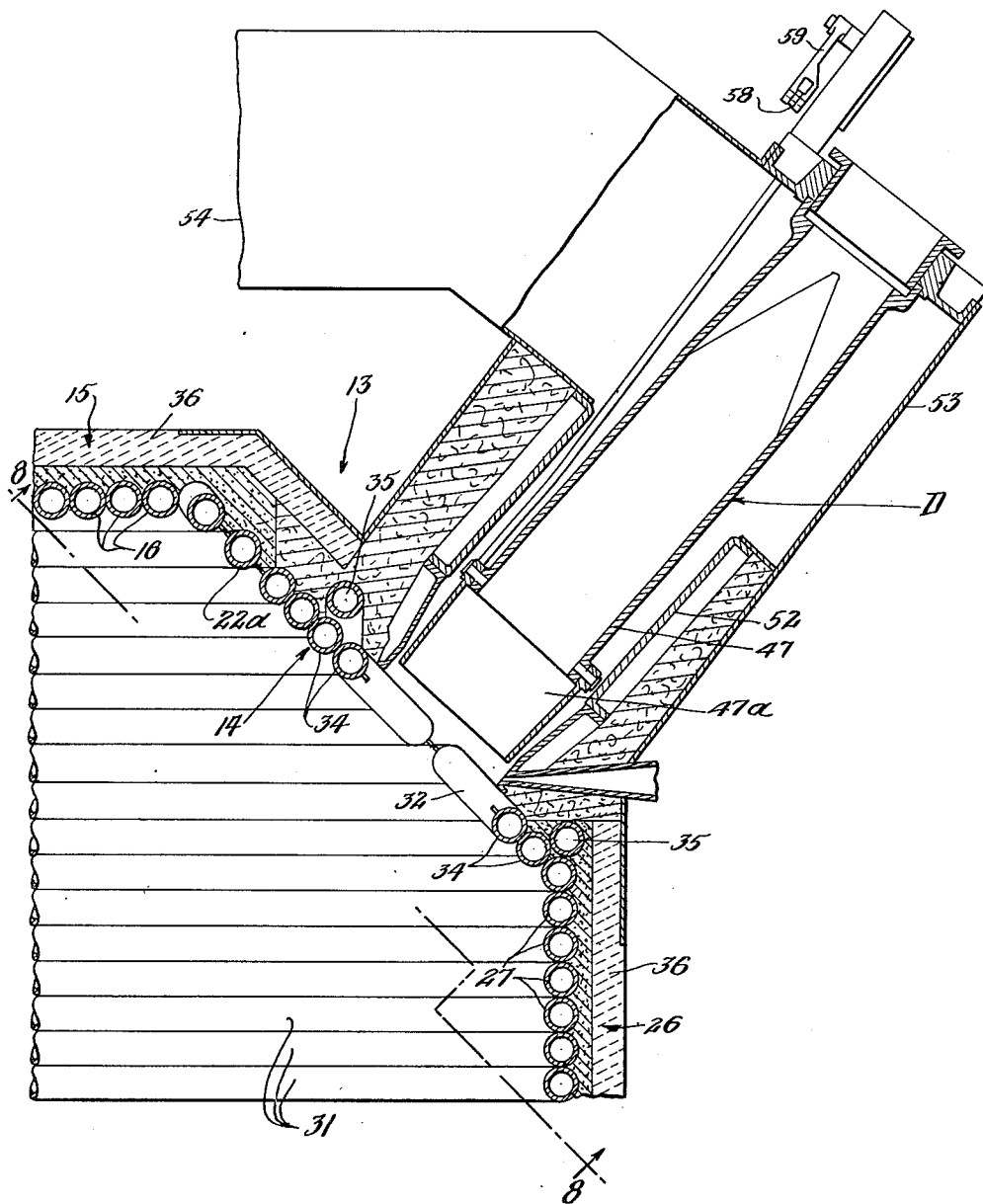
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Fig. 5.



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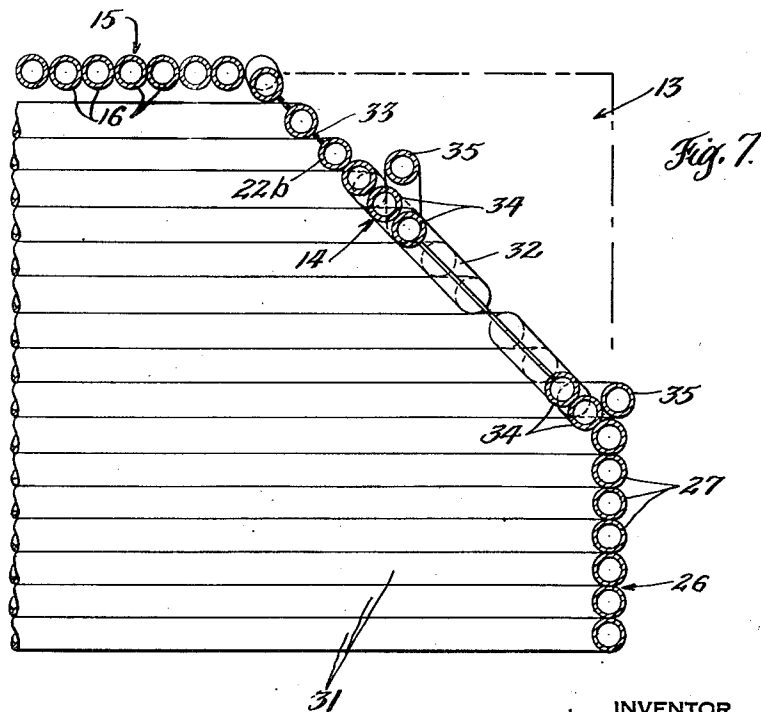
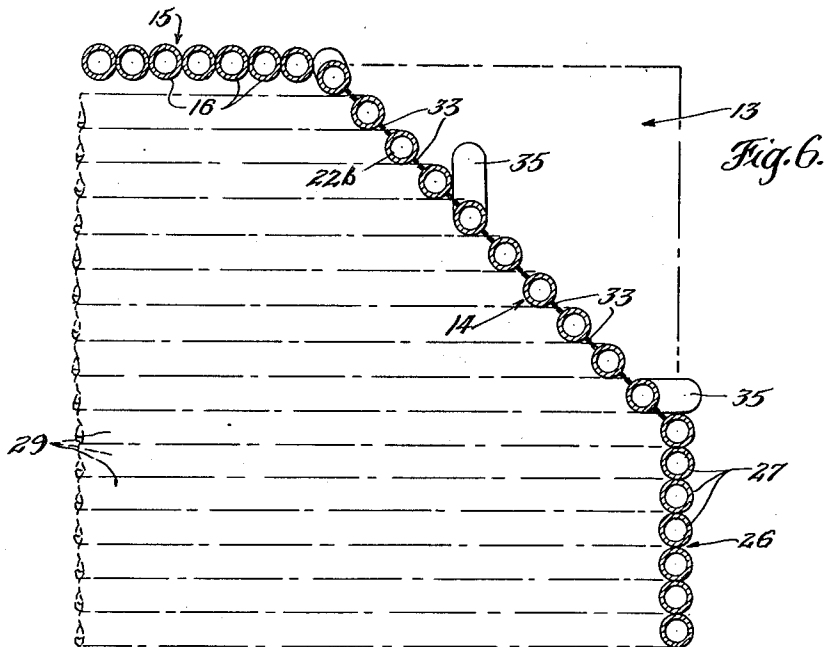
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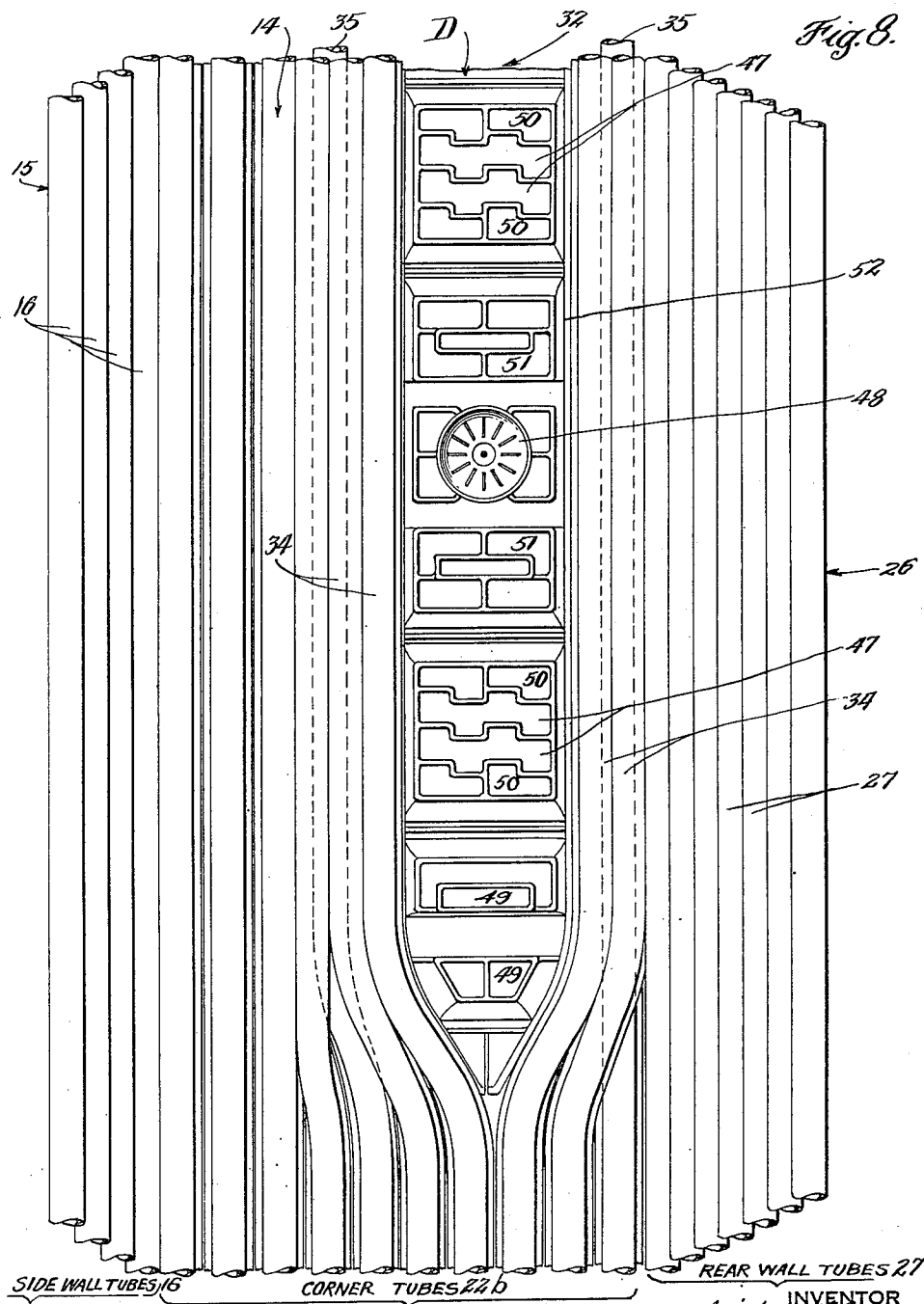


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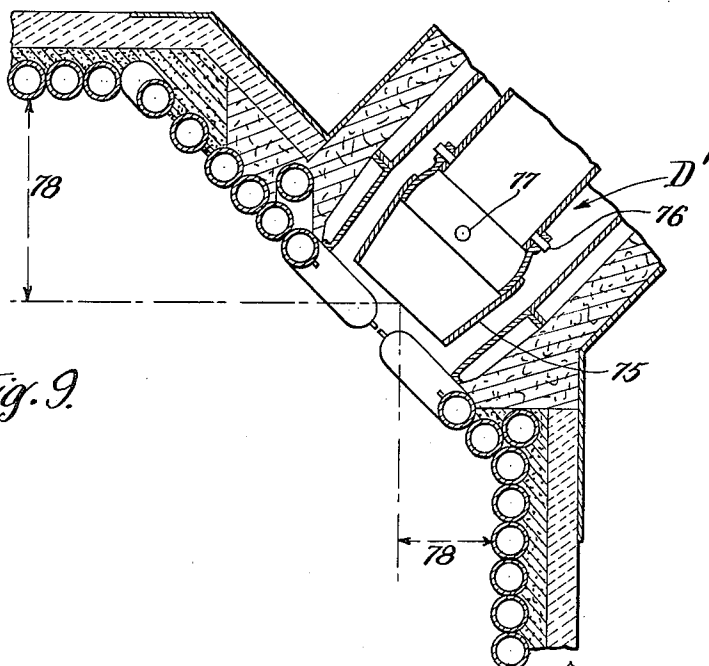


Fig. 9.

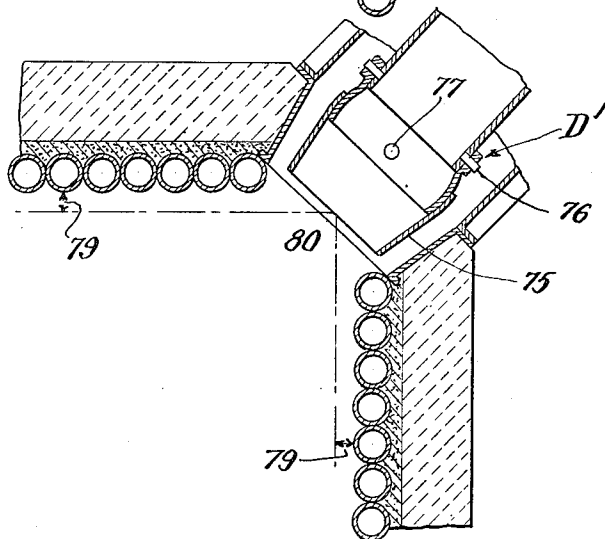


Fig. 10.

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BOILER FURNACE

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10 Claims. (Cl. 122—333)

This invention relates to steam generating boiler furnaces in which the steam generating surfaces are largely subject to radiant heat and in which so-called tangential firing of the fuel is employed.

The primary object of my invention is the provision of a high capacity steam generating installation employing a furnace or combustion chamber lined with radiant heat tubes in which wide flexibility of flame control and wide angle of flame adjustment to meet varying operating conditions may be procured without encountering objectionable fuel and flame impingement on the tubular walls of the furnace and other difficulties and while securing superheat temperature control and other advantages hereinafter set forth.

How the foregoing, together with such other objects and advantages as may hereinafter appear, or are incident to my invention, are realized is illustrated in the following drawings, in which—

Fig. 1 is a broken out vertical sectional view of a steam generating boiler furnace constructed in accordance with my invention;

Fig. 2 is an enlarged broken out vertical elevational view with the right hand half of the view looking in the direction of the arrows 2—2 of Fig. 1 and with the left hand half of the view being a section taken substantially on the line 2a—2a of Fig. 1;

Fig. 3 is an enlarged horizontal section taken substantially on the line 3—3 of Fig. 1 but with certain burner and air casing parts in full view;

Fig. 4 is an enlarged vertical sectional view of a portion of one of the burners taken substantially on the line 4—4 of Fig. 1;

Fig. 5 is a fragmentary horizontal section taken substantially on the line 5—5 of Fig. 1;

Fig. 6 is a fragmentary horizontal section taken substantially on the line 6—6 illustrating the corner tube arrangement;

Fig. 7 is a view similar to Fig. 6 but showing the tube arrangement at the burner opening and taken substantially on the line 7—7 of Fig. 1;

Fig. 8 is a fragmentary vertical face view looking toward a corner burner as indicated by the line 8—8 of Fig. 5;

Fig. 9 is a fragmentary sectional view similar to Fig. 5; and

Fig. 10 is a view similar to Fig. 9.

The boiler furnace is rectangular in cross section and comprises, in general, a combustion chamber A having a basket-bottom portion B with a bottom discharge opening 9, and an upper throat portion C having an outlet portion 10. Hot gaseous products of combustion pass downwardly from the outlet portion 10 and finally to the stack (not shown). Superheaters and reheaters 11, 11a, 12 and 12a are desirably located as indicated in Figure 1.

The combustion chamber is lined with radiant heat tubes and is provided with burners D at the corners arranged for tangential firing. The particular construction of the combustion chamber, combined with adjustable burners, enables me to obtain, inter alia, wide latitude of flame control without flame impingement on the walls, and enables the positioning of structural work such as columns close to the installation at the corners without interference with the burners, all as will appear hereinafter.

Before describing the invention in detail, particular attention is called to the fact that the corners 13 of the

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boiler furnace, as viewed in Figs. 3, 5, 6 and 7 are cut away to provide substantial flat corner surfaces or walls 14 at which the burners D are located. For convenience of description these corners will be referred to hereinafter as "cut off corners."

The side walls 15 of the furnace are lined with closely spaced upright radiant heat wall tubes 16 connected at their lower ends into bottom headers 17 and at their upper ends into top headers 18. As will be seen in Fig. 3, the rows of these tubes extend across the side walls of the furnace from edge to edge of the cut-off corners. A plurality of connecting tubes 19 lead from the headers 18 to a steam and water drum 20.

The front wall 21 of the furnace is lined with closely spaced upright radiant heat wall tubes 22, connected at their lower ends into a bottom header 23 and at their upper ends, after inclining upwardly at 24 across the top of the furnace, into the steam and water drum 20. The lower portion of these front wall tubes incline downwardly and inwardly at 25 to form the front of a basket-bottom for the furnace. It is to be noted that a group of the front wall tubes 22a, see Figs. 1 and 3, at each end are arranged to line the corner surfaces 14 of the cut-off corners. The tubes of these groups have their lower end portions bent downwardly and inwardly to line up with the tube portions 25 above mentioned so as to complete the front of the basket-bottom from side wall to side wall of the furnace. At their lower ends these tubes connect into the bottom header 23 which extends for the full width of the furnace. At their upper end portions the tubes of these groups are bent to incline upwardly in line with the upper portions 24 of the front wall tubes 22 for connection into the drum 20.

Certain of these corner tubes are bent or bowed to provide openings 32 for the burners D, while the remaining tubes are straight. It will be noted that because of the diagonal width of the corner surfaces 14, a space develops between the tubes, and in order to provide a complete metallic surface at these corners longitudinally extending fins 33 are provided on the tubes as shown in Fig. 6 for example.

The rear wall 26 of the furnace is lined with closely spaced upright radiant heat tubes 27 connected at their lower ends into a bottom header 28 and at their upper ends (after inclining upwardly and inwardly to form an arch 29, then upwardly and rearwardly to form the bottom 30 of a superheater space 30a, and then upwardly again) into the upper steam and water drum 20. The lower portion of these rear wall tubes inclines downwardly and inwardly at 31 to form the rear of the basket-bottom for the furnace. In a manner similar to that described above in connection with the front wall, a group of the rear wall tubes 22b (see Figs. 1, 3, 6, 7 and 8) at each end are arranged to line the corner surfaces 14 of the cut-off corners. The tubes of these groups have their lower end portions bent downwardly and inwardly to line up with the tube portions 31 so as to complete the rear of the basket-bottom of the furnace from side wall to side wall of the furnace. At their lower ends these tubes connect into the bottom header 28 which extends for the full width of the furnace. At their upper end portion the tubes of these groups bend in the same manner as the rear wall tubes 26 and then connect into the drum 20.

Referring to Figs. 5—7 and 8 which show the tube arrangement at the burner openings, it will be seen that the bowed portions 34 of several of the tubes at each side of the opening come into close contact and that several of the tubes are bowed rearwardly at the opening, as at 35.

The wall tubes are desirably lined on the outside with refractory material 36 and refractory material 37 and 38 is provided on the roof and arch portions of the tubes.

The upper drum 20 is interconnected with a rear drum 39 by means of a plurality of circulating tubes 40 and to a lower drum 41 by a plurality of circulating tubes 42. The drums 39 and 41 are connected by means of a plurality of circulating tubes 43. A plurality of downcomer tubes 44 lead from the lower drum 41 to the lower portion of the installation and from the lower portion of these tubes a plurality of downcomer tubes 45 and 46 lead to the bottom headers 17, 23 and 28.

Reverting now to the tubular wall construction, it is to be noted that by employing the cut-off corner arrangement described I am enabled, inter alia, to reduce the number of tubes in the side walls by grouping the corner tubes with the tubes of the front and rear walls, thus enabling the use of short headers for the side walls as contrasted with the longer headers for the front and rear walls.

The burners D, of which there is one for each corner of the installation, comprise in general a plurality of tiltable air nozzles and a plurality of tiltable fuel nozzles arranged alternately in vertically spaced relation, the number of nozzles employed being determined by the size of the installation. In this particular instance, I employ a plurality of fuel nozzles 47 for burning pulverized fuel and a plurality of fuel nozzles 48 for burning oil, and upon inspection of Fig. 1 it will be seen that each burner has four pulverized fuel nozzles 47 and three oil nozzles 48. At the bottom and top of the burner, tiltable air nozzles 49 are provided. Each pulverized fuel nozzle 47 has air nozzles 50 in the nozzle tip and movable therewith; and the oil nozzles 48 each have tiltable air nozzles 51 associated and movable therewith as clearly shown in Fig. 4.

All of the nozzles are supported in a burner casing 52, the outlet ends of which register with the burner openings 32 in the angular corner surfaces 14 of the furnace. The casings 52 and fuel nozzles are so positioned that tangential firing is obtained as clearly indicated by the dot and dash lines in Figure 3.

The burner casings 52 are housed in air casings or wind boxes 53 which have connection by means of conduits 54 with air ducts 55 leading from a source of preheated air such as a regenerative air heater located in the furnace off-take. Suitable dampers indicated at 56 in Fig. 3 are associated with each wind box to provide for air control.

Control and latitude of firing is obtained by employing the tiltable nozzles above described, the construction and operation of which are as follows:

The nozzle tips 47a of the pulverized fuel nozzles 47 have pivotal connection with the nozzles at 57 so that they can be tilted through the range indicated by the dot and dash positions 47b and 47c. Adjustment to the desired position of tilt is obtained by means of an operating bar 58 connected to a bell crank 59 which in turn is connected to a link 60 having connection with the nozzle tip 47a at 61.

The oil burner nozzles 48 are pivotally mounted at 62 and the air nozzles 51 associated therewith are pivotally mounted at 63 so that they can be tilted through the ranges indicated by the dot and dash position 62a and 62b and 63a and 63b. Adjustment to the desired position of tilt is obtained by means of the operating bar 58 connected to the bell crank 64 which in turn is connected to a link 65 having connection with the air nozzle 51 at 66. The two air nozzles 51 and the oil burner nozzle 48 are interconnected by means of a link 67 and levers 68.

The air nozzles 49 are pivotally mounted at 69 so that they can be tilted through the range indicated by the dot and dash position 49a and 49b. Adjustment to the desired position of tilt is obtained by means of the operating bar 58 connected to the bell crank 70 which in turn is connected to a link 71 having connection with the upper air nozzle 49 at 72. This upper air nozzle 49 is connected to the lower nozzle 49 by means of a link 73 and levers 74.

It is to be observed that by mounting the burners D in the set-in angular corner wall portions 14 of the combustion chamber, see particularly Figs. 5 and 9, the burner tips extend well into the combustion chamber with the result that the fuel streams discharging therefrom are spaced from the adjacent walls of the chamber. This is very advantageous from the standpoint of flexibility of firing because I am thus enabled to employ a flame ranging from a narrow to a very wide angle without flame impingement on the walls.

In order that the advantages to be realized through the practice of my invention may be better understood, I have illustrated, more or less diagrammatically, a comparison of my arrangement, see Fig. 9, with the usual arrangement of corner firing, see Fig. 10.

In Figs. 9 and 10 I have illustrated burners D' having nozzle tips 75 which, in addition to being adjustable up and down on pivots 76, are also adjustable from side to side on pivots 77, thus enabling universal adjustment of the tips. In Fig. 9 I have indicated at 78 the distance that the center of discharge of the burners is from the furnace wall in my arrangement, while in Fig. 10 I have indicated at 79

the distance that the center of discharge of the burners could be from the furnace walls when employing the usual arrangement of burners for corner firing. It will thus be observed that with my arrangement it is possible to employ an adjustable burner to produce a wide angle of flame without flame impingement on the walls, while with the previous arrangement as exemplified in Fig. 10, adjustment of the burner for a wide angle of flame would cause flame impingement on the walls.

Another advantage of my arrangement resides in the fact that, by employing the flattened corners, I eliminate the relatively cold or dead areas of the conventional sharp V corners, such as are present at 80 in the arrangement of Fig. 10. Thus the collecting of coked unburned fuel on the corner surfaces, which is an incident to the arrangement of Fig. 10, is avoided.

My arrangement is also advantageous in that by employing cut-off corners, the burners and associated casings can be set in close to the furnace, thus giving ample clearance on the outside for the location of structural columns and beams close to the sides of the furnace without interfering with the burners as clearly shown at 81 in Fig. 3.

The provision of the flattened corners and the location of the burner tips closely adjacent thereto shortens the distance from the burner tips to the center of the furnace. This ensures turbulence of the fuel and flame streams in all positions of burner adjustment. With the burners in mid position, vertically and laterally, the turbulence will be at a maximum for any given velocity of fuel and air admission, and will be reduced somewhat as the burners are shifted from such position, sidewise or up and down.

With turbulence at the maximum, the intensity of the flame and therefore its temperature is at the greatest, decreasing as adjustment is made of the burners from said position. By vertical adjustment, the body of flame is lowered or raised as the case may be. Thus, by virtue of the flexibility of flame control and flame location, a variety of operating conditions may be met while ensuring effective combustion and control of superheat temperatures, and without encountering the difficulties which would be encountered if the wall tubes were substantially impinged by the fuel and flame streams.

While the invention has been described in connection with an installation using pulverized fuel as the primary fuel, it is to be understood that the advantages to be realized through the practice of the invention will be realized when other fuels are used, such as oil or gas.

I claim:

1. In a steam generating boiler furnace, the combination of an interiorly unobstructed combustion chamber having its walls lined with closely spaced upright radiant heat tubes, said combustion chamber being generally rectangular in cross section with its four corners cut at an angle to provide substantially cut-off corner wall portions set in a substantial distance from the theoretical, projected corners of the combustion chamber, radiant heat tubes lining said corner wall portions, said corner wall portions having burner openings therein, and fuel burners for introducing fuel into said combustion chamber through said openings to provide tangential firing, said fuel burners comprising casing structure mounted in said corner wall portions at said openings, fuel and air nozzles mounted in said casing structure with their discharge ends extending well into said openings, and adjustable tips for said nozzles for controlling fuel and air admission into the combustion chamber, the extent of the cut off at the corners and the location of the adjustable burner tips being such that in no position of adjustment of the tips will there be impingement of the fuel and flame stream of the radiant heat wall tubes.

2. In a steam generating boiler furnace, the combination of a combustion chamber generally rectangular in cross section and having its walls lined with closely spaced upright radiant heat tubes, substantial cut-off wall portions at the corners of said combustion chamber having burner openings therein, upright radiant heat tubes lining said angular wall portions, and fuel burners mounted at said openings and extending well thereinto for introducing fuel into said combustion chamber to provide tangential firing, said fuel burners comprising air and fuel nozzles mounted with their discharge ends at said fuel openings, and adjustable tips for said nozzles for controlling fuel and air admission into the combustion chamber, the extent of the cut off at the corners and the location of the adjustable burner tips being such that in no position of

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adjustment of the tips will there be impingement of the fuel and flame stream of the radiant heat wall tubes.

3. In a steam generating boiler furnace, the combination of a combustion chamber generally rectangular in cross section with its corners formed to provide substantial cut-off corner wall portions, upright radiant heat tubes lining the walls of said combustion chamber including said cut-off corner wall portions, said flattened-corner wall portions having burner openings therein, and burners for introducing fuel through said openings into the combustion chamber to provide tangential firing, said burners including adjustable nozzles the discharge ends of which lie closely adjacent the plane of said fuel openings for introducing fuel with wide latitude of flame adjustment, the extent of the cut-off at the corners and the position of the adjustable burner nozzles being such that in no position of adjustment of the latter will there be impingement of the fuel and flame stream on the radiant heat tubes.

4. In a steam generating boiler furnace, the combination of a combustion chamber generally rectangular in cross section, fuel burners mounted at the corners of said combustion chamber for introducing fuel tangentially into said chamber, said burners having nozzles extending well into the combustion chamber at said corners, substantial cut-off corner wall portions for said combustion chamber cutting the corners thereof and having fuel openings in registry with said nozzles, upright radiant heat tubes lining the walls of the combustion chamber including said corner wall portions, and means for adjusting said nozzles for flame control, the extent of the cut-off at the corners and the position of the burner nozzles being such that in no position of adjustment of the burner nozzles will there be impingement of the fuel and flame stream on the radiant heat tubes.

5. A steam generating boiler furnace comprising in combination a combustion chamber generally rectangular in cross section having side walls, a front wall, a rear wall, and substantial corner wall portions cutting its corners, upright radiant heat tubes lining said side walls, lower headers into which the lower ends of the side wall tubes are connected, upper headers into which the upper ends of the side wall tubes are connected, upright radiant heat tubes lining said front and rear walls, upright radiant heat tubes lining said corner wall portions, a lower header into which the lower ends of the front wall tubes are connected and into which the lower ends of the corner wall tubes adjacent the front wall tubes are connected, a lower header into which the lower ends of the rear wall tubes are connected and into which the lower ends of the corner wall tubes adjacent the rear wall tubes are connected, an upper drum into which the upper ends of said front, rear, and corner tubes are connected, and burner means mounted in said corner wall portions extending well within the theoretical projected corners formed by the walls of the combustion chamber for introducing fuel into said combustion chamber tangentially, said burner means being adjustable to alter the delivery of fuel therefrom, the extent to which the corner wall portions cut the corners of the combustion chamber and the location of the adjustable burner means being such that in no position of adjustment of the latter will there be impingement of the fuel and flame stream on the radiant heat tubes.

6. A steam generating boiler furnace comprising in combination a combustion chamber generally rectangular in cross section having side walls, a front wall, a rear wall, and substantial corner wall portions cutting its corners, upright radiant heat tubes lining said side walls, lower headers into which the lower ends of the side wall tubes are connected, upper headers into which the upper ends of the side wall tubes are connected, upright radiant heat tubes lining said front and rear walls, and upright radiant heat tubes lining said corner wall portions, a lower header into which the lower ends of the front wall tubes are connected and into which the lower ends of the corner wall tubes adjacent the front wall tubes are connected, a lower header into which the lower ends of the rear wall tubes are connected and into which the lower ends of the corner wall tubes adjacent the rear wall tubes are connected, an upper drum into which the upper ends of said front, rear, and corner tubes are connected, and burner means mounted in said corner wall portions for introducing fuel into said combustion chamber tangentially at a point well within the theoretical projected corners formed by the walls of the combustion chamber, certain tubes of said corner wall tubes being bowed to

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provide openings for said burner means, and said burner means being adjustable to alter the delivery of fuel therefrom, the extent to which the corner wall portions cut the corners of the combustion chamber and the location of the adjustable burner means being such that in no position of adjustment of the latter will there be impingement of the fuel and flame stream on the radiant heat tubes.

7. A steam generating boiler furnace comprising in combination a combustion chamber generally rectangular in cross section having side walls, a front wall, a rear wall, and substantial corner wall portions cutting its corners, upright radiant heat tubes lining said side walls, upright radiant heat tubes lining said front walls, upright radiant heat tubes grouped with said front wall tubes lining the corner wall portions adjacent said front wall, upright radiant heat tubes lining said rear wall, upright radiant heat tubes grouped with said rear wall tubes lining the angular wall portions adjacent said rear wall, lower headers for said side wall tubes, a lower header common to said front wall tubes and the corner wall tubes grouped therewith, a lower header common to said rear wall tubes and the corner wall tubes grouped therewith, and adjustable burner means at the corners the discharge ends of which extend well within the theoretical projected corners formed by the walls of the combustion chambers, the extent to which the corner wall portions cut the corners of the combustion chamber and the location of the adjustable burner means being such that in no position of adjustment of the latter will there be impingement of the fuel and flame stream on the radiant heat tubes.

8. A steam generating boiler furnace comprising in combination a combustion chamber generally rectangular in cross section having side walls, a front wall, a rear wall, substantial corner wall portions cutting its corners, and a basket-bottom, upright radiant heat tubes lining said side walls, upright radiant heat tubes lining said front wall, upright radiant heat tubes grouped with said front wall tubes lining the corner wall portions adjacent said front wall, said front wall tubes and the corner wall tubes grouped therewith being bent downwardly and inwardly at their lower portions to form the front of said basket-bottom from side wall to side wall of the combustion chamber, upright radiant heat tubes lining said rear wall, upright radiant heat tubes grouped with said rear wall tubes lining the corner wall portions adjacent said rear wall, said rear wall tubes and the corner wall tubes grouped therewith being bent downwardly and inwardly at their lower portions to form the rear of said basket-bottom from side wall to side wall of the combustion chamber, upper and lower headers into which the side wall tubes are connected, lower headers into which the front and rear wall tubes and their grouped corner tubes are connected, an upper drum into which said front, rear and grouped tubes are connected, and adjustable burner means at the corners the discharge ends of which extend well within the theoretical projected corners formed by the walls of the combustion chamber, the extent to which the corner wall portions cut the corners of the combustion chamber and the location of the adjustable burner means being such that in no position of adjustment of the latter will there be impingement of the fuel and flame stream on the radiant heat tubes.

9. A steam generating boiler furnace comprising in combination a combustion chamber generally rectangular in cross section having side walls, a front wall, a rear wall, substantial corner wall portions cutting its corners, and a basket-bottom, and a top wall, upright radiant heat tubes lining said side walls, upright radiant heat tubes lining said front wall, upright radiant heat tubes grouped with said front wall tubes lining the angular wall portions adjacent said front wall, said front wall tubes and the corner wall tubes grouped therewith being bent upwardly and rearwardly at their upper portions to line said top wall from side to side wall of the combustion chamber, upright radiant heat tubes lining said rear wall, upright radiant heat tubes grouped with said rear wall tubes lining the corner wall portion adjacent said rear wall, upper and lower headers into which the side wall tubes are connected, lower headers into which the front and rear wall tubes and their grouped corner tubes are connected, an upper drum into which said front, rear and grouped tubes are connected, and adjustable burner means at the corners the discharge ends of which extend well within the theoretical projected corners formed by the walls of the combustion chamber, the extent to which the corner wall portions cut

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the corners of the combustion chamber and the location of the adjustable burner means being such that in no position of adjustment of the latter will there be impingement of the fuel and flame stream on the radiant heat tubes.

10. A steam generating boiler furnace comprising in combination a combustion chamber generally rectangular in cross section having side walls, a front wall, a rear wall, substantial corner wall portions cutting its corners, upright radiant heat tubes lining said side walls, upright radiant heat tubes lining said front walls, upright radiant heat tubes grouped with said front wall tubes lining the corner wall portions adjacent said front wall, upright radiant heat tubes lining said rear wall, upright radiant heat tubes grouped with said rear wall tubes lining the corner wall portions adjacent said rear wall, said rear wall tubes and the corner wall tube grouped therewith being bent upwardly and forwardly at their upper portions to provide an arch for said combustion chambers from side wall to side wall thereof, downcomer connections to all of said upright tubes, an upper drum with which all of said tubes have upcomer connection, and adjustable burner means at the corners the discharge ends of which extend well within the theoretical projected corners formed by

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the walls of the combustion chamber, the extent to which the corner wall portions cut the corners of the combustion chamber and the location of the adjustable burner means being such that in no position of adjustment of the latter will there be impingement of the fuel and flame stream on the radiant heat tubes.

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