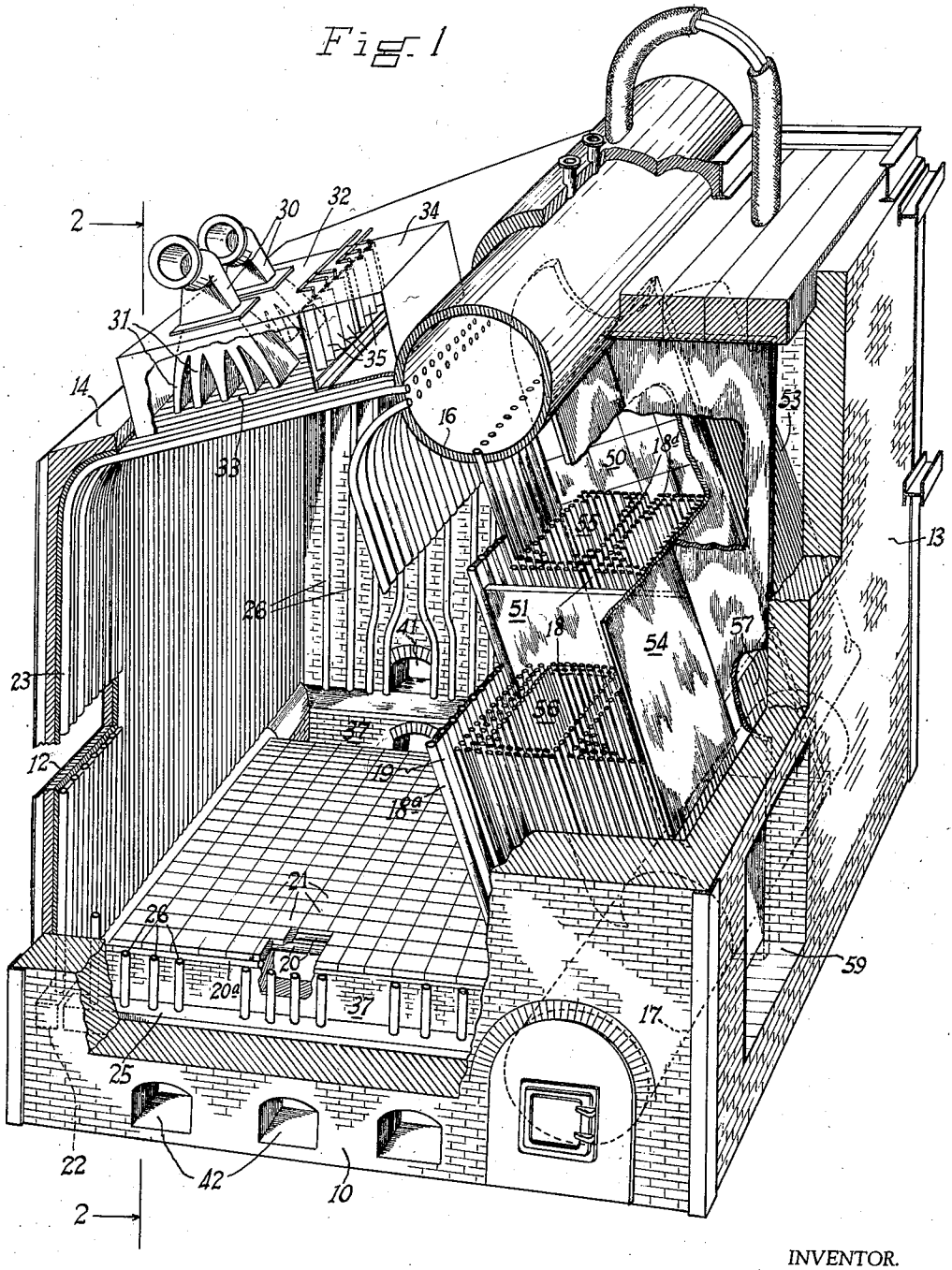
Jan. 9, 1940. E. G. BAILEY 2,186,919

STEAM BOILER

Filed June 24, 1936 5 Sheets-Sheet 1

Fig. 1



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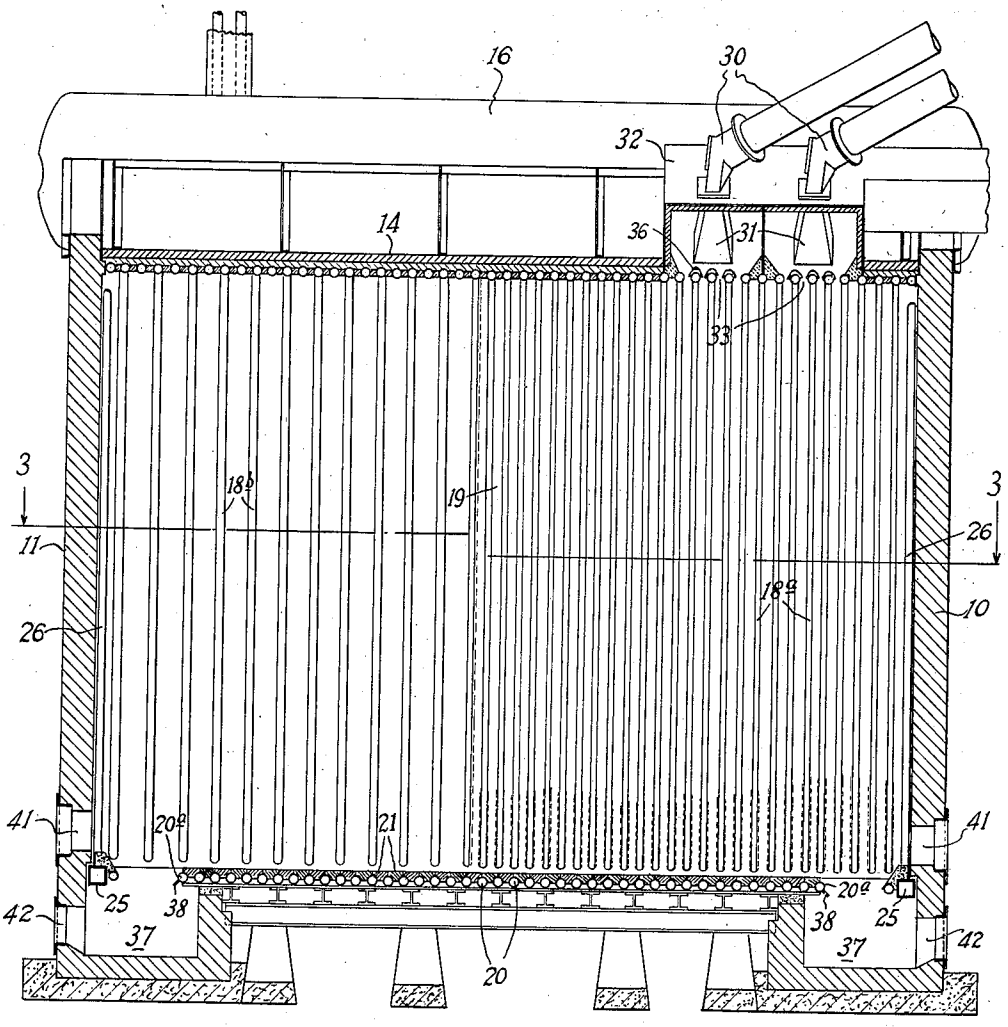
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STEAM BOILER

Filed June 24, 1936 5 Sheets-Sheet 2

Fig. 2



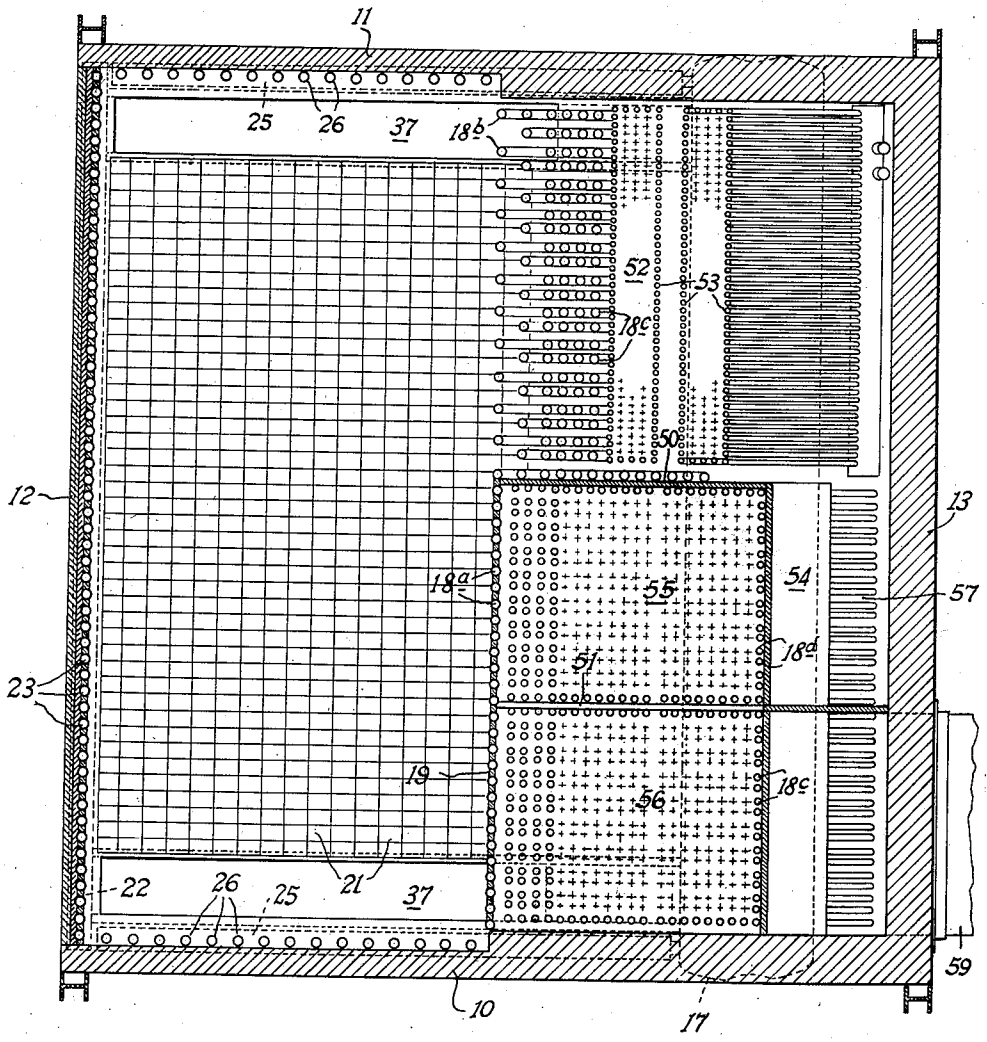
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STEAM BOILER

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Fig. 3



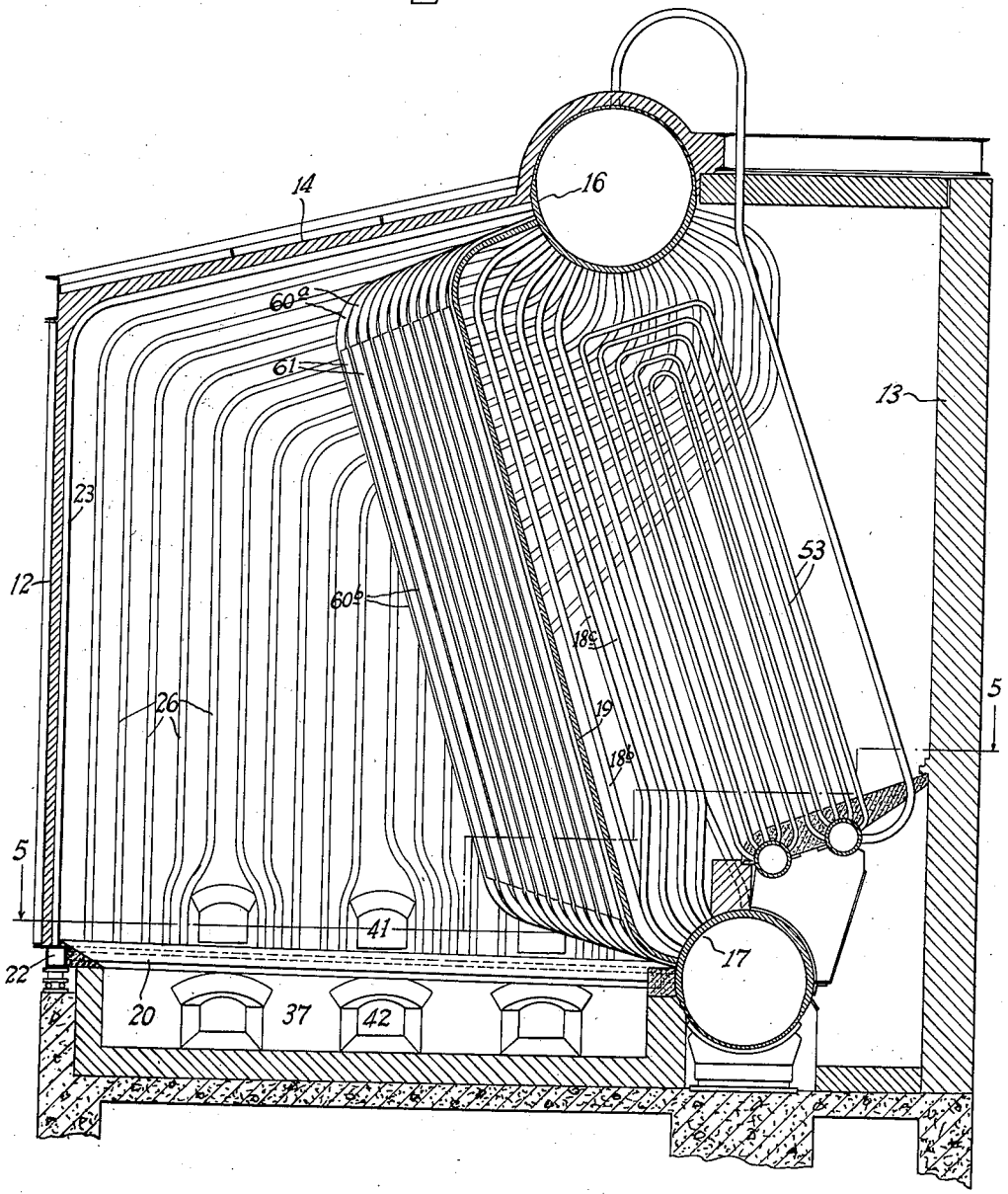
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STEAM BOILER

Filed June 24, 1936 5 Sheets-Sheet 4

Fig. 4



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STEAM BOILER

Filed June 24, 1936 5 Sheets-Sheet 5

Fig. 5

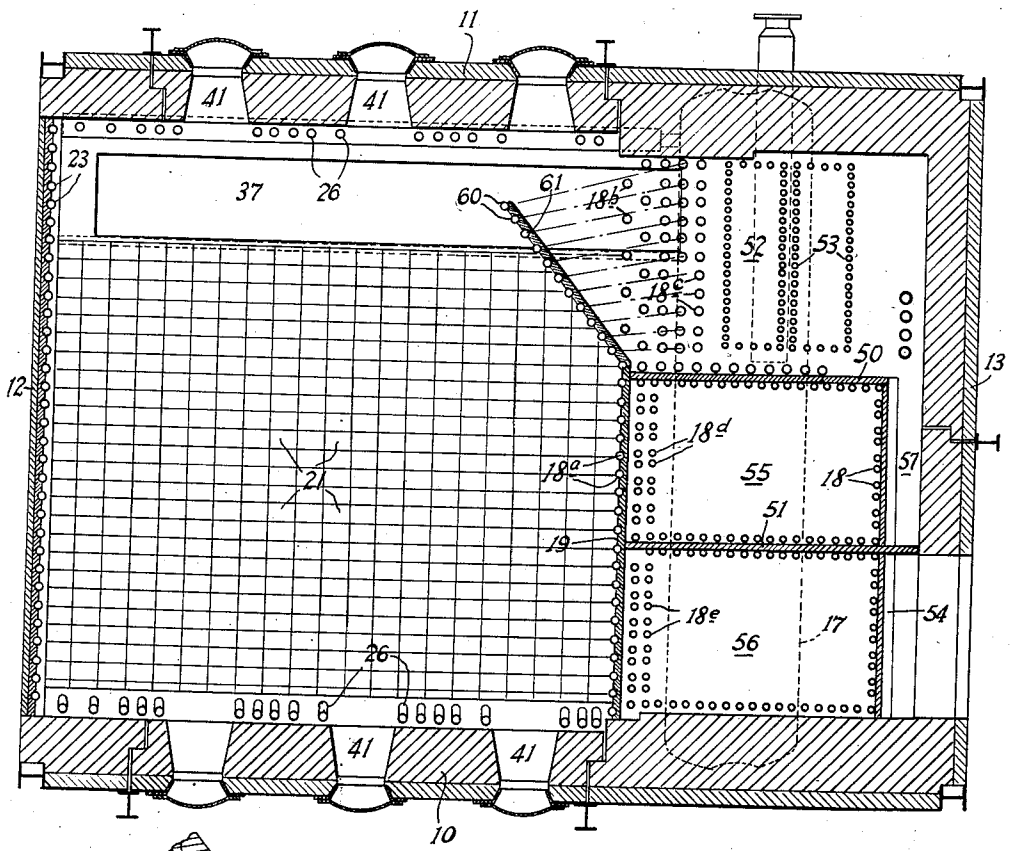
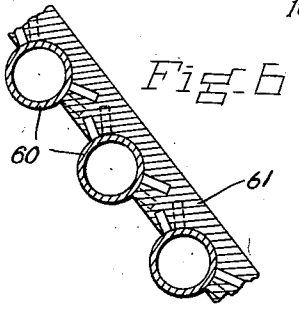


Fig. 6



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Patented Jan. 9, 1940

2,186,919

UNITED STATES PATENT OFFICE

2,186,919

STEAM BOILER

Ervin G. Bailey, Easton, Pa., assignor to The Babcock & Wilcox Company, Newark, N. J., a corporation of New Jersey

Application June 24, 1936, Serial No. 86,905

17 Claims. (Cl. 122—336)

The present invention relates to the construction and operation of water tube steam boilers of moderate capacity of the general type disclosed in my prior joint Patent No. 1,999,984, and which type of boiler is characterized by its low floor space and head-room requirements, reliability, low draft loss, high efficiency, and relatively low cost of construction and maintenance.

One object of the present invention is the provision in a steam boiler of the character described of an improved arrangement of the fuel burning means relative to the furnace chamber, and of the provisions for removing ash deposited in the furnace chamber. Another object is the provision of a novel path of flow of the heating gases relative to the convection heated steam generating surface of the boiler. Another object is the provision of water cooled means for increasing the effective furnace length, and effecting better distribution of the furnace gases and shielding of the tube bank from furnace radiation.

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

Of the drawings:

Fig. 1 is a somewhat diagrammatic perspective view with parts broken away and in section illustrating one embodiment of my invention;

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

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

Fig. 4 is a sectional elevation of a modified construction;

Fig. 5 is a horizontal section taken on the line 5—5 of Fig. 4; and

Fig. 6 is an enlarged view of a portion of the wing wall shown in Fig. 5.

In the steam boiler unit illustrated in Figs. 1 to 3 a vertically disposed front wall 10, rear wall 11, and opposite side walls 12 and 13 unite to form a setting of substantially rectangular cross-section. The top of the setting is formed by a partly inclined roof or arch 14. The space enclosed by the setting is divided into a horizontally elongated furnace chamber and a laterally adjoining space containing a steam generating tube bank. The pressure parts of the boiler include a pair of upper and lower drums 16 and 17 respectively, which extend substantially the full length of the setting in parallel offset relation, and are connected by a bank of vertically disposed water tubes 18. The innermost longitudinal row of tubes 18a of the tube bank has its intertube spaces for a portion of its length closed by suitable refractory material to form a gas-tight partition 19 extending the full height of the tube bank and from the front wall 10 towards the rear wall 11. The partition separates the furnace chamber from the space containing the tube bank except along the rear portions thereof.

The walls of the furnace chamber are desirably water cooled. As shown, a row of tubes 20 extends from the drum 17 at a slight inclination laterally across the bottom of the furnace chamber, with the spaces therebetween closed by suitable blocks 21 to form a smooth floor for the furnace chamber. The tubes 20 are connected at their outer ends to a longitudinally extending header 22 at the lower end of the side wall 12. The inner portion of the side wall 12 is formed by a row of spaced vertical tubes 23 with refractory therebetween, bent at their upper ends and inclined inwardly across the arch 14 to the upper drum 16. The cooling provisions for the front and rear walls 10 and 11 consist of a pair of inclined bottom headers 25 connected at one end to the drum 17 and along their lengths to the upper drum 16 by a row of vertically disposed tubes 26 extending upwardly along the inner side of the corresponding wall and bent laterally at their upper ends into the upper drum 16.

The furnace chamber construction described is particularly adapted for the burning of fluid fuel, such as pulverized coal, gas, or oil, in suspension. In the construction shown, a pair of pulverized coal burners are advantageously arranged to discharge downwardly through the furnace roof at longitudinally spaced points adjacent the front wall 10. As shown in Figs. 1 and 2, each fuel burner comprises a pulverized coal and primary air conduit 30 terminating in a series of transversely spaced tapering nozzles 31 spaced along the roof tubes 23 and enclosed by a sectional air box 32, which registers with a burner port 33 formed by omitting the intertube refractory over a portion of the roof tubes. The air box 32 is supplied with secondary air for combustion, preferably preheated, through a conduit extention 34 at one side thereof, with the supply of air from the conduit 34 to each section of the air box controlled by suitable dampers 35. Each fuel discharge nozzle 31 extends transversely across a plurality of roof tubes, as shown in Fig. 2. The corresponding subjacent roof tubes are provided with tube protectors 36 on their upper sides to minimize erosion of the tubes by the entering fuel streams. Each fuel stream is thus subdivided by the subjacent tube portion into a plurality of initially separate streams. The secondary air supplied to the air box passes downwardly

through the burner port between and around the fuel nozzles.

With the described burner arrangement the pulverized coal will be discharged downwardly into the furnace chamber in a multiplicity of small streams which will be rapidly ignited, and the burning fuel stream and heating gases generated will pass rearwardly in the furnace chamber in a generally horizontal path and around the rear end of the partition 19 into the tube space. A relatively long flame path for the fuel will be thus provided of a character contributing to the separation of ash particles during the flame travel which deposit on the floor of the furnace chamber. To facilitate ash removal, the floor is terminated adjacent both the front and rear walls of the furnace chamber and an ash trench or pit 37 formed between each end of the floor and the adjacent wall. As shown in Fig. 2, the ends of the floor project beyond the corresponding end of the ash pits 37. The end floor tubes 20^a each have an inclined plate 38 welded thereto along its exposed side, forming a slag drip ledge and also reducing the amount of exposure of the refractory walls of the ash pit to slag erosion. Door closed openings 41 and 42 are provided in both the front and rear walls at levels above and below the floor to facilitate removal of the deposited ash from the floor and the adjacent ash pits.

As shown in Figs. 1 and 3, the tube bank is divided into three longitudinal sections by transversely extending vertical baffles 50 and 51. The baffle 50 extends outwardly from the rear end of the partition 19 to a point spaced from the side wall 13 and unites with the adjacent portions of the setting to provide a gas pass 52 open along its inner side to the furnace chamber. The innermost rows of boiler tubes 18^b in this pass are spaced to form a slag screen across the entrance to the pass, while the remaining boiler tubes 18^c in the pass are arranged with standard spacing. In the outer portion of the first pass is arranged a group of inverted U-shaped superheater tubes 53. The remaining tubes in the tube bank are preferably of smaller diameter than the water tubes in the first pass and the partition tubes 18^a.

While the heating gases pass generally horizontally across the tubes in the first pass, the remaining portion of the tube space is divided into a pair of vertical gas passes. The provisions for this purpose comprise the vertical transverse baffle 51 extending the full width of the tube space between the partition 19 and the side wall 13, and a longitudinally extending vertical baffle 54 extending along the outer side of the tube bank from the outer end of the baffle 50 to the front wall 10. Boiler tubes 18^d are thus located in the second pass 55 and tubes 18^e in the third pass 56. The longitudinal baffle 54 has an opening 57 adjacent the bottom of the second pass 55 to provide a passage for the entry of heating gases into the second pass. The portion of the transverse baffle 51 inwardly of the baffle 54 is terminated at its upper end substantially below the level of the drum 16 to provide an opening between the second and third passes. The lower portion of the baffle 54 opposite the third pass 56 is also cut away to provide communication between the third pass and a gas outlet 59 formed in the lower forward end of the side wall 13.

With the described construction and arrangement of the parts, the heating gases enter the first pass 52 throughout its height and flow successively across the slag screen tubes 18^b, the water tubes 18^c, and the superheater tubes 53, and downwardly around the outer end of the baffle 50. The gases enter the lower portion of the second pass 55 through the opening 57, flow upwardly along the boiler tubes therein, and then forwardly over the upper end of the inner section of the baffle 51 into the third pass 56. The heating gases flow downwardly along the boiler tubes in the third pass and outwardly below the lower end of the corresponding portion of the baffle 54 to the gas outlet 59.

In the modified construction illustrated in Figs. 4 and 5, a row of tubes 60 is arranged partly in front of and at an oblique angle to the rows of water tubes 18^b forming the slag screen. The row of tubes 60 have bent end portions 60^a of progressively increasing length rearwardly of the boiler connected to the drums 16 and 17 in the same manner as the partition tubes, and straight intermediate portions 60^b of progressively decreasing length rearwardly arranged in alignment in a plane inclined vertically and longitudinally toward the side wall 12 from the end of the partition 19. The bent end portions 60^a are arranged so that the straight portions will be forwardly offset from the corresponding drum tube openings, whereby the rearmost straight portion 60 will be spaced a predetermined distance from the rear wall 11. The tube straight portions are provided with suitable means, such as rows of projecting studs as shown in Fig. 6, along their adjacent sides over substantially their entire length for supporting refractory material 61 for closing the intertube spaces. A water cooled wing wall or deflector baffle extending from the rear end of the partition partly across the entrance to the first gas pass 52 is thus formed. This arrangement provides a long flow path for the heating gases in the furnace chamber, avoiding short circuiting of the flame and high carbon loss. The gases flow mainly around the rear end of the baffle, and also above and below the same across the tube portions 60^a. In this flow path, the heating gases are caused to converge and mix in the rear section before entering the narrow passage between the baffle and rear wall, and then diverge into the flaring space between the baffle, rear wall, and slag screen tubes 18^b. The distribution of the heating gases entering the first pass is improved and the tubes therein effectively shielded from furnace radiation. With this arrangement, the rear wall cooling tubes 26 may be concentrated, if desired, along the portion thereof between the baffle and side wall 12.

While in accordance with the provisions of the statutes I have illustrated and described herein the best forms of my invention now known to me, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by my claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features.

I claim:

1. A steam boiler having a pair of horizontally disposed upper and lower drums, a bank of vertically disposed water tubes connected to said drums along the length thereof, means including a vertically disposed partition alongside said tube bank forming a furnace chamber laterally adjoining the space containing said tube bank and communicating with the rear end thereof, baffle means in said tube space arranged to divide said tube space into a plurality of serially connected

gas passes, said baffle means including a vertical baffle extending from the rear end of said partition transversely of said tube space and a second vertical baffle extending forwardly from said first baffle at the outer side of said tube bank and having an opening in the lower portion thereof for the passage of heating gases upwardly along the tubes in the adjacent portion of said tube bank and means for burning fuel in said furnace chamber and generating heating gases flowing through said furnace chamber and thence through said tube space.

2. A steam boiler having a pair of horizontally disposed upper and lower drums, a bank of vertically disposed water tubes connected to said drums along the length thereof, means including a vertically disposed partition alongside said tube bank forming a furnace chamber laterally adjoining the space containing said tube bank and communicating with the rear portion thereof, baffle means in said tube space arranged to divide said tube space into a plurality of serially connected gas passes, said baffle means including a vertical baffle extending from the rear end of said partition transversely of said tube space, a second vertical baffle extending forwardly from said first baffle at the outer side of said tube bank, and a third vertical baffle extending across said second baffle to said partition, said second and third baffles having openings therein relatively arranged to effect a heating gas flow upwardly along the tubes between said first and third baffles and downwardly along the tubes forwardly of said third baffle, and means at the front end of said furnace chamber for burning fuel in suspension and generating heating gases flowing longitudinally of said furnace chamber and thence through said tube space.

3. A steam boiler comprising a bank of vertically disposed water tubes, means forming a horizontally elongated furnace chamber laterally adjoining the space containing said tube bank and communicating therewith at one end thereof, means forming a floor for a major portion of said furnace chamber, a fuel burner mounted in the roof of said furnace chamber and arranged to downwardly discharge fuel into said furnace chamber, and a pair of ash receiving openings extending transversely of said floor adjacent the opposite ends of said furnace chamber.

4. A steam boiler comprising a bank of vertically disposed water tubes, means forming a horizontally elongated furnace chamber laterally adjoining the space containing said tube bank and communicating therewith at the rear end thereof, means forming a floor for a major portion of said furnace chamber, a fuel burner mounted in the roof of said furnace chamber at the front end thereof and arranged to downwardly discharge pulverized fuel and air into said furnace chamber, and a pair of ash receiving openings extending transversely of said floor adjacent the opposite ends of said furnace chamber.

5. A steam boiler having upper and lower horizontally disposed drums, a bank of vertically disposed water tubes connected to said drums along the length thereof, a partition defining the inner side wall of a fluid cooled furnace chamber laterally adjoining the space containing said tube bank and communicating therewith at its rear end, means defining the remaining sides and roof of said furnace chamber, means forming a fluid cooler floor for a major portion of said furnace chamber, a row of water tubes extending along the roof of said furnace chamber, a fuel burner mounted in said furnace chamber roof at the front end thereof and arranged to discharge fuel downwardly between said roof tubes into said furnace chamber, and a pair of ash receiving openings extending transversely of said floor adjacent the opposite ends of said furnace chamber.

6. A steam boiler having upper and lower horizontally disposed drums, a bank of vertically disposed water tubes connected to said drums along the length thereof, a partition defining the inner side wall of a fluid cooled furnace chamber laterally adjoining the space containing said tube bank and communicating therewith at its rear end, means dfining the remaining sides and roof of said furnace chamber, means forming a fluid cooled floor for a major portion of said furnace chamber, a row of water tubes extending along the roof of said furnace chamber, rows of water tubes extending along the opposite end walls of said furnace chamber, a fuel burner mounted in said furnace chamber roof at the front end thereof and arranged to discharge pulverized fuel and air downwardly between said roof tubes into said furnace chamber, and a pair of ash receiving openings extending transversely of said floor adjacent the opposite ends of said furnace chamber.

7. A steam boiler comprising a longitudinally extending bank of vertically disposed water tubes, a partition defining the inner side wall of a furnace chamber laterally adjoining the space containing said tube bank and communicating therewith at its rear end, means defining the remaining sides of said furnace chamber, fuel burning means at the front end of said furnace chamber, and means forming a fluid cooled deflector baffle in said furnace chamber extending at an angle to said partition across the heating gas entrance to said tube space.

8. A steam boiler having upper and lower horizontally disposed drums, a bank of vertically disposed water tubes connected to said drums along the length thereof, a partition defining the inner side wall of a fluid cooled furnace chamber laterally adjoining the space containing said tube bank and communicating therewith at its rear end, means defining the remaining sides of said furnace chamber, fuel burning means at the front end of said furnace chamber, and means forming a deflector baffle extending from the rear portion of said partition outwardly and rearwardly in said furnace chamber across the heating gas entrance to said tube space and spaced from the rear wall of said furnace chamber.

9. A steam boiler having upper and lower horizontally disposed drums, a bank of vertically disposed water tubes connected to said drums along the length thereof, a partition defining the inner side wall of a fluid cooled furnace chamber laterally adjoining the space containing said tube bank and communicating therewith at its rear end, means defining the remaining sides of said furnace chamber, fuel burning means at the front end of said furnace chamber, and means forming a fluid cooled deflector baffle in said furnace chamber extending at an angle to said partition outwardly and rearwardly across the heating gas entrance to said tube space, said baffle-forming means including a row of water tubes having bent end portions connected to said upper and lower drums and intermediate straight portions arranged in alignment.

10. A steam boiler having upper and lower

horizontally disposed drums, a bank of vertically disposed water tubes connected to said drums along the length thereof, a partition defining the inner side wall of a fluid cooled furnace chamber laterally adjoining the space containing said tube bank and communicating therewith at its rear end, walls defining the remaining sides of said furnace chamber, fuel burning means at the front end of said furnace chamber, means forming a fluid cooled deflector baffle in said furnace chamber extending at an angle to said partition outwardly and rearwardly across the heating gas entrance to said tube space, said baffle-forming means including a row of water tubes having bent end portions connected to said upper and lower drums and intermediate straight portions arranged in alignment, and refractory means arranged to close the spaces between said tube straight portions.

11. A steam boiler having upper and lower horizontally disposed drums, a bank of vertically disposed water tubes connected to said drums along the length thereof, a partition defining the inner side wall of a fluid cooled furnace chamber laterally adjoining the space containing said tube bank and communicating therewith at its rear end, means defining the remaining sides of said furnace chamber, fuel burning means at the front end of said furnace chamber, means forming a fluid cooled deflector baffle extending from adjacent the rear end of said partition outwardly and rearwardly in said furnace chamber across the heating gas entrance to said tube space to a point spaced from the rear wall of said furnace chamber, said baffle-forming means including a row of water tubes having bent end portions connected to said upper and lower drums and intermediate closely spaced straight portions arranged in alignment, refractory means arranged to close the spaces between said tube straight portions, and water tubes along the portion of the rear wall of said furnace chamber beyond the rear end of said baffle.

12. A steam boiler comprising upper and lower drums, a bank of water tubes connecting said drums, a partition defining the inner side wall of a furnace chamber laterally adjoining the space containing said tube bank and separated therefrom except at one end by said partition, means for burning fuel in said furnace chamber, and a deflector baffle in said furnace chamber forming an angular continuation of said partition into said furnace chamber and extending partly across the heating gas entrance to said tube space.

13. A steam boiler comprising upper and lower drums, a bank of water tubes connecting said drums, means forming a partition defining the inner side wall of a furnace chamber at one side of and communicating with one end of said tube bank space, means for burning fuel in said furnace chamber, and a series of water tubes having vertically disposed aligned portions in said furnace chamber forming an oblique angular continuation of said partition extending partly across the heating gas entrance to said tube space.

14. A steam boiler comprising upper and lower drums, a bank of water tubes connecting said drums, means forming a partition defining the inner side wall of a furnace chamber at one side of and communicating with one end of said tube bank space, means for burning fuel in said furnace chamber, and a continuation of said partition having a series of water tubes connected to said upper and lower drums and having vertically disposed aligned portions arranged in a plane in said furnace chamber extending at an angle to said partition.

15. A steam boiler comprising a bank of vertically disposed tubes, means including a vertically disposed partition alongside said tube bank forming a furnace chamber laterally adjoining the space containing said tube bank and communicating with the rear end thereof, means forming a floor for a major portion of said furnace chamber, a pulverized fuel burner mounted in the roof of said furnace chamber at the front end thereof and arranged to downwardly discharge fuel into said furnace chamber, a pair of ash receiving openings extending transversely of said floor adjacent the opposite ends of said furnace chamber, and baffle means in said tube space arranged to divide said tube space into a plurality of serially connected gas passes, said baffle means including a vertical baffle extending from the rear end of said partition transversely of said tube space, and a second vertical baffle extending forwardly from said first baffle at the outer side of said tube bank and having an opening in the lower portion thereof for the passage of heating gases upwardly along the tubes in the adjacent portion of said tube bank.

16. A steam boiler comprising a bank of vertically disposed tubes, means including a vertically disposed partition alongside said tube bank forming a furnace chamber laterally adjoining the space containing said tube bank and communicating with the rear end thereof, a fuel burner at the front end of said furnace chamber and arranged to discharge fuel into said furnace chamber, a series of water tubes having vertically disposed aligned portions in said furnace chamber forming an oblique angular continuation of said partition extending partly across the heating gas entrance to said tube space, and baffle means in said tube space arranged to divide said tube space into a plurality of serially connected gas passes, said baffle means including a vertical baffle extending from the rear end of said partition transversely of said tube space, and a second vertical baffle extending forwardly from said first baffle at the outer side of said tube bank and having an opening in the lower portion thereof for the passage of heating gases upwardly along the tubes in the adjacent portion of said tube bank.

17. A steam boiler comprising spaced water chambers, a bank of water tubes connecting said chambers, a partition defining one side of a furnace chamber adjacent the space containing said tube bank and separated therefrom except at one end by said partition, means for burning fuel in said furnace chamber, and a deflector baffle in said furnace chamber forming an angular continuation of said partition into said furnace chamber and extending partly across the heating gas entrance to said tube space.

ERVIN G. BAILEY.