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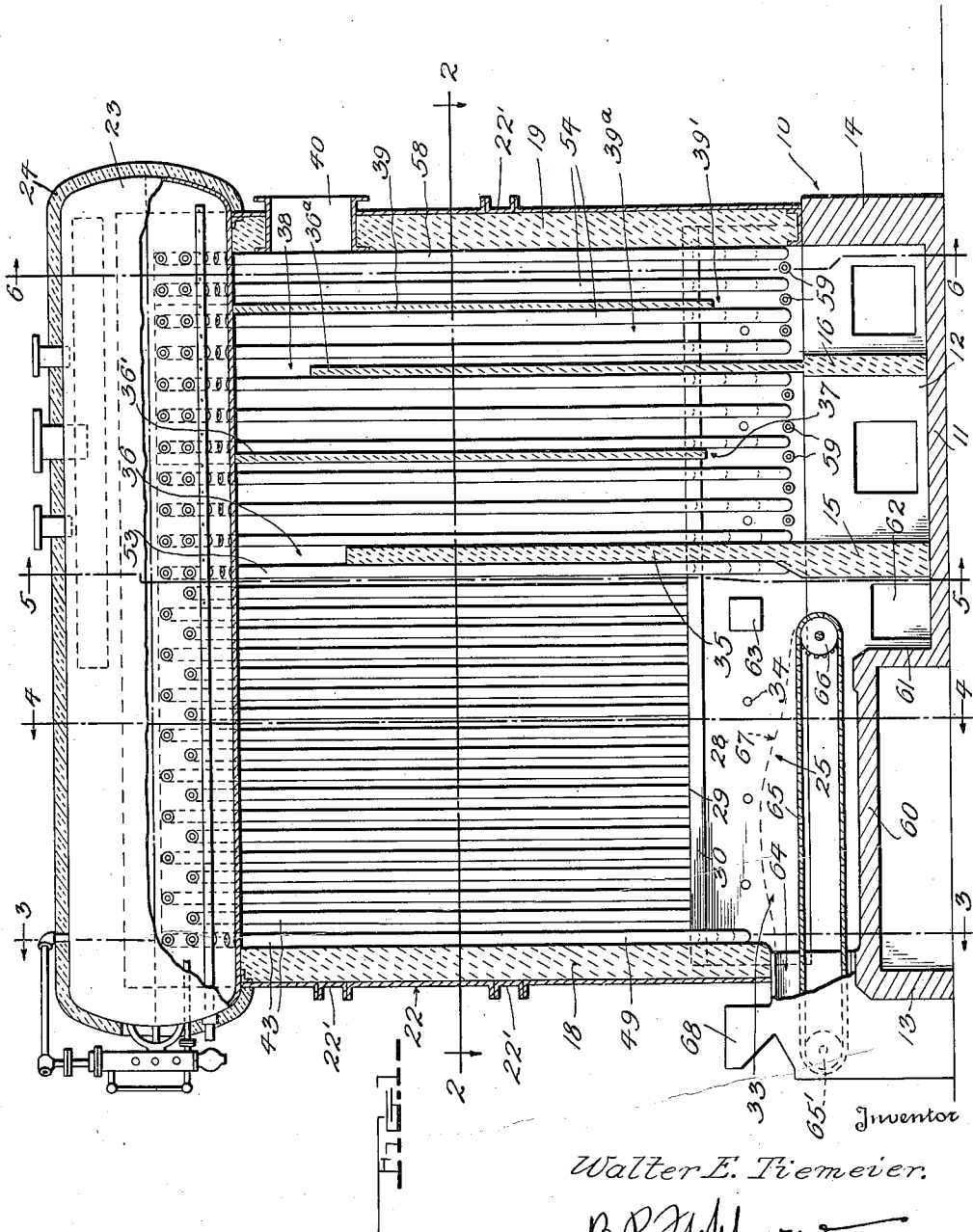
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2,393,205

STEAM BOILER

Filed Aug. 4, 1944

4 Sheets-Sheet 1



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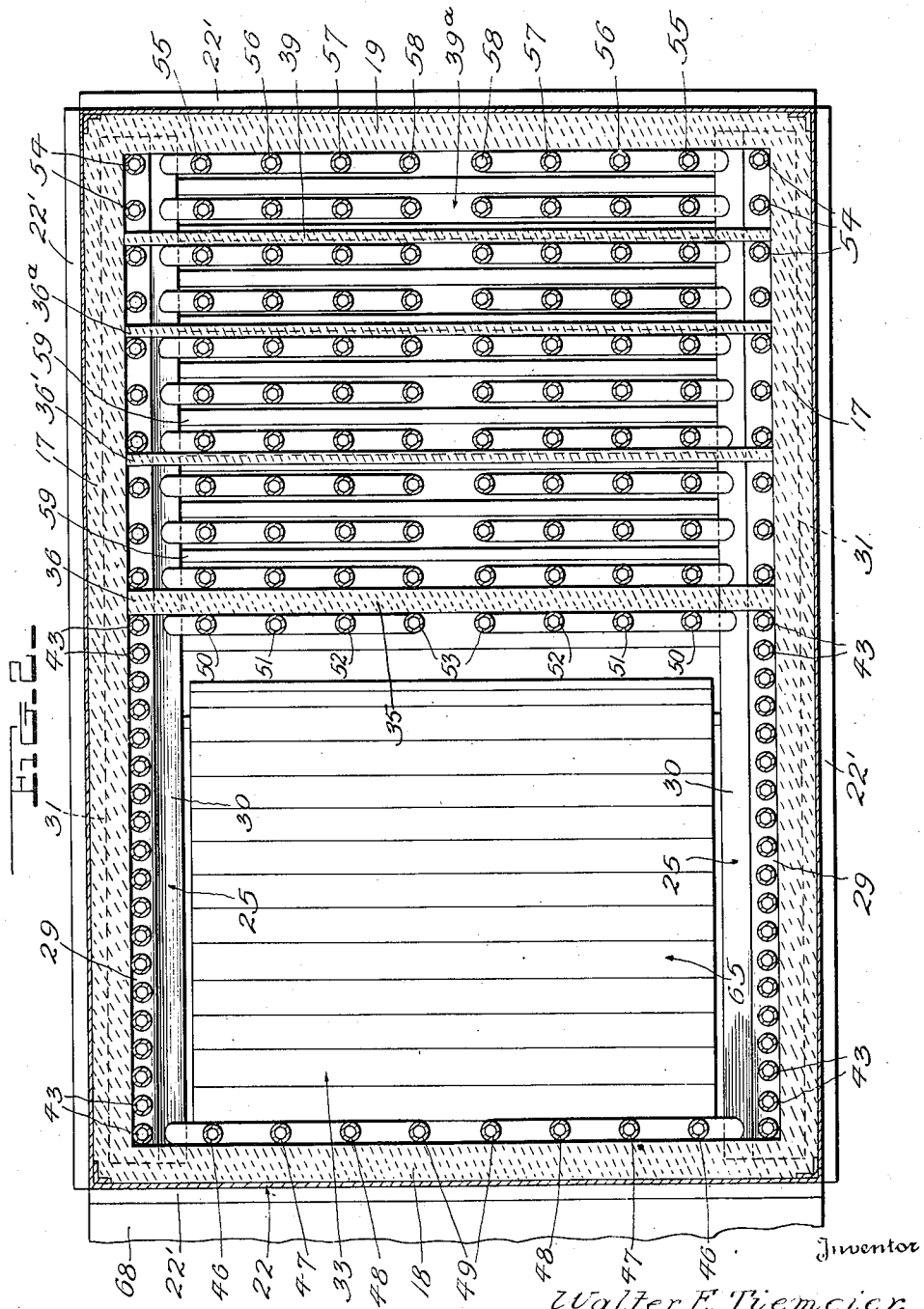
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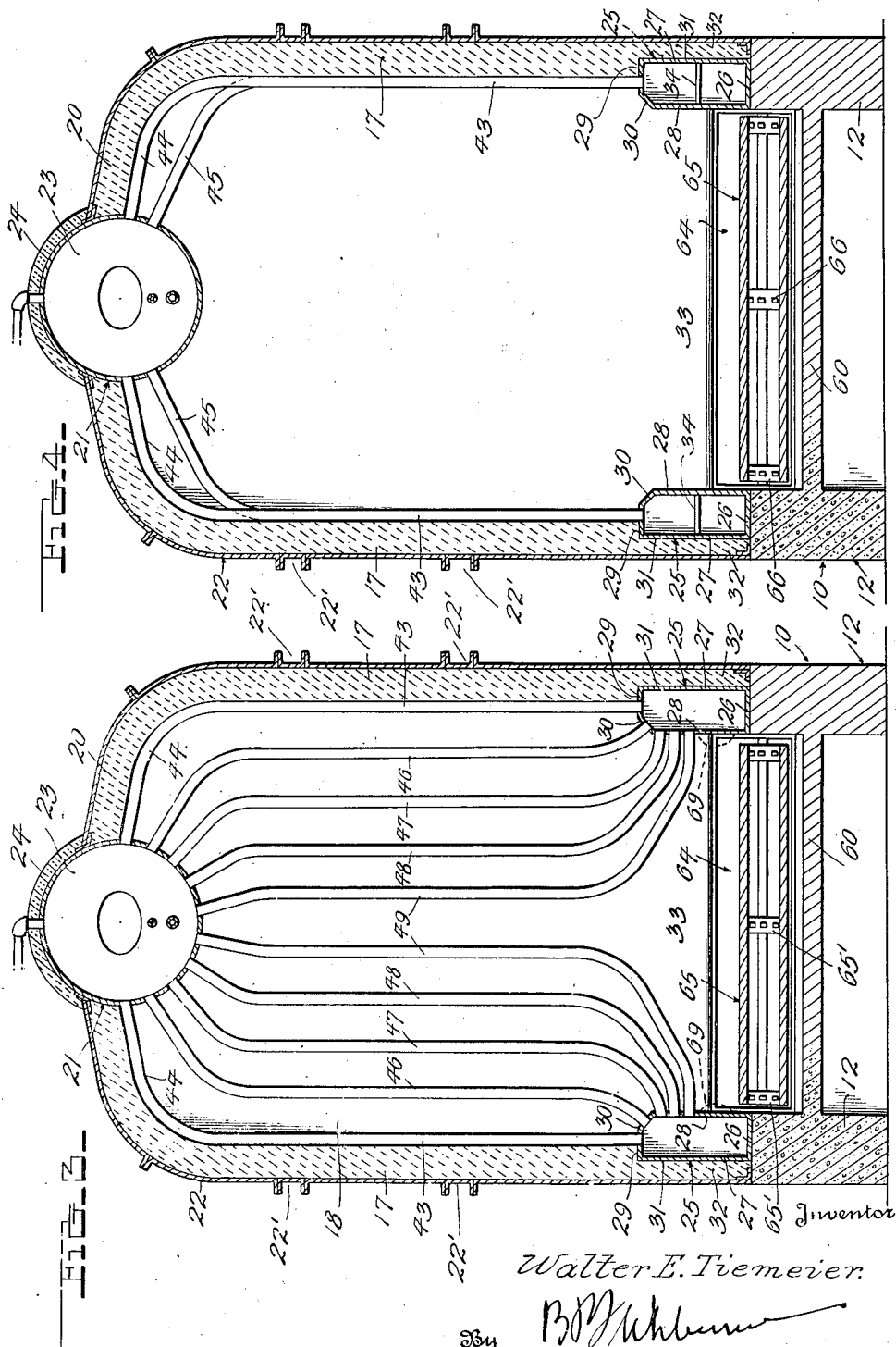
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STEAM BOILER

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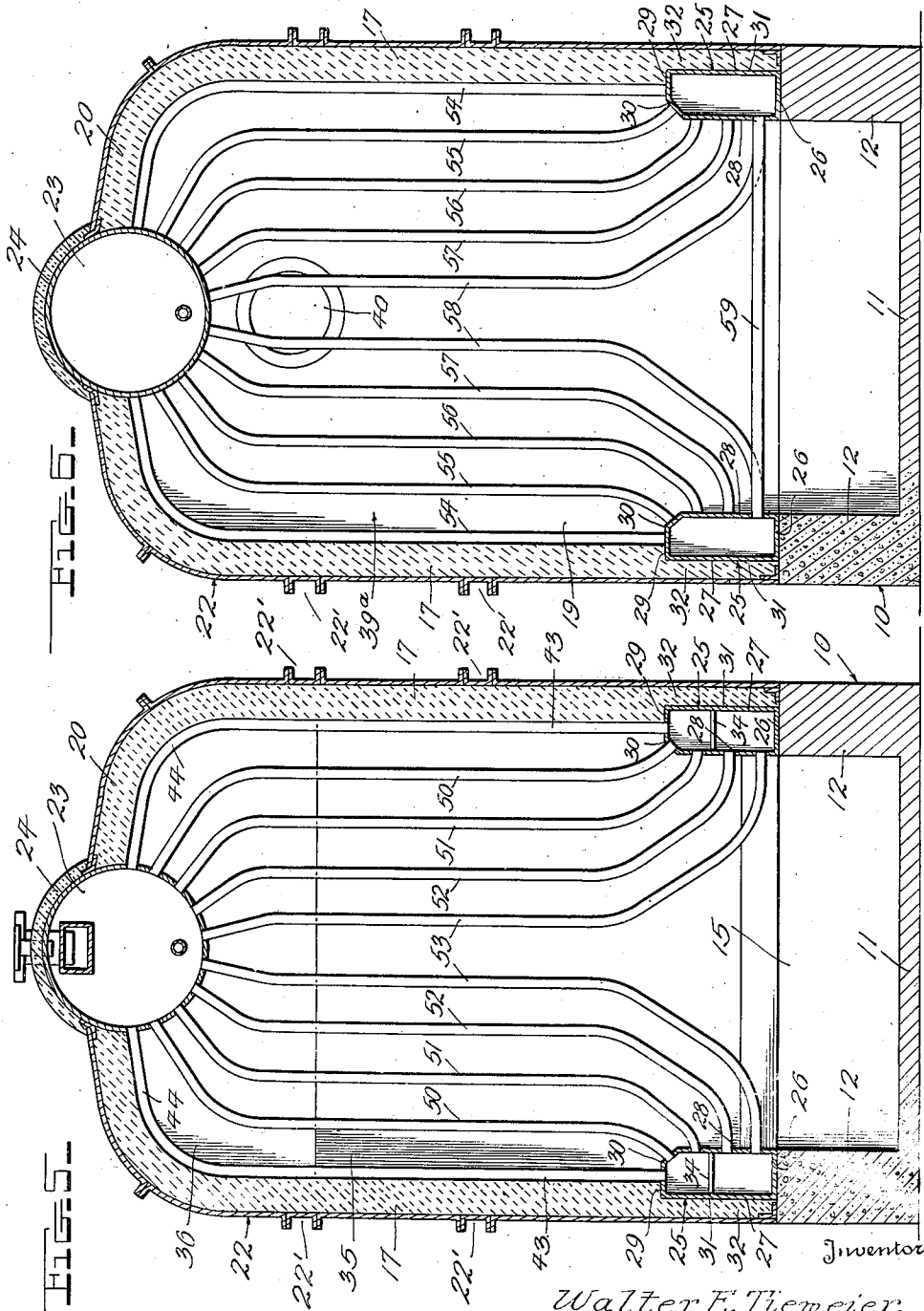
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STEAM BOILER

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UNITED STATES PATENT OFFICE

2,393,205

STEAM BOILER

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Application August 4, 1944, Serial No. 547,996

9 Claims. (Cl. 122—347)

My invention relates to steam boilers.

An important object of the invention is to provide a steam boiler which is compact and highly efficient in operation.

A further object of the invention is to provide water tubes for cooling the walls of the furnace section whereby the heat is reduced before it enters the boiler section, and the efficiency of the steam boiler increased.

A further object of the invention is to provide bank or banks of water tubes within the boiler section which will absorb practically all of the heat generated and also permit of the free travel of the heated gases.

A further object of the invention is to provide a bank or banks of water tubes and baffles, arranged within the boiler section, for causing the heated gases to travel through a long path, while contacting with the water tubes, the arrangement of the water tubes and baffles being such that the gases are free to travel through the elongated passage without the assistance of an induced draft.

A further object of the invention is to provide a steam boiler, the small sizes of which are adapted to be assembled as complete units for so-called package shipments, as far as shipping clearances and equipment will permit.

A further object of the invention is to provide a steam boiler having two side water headers having flat inner faces which take the place of refractories so that no trouble will be experienced due to the brasion of the refractories or clinker adherence to such refractories.

A further object of the invention is to provide side water headers of the above mentioned character having flat sides which are connected with stay bolts so that the headers may be satisfactorily used with steam boilers of all but extremely high pressures.

A further object of the invention is to provide side water headers having inner flat faces and being of sufficient areas to extend above the fuel bed so that molten ash, which at times may adhere to these water cooled flat faces, may be removed therefrom by reducing capacity operations when permissible, which will cool the ash and such ash will then solidify and the resulting ash slag will automatically fall from the water cooled faces into the fuel bed so that the traveling or dumping grate will discharge the same into the ash pit.

Other objects and advantages of the invention will be apparent during the course of the following description:

In the accompanying drawings forming a part

of this application and in which like numerals are employed to designate like parts throughout the same,

Figure 1 is a central vertical longitudinal section through a steam boiler embodying my invention,

Figure 2 is a horizontal section taken on line 2—2 of Figure 1,

Figure 3 is a transverse section taken on line 3—3 of Figure 1,

Figure 4 is a similar view taken on line 4—4 of Figure 1 with the front wall tubes omitted,

Figure 5 is a similar view taken on line 5—5 of Figure 1, and

Figure 6 is a similar view taken on line 6—6 of Figure 1.

In the drawings, wherein for the purpose of illustration is shown a preferred embodiment of my invention, the numeral 10 designates a foundation which may be formed of concrete or the like and includes a bottom 11, sides 12, a forward end 13 and rear end 14. Disposed between the ends 13 and 14 are transverse walls or bridges 15 and 16, as shown. The steam boiler casing which is mounted upon the foundation 10 is formed of refractory and heat insulating material and comprises sides 17, a forward end 18 and a rear end 19. The sides 17 are curved and converge inwardly at their upper ends to form a top or arch 20, having a central longitudinal opening 21 formed therein, for a purpose to be described. Surrounding the refractory casing is a jacket 22, formed of metal, and this jacket is formed in sections secured together by jacket supports 22'.

Arranged within the opening 21 is an upper central longitudinal water and steam drum 23, which extends throughout the entire length of the steam boiler casing and projects beyond the forward and rear ends 18 and 19. This central water and steam drum is covered by heat insulating material 24.

The numeral 25 designates side water headers, which extend throughout the entire length of the steam boiler casing. Each water header 25 is rectangular in cross section and includes a horizontal bottom 26, a vertical outer side 27, a vertical inner side 28, upper horizontal top section 29, and an inclined or diagonal top section 30. The water header 25 is partly embedded within the side 17 and is arranged within the recess 31 formed within the side and projects inwardly beyond the inner face of the side 17. The recess or opening 31 extends throughout the entire length of the side 17 and the side is supported by the top section 29. The water header 25 has its bottom 26 resting upon the side 12. The heat insulating material

32 may be arranged between the outer side 27 and the jacket 22. Attention is called to the fact that the sides 27 and 28 on the header are vertical and parallel and that the inner side 28 is disposed within the furnace section 33 and defines the sides of the lower or fuel bed holding portion of this furnace section. The header 25 is formed of metal and the sides 27 and 28 are connected by stay bolts 34. These stay bolts retain the sides 27 and 28 parallel. The headers are sufficiently strong for use with all types of steam boilers excepting those of extremely high pressure.

The numeral 35 designates an upwardly extending vertical baffle or bridge, defining the rear end of the furnace section 33. This upwardly extending baffle 35 terminates short of the water and steam drum 23 providing an opening 36, for the products of combustion. At the rear of the baffle or bridge 35 is a downwardly extending vertical baffle 36', extending from the top 20 and terminating short of the lower end of the baffle 35 to provide an opening 37. At the rear of the baffle 36' is a vertical baffle 36^a extending upwardly, and terminating short of the top 20 to provide an opening 38. At the rear of the baffle 36^a is a vertical baffle 39, extending downwardly from the top 31 and terminating at its lower end short of the lower end of the baffle 36^a to provide an opening 39'. The space between the baffle 35 and the rear end 19 constitutes a boiler section 39^a, and the several baffles coact to provide a long tortuous passage within the boiler section for the heated gases or products of combustion. These heated gases discharge through an opening 40 to a suitable stack or the like.

Arranged adjacent to or in thermal contact with each side 17 in the furnace section, is a longitudinal row of vertical water tubes 43, which serve to cool sides 17. At their lower ends, the water tubes 43 in each row are attached to the top section 29 of the corresponding header 25 and communicate with the interior of the header. The vertical tubes 43 in each row are bent so that they may expand without disrupting their connections and alternate tubes 43 are bent to form upper portions 44, while the remaining alternate tubes 43 are bent to form upper portions 45. The upper portions 44 closely follow the contour of the top 20 while the upper portions 45 are spaced downwardly from the same. The upper portions 44 and 45 are secured to the drum 23, in staggered relation so that the drum is not unduly weakened and need not be formed of unnecessarily heavy material. The upper portions 44 and 45 of course communicate with the interior of the water and steam drum 23. The longitudinal rows of vertical tubes 43 are confined within the furnace section 33 and are arranged in relatively close relation and contact with the sides to screen or cool sides 17. These water tubes 43 are entirely uncovered. The forward end tubes 43 also extend across the inner face of the end 18 and additional vertical water tubes 46, 47, 48 and 49 also extend across the inner face of the end 18. The water tube 46 is attached to the diagonal top section 30 of the header 25, while the water tubes 47, 48 and 49 are attached to the vertical side 28. These water tubes are bent near their upper and lower ends and at their upper ends they are attached to the water and steam drum 23 at spaced points and are disposed in the same transverse vertical plane and lead them into the drum. The two sets of water tubes 43, 46, 47, 48 and 49 extending across the end 18, have thermal contact therewith and serve to cool the end 18. The rear

water tube 43 attached to each header 25 extends across the baffle 35 and vertical tubes 50, 51, 52 and 53 also extend across the baffle 35 and are connected with each header 25. The water tubes 50, 51, 52 and 53 are bent at their lower ends. The tube 50 is attached to the diagonal top section 30 and the tubes 51, 52 and 53 are attached to the vertical side 28. All of these tubes lead into the interior of the header 25. The tubes 50, 51, 52 and 53 are bent at their upper ends and these upper ends are attached to the water and steam drum 23, at spaced points and lead into the drum 23. The upper ends of the tubes 50, 51, 52 and 53 are disposed in the same transverse vertical plane. It is thus seen that the two sets of tubes 43, 50, 51, 52 and 53, having thermal contact with the baffle 35, serve to cool the same. The vertical water tubes support the water and steam drum.

Arranged within the boiler section 39^a at the rear of the baffle 35 is a bank of vertical tubes 54, 55, 56, 57 and 58. These tubes are arranged in longitudinal and transverse rows. In the longitudinal rows the tubes are spaced a greater distance than the tubes 43. In the transverse rows the tubes are spaced the same distance as the spacing of the transverse rows of tubes which extend along the end 18 and baffle 35. The longitudinal rows of tubes 54 extend along the sides 17 in the furnace section 39^a and have thermal contact therewith. Each set of tubes 54, 55, 56, 57 and 58, in each transverse row, is associated with one side of the water header 25. The tube 54 is attached to the horizontal top section 29 and communicates with the interior of the header. The tubes 55, 56, 57 and 58 are bent at their lower ends. The tube 55 is attached to the diagonal top section 30 while the tubes 56, 57, and 58 are attached to the vertical side 28 and these tubes all communicate with the interior of the header 25. The tube 54 is bent at its upper end and is attached to the water and steam drum 23, and also the tubes 55, 56, 57 and 58 have their upper ends bent and are attached to the drum 23. All of these tubes communicate with the interior of the drum. Their upper ends are disposed in the same vertical transverse plane. The baffles 36', 36^a, and 39 are arranged between certain of the transverse rows of boiler section tubes 54, 55, 56, 57 and 58, to provide a long zig zag passage for the heated gases and these tubes and the vertical water tubes within the furnace section 33 absorb practically all of the heat generated before these gases discharge through the opening 40.

In the boiler section 39^a, the side headers 25 are preferably connected by horizontal water tubes 59, arranged between the transverse rows of vertical water tubes.

The bottom 11 has a bridge 60 at the rear of which is an ash pit 61 having an ash removal door 62. One or both side water headers may be provided with an entry passage 63 formed by a tube and covered by a suitable door. This passage is arranged near and above the ash pit 61. The forward end 18 has an opening 64 between its lower end and the bridge 60 and this opening extends throughout substantially the entire width of the forward end 18.

The numeral 65 designates endless chain grate elements of a chain grate stoker. These endless chain grate elements are supported by sprocket wheels 65' and 66. The sprocket wheels 65' are disposed exteriorly of the furnace section 33 while the sprocket wheels 66 are arranged within the furnace section over the ash pit 61.

The endless chain grate elements are driven in the usual manner so that their upper runs travel rearwardly as indicated by the arrows. The endless chain grate elements extend through the transverse opening 64 and are suitably spaced from the top wall of the opening 64 to provide a passage for the fuel 67, supplied from a hopper 68.

Particular attention is called to the fact that the endless chain grate elements are arranged in close relation to the inner vertical side walls 28 of the side wall headers 25. The inner vertical walls 28 extend only to the level of the upper runs of the endless chain grate elements while they extend above the upper runs of the said grate elements and above the bed of fuel 67 for a considerable distance. The side water headers and the upper runs of the endless chain grate elements therefore constitute a fuel bed holding portion. The fuel bed therefore contacts with the vertical walls 28 of the side water headers and not with the refractory sides 17. During the operation of the boiler the molten ash will adhere to the inner vertical wall 28 and this molten ash may be removed by reducing capacity operations when permissible, which will cool the molten ash and such ash will then solidify and the resultant ash slag 69 formed upon the water cooled vertical metal wall 28 will automatically fall from the vertical water cooled surface into the fuel bed so that the grate, traveling or dumping, will discharge the ash slag into the ash pit.

It is to be understood that the invention is not restricted to the use of a chain grate stoker and that other types of stokers may be employed. I may employ a stoker having a dumping grate with mechanical means to push the fuel rearwardly along the grate. When this form of stoker is used the grate is arranged near the bottom of the side water headers, in the position occupied by the upper runs of the endless chain grate elements 65 so that the side water headers will project for substantial distances above the fuel bed carried by the grate. I also contemplate using a grate without the stoker feature, in which event the grate will be arranged near the lower ends of the side water headers. The invention is not necessarily restricted to the use of solid fuel requiring grates, as I contemplate using powdered solid fuel or oil. In this event, a burner nozzle would extend through a suitable opening formed in the forward end 18, and the large opening 64 would be dispensed with. The forward end 18 may be provided with any suitable number and arrangement of openings, depending upon the type of fuel handling apparatus to be used. The water tubes which extend over the end 18 to cool the same, will be suitably shaped or bent to accommodate themselves to these openings, or some of these tubes may be omitted. In some circumstances, the water tubes which contact with the forward end 18 and the baffle 35 to cool the same, may be dispensed with.

The operation of the steam boiler is as follows: The fuel is burned within the furnace section 33 and the longitudinal rows of tubes 43 reduce the temperature and cool the sides 17. The water tubes contacting with the forward end 18 and baffle 35 also cool these parts and further reduce the temperature. The heated gases, at a somewhat reduced temperature, now travel through the long zig zag passage produced by the baffles and heat exchange is effected with the water in the bank of water tubes of the boiler section. The fuel bed upon the grate contacts

with the inner vertical water cooled metal walls 28 and not with the refractory sides 17. As a result of this no trouble will be experienced due to the abrasion of the refractories or clinker adherents to such refractories. When the molten ash adheres to the flat vertical water cooled walls 28 the same may be removed therefrom by reducing capacity operations when permissible, which will cool the ash and such ash will then solidify and the resultant ash slag will automatically drop from the wall 28 into the fuel bed. This slag will be discharged into the ash pit by the action of the grate which may be of the traveling or dump type.

It is to be understood that the form of my invention herewith shown and described is to be taken as a preferred example of the same and that various changes in the shape, size, and arrangement of parts may be resorted to without departing from the spirit of my invention or the scope of the subjoined claims.

Having thus described my invention, what I claim is:

1. In a steam boiler, a casing formed of refractory material, means to divide the casing into a furnace section and a boiler section, an upper central longitudinal water and steam drum extending throughout substantially the entire length of the casing, side water headers having inner substantially vertical and substantially flat sides, the headers extending throughout substantially the entire length of the casing, a grate arranged within the furnace section and disposed between the inner substantially vertical sides of the headers, said side water headers having their bottoms arranged generally at the elevation of the upper surface of the grate so that such headers project above the upper surface of the grate throughout the major portion of their vertical dimensions, said grate and side water headers constituting deep means for holding a fuel bed and retaining the same out of contact with the refractory sides of the casing, longitudinal rows of upstanding water tubes arranged within the furnace section and disposed adjacent to the sides of the furnace section to cool the same and having their lower ends connected with the side water headers and their upper ends connected with the water and steam drum, and a bank of upstanding tubes arranged within the boiler section and connected at their lower ends with the side water headers and at their upper ends with the water and steam drum.

2. In a steam boiler, a casing formed of refractory material, means to divide the casing into a furnace section and a boiler section, an upper central longitudinal water and steam drum extending throughout substantially the entire length of the casing, side water headers having inner substantially vertical and substantially flat sides, the headers extending throughout substantially the entire length of the casing, said headers being arranged within the lower portion of the furnace section and having their inner substantially vertical and substantially flat sides arranged for contact with the fuel bed, a grate arranged within the furnace section between the inner substantially vertical sides of the headers to support the fuel bed, said headers having a much greater vertical transverse dimension than horizontal transverse dimension and projecting above the upper surface of the grate throughout the major portion of the vertical dimensions of such headers so that the fuel bed is retained out of contact with the refractory sides of the fur-

nace section, longitudinal rows of upstanding water tubes arranged within the furnace section and disposed adjacent to the sides of the furnace section to cool the same and having their lower ends connected with the side water headers and their upper ends connected with the water and steam drum, and a bank of upstanding water tubes arranged within the boiler section and connected at their lower ends with the side water headers and at their upper ends with the water and steam drum.

3. In a steam boiler, a casing formed of refractory material, said casing having a furnace section and a boiler section, an upper central longitudinal water and steam drum extending throughout substantially the entire length of the casing, side water headers which are substantially rectangular in transverse vertical section arranged within the lower portion of the casing and extending throughout substantially the entire length of the casing, said headers having inner substantially vertical and substantially flat sides, an endless chain grate device arranged within the furnace section between the inner substantially vertical sides of the headers to support the fuel bed and move the same rearwardly said headers having a considerably greater vertical transverse dimension than horizontal transverse dimension and having the major portions of their vertical dimensions arranged above the upper face of the endless chain grate, the inner substantially vertical sides of the headers contacting with the fuel bed and extending above the same to retain the fuel bed out of contact with the refractory sides of the furnace section, longitudinal rows of upstanding water tubes arranged within the furnace section and disposed adjacent to the sides of the furnace section to cool the same and having their lower ends connected with the side water headers and their upper ends connected with the water and steam drum, and a bank of upstanding water tubes arranged within the boiler section and connected at their lower ends with the side water headers and at their upper ends with the water and steam drum.

4. In a steam boiler, a casing formed of refractory material, said casing including sides, a forward end and a rear end, a baffle arranged within the casing to form therewith a furnace section and a boiler section, an upper central longitudinal water and steam drum extending throughout substantially the entire length of the casing, side water headers which are rectangular in vertical cross section arranged within the casing and extending throughout substantially the entire length of the casing, each header comprising inner and outer substantially vertical sides the inner sides being substantially flat, a substantially horizontal top section and a substantially horizontal bottom, each header being embedded within the lower portion of the refractory side of the casing and projecting inwardly beyond such side, a grate arranged within the furnace section between the inner substantially vertical and substantially flat sides of the headers to support the fuel bed, the headers extending above the grate for the major portion of their vertical dimensions, longitudinal rows of upstanding water tubes arranged within the furnace section and disposed adjacent to the sides of the furnace section to cool the same and having their lower ends connected with the substantially horizontal top sections of the headers and their upper ends connected with the water and

steam drum, and a bank of upstanding water tubes arranged within the boiler section and connected at their lower ends with the side water headers and at their upper ends with the water and steam drum.

5. In a steam boiler, a casing formed of refractory material, said casing including sides, a forward end and a rear end, a baffle arranged within the casing to form therewith a furnace section and a boiler section, an upper central longitudinal water and steam drum extending throughout substantially the entire length of the casing, side water headers arranged within the lower portion of the furnace section and within the lower portion of the boiler section and extending throughout substantially the entire length of the casing, each header comprising inner and outer substantially vertical sides, the inner substantially vertical sides being substantially flat a substantially horizontal top section and a substantially horizontal bottom, each header being embedded within the refractory side of the casing and projecting inwardly beyond such side, a grate arranged within the furnace section between the inner substantially vertical sides of the headers, said headers having the major portion of their vertical dimensions arranged above the upper surface of the grate, the substantially vertical sides of the headers extending above the grate for a substantial distance, a longitudinal row of upstanding water tubes arranged within the furnace section and disposed in substantial contact with each refractory side of the furnace section to cool the same, the tubes in the longitudinal row being arranged in close relation and having their lower ends connected with the substantially horizontal top section of the header, the tubes in the longitudinal row having their upper ends disposed in two groups having different elevations so that such upper ends are staggered, the upper staggered ends being connected with the water and steam drum, and a bank of upstanding water tubes arranged within the boiler section and connected at their lower ends with the side water headers and at their upper ends with the water and steam drum.

6. In a steam boiler, a casing formed of refractory material, said casing including sides, a forward end and a rear end, a baffle arranged within the casing to form therewith a furnace section and a boiler section, an upper central longitudinal water and steam drum extending throughout substantially the entire length of the casing, side headers arranged within the casing and extending throughout substantially its entire length, the side headers being disposed within the lower portion of the furnace section, each header comprising inner and outer substantially vertical sides, the inner side being substantially flat, a substantially horizontal top section and a substantially horizontal bottom, each header being embedded within the refractory side of the casing and projecting inwardly beyond such side, a grate arranged between the inner substantially flat faces of the headers, said headers having a considerably greater transverse vertical dimension than transverse horizontal dimension and projecting above the grate throughout the major portion of their vertical dimensions, a longitudinal row of upstanding water tubes arranged within the furnace section and disposed in substantial contact with each refractory side of the furnace section to cool the same, the tubes in the longitudinal row being arranged in close re-

lation and having their lower ends connected with the substantially horizontal top section of the header, the alternate tubes in the longitudinal row having their upper ends staggered and connected with the water and steam drum, and a bank of upstanding tubes arranged within the boiler section and connected at their lower ends with the inner substantially vertical sides of the side water headers and at their upper ends with the water and steam drum, the tubes in the bank being spaced sufficient distances apart so that the heated gases will travel through the boiler section without an induced draft.

7. In a steam boiler, a casing formed of refractory material, said casing including sides, a forward end and a rear end, a baffle arranged within the casing to form therewith a furnace section and a boiler section, an upper central longitudinal water and steam drum extending throughout substantially the entire length of the casing, side headers arranged within the casing and extending throughout substantially its entire length, the side headers being disposed within the lower portion of the furnace section, each header comprising inner and outer substantially vertical sides, a substantially horizontal top section and a substantially horizontal bottom, each header having a considerably greater vertical transverse dimension than horizontal transverse dimension, each header being embedded within the refractory side of the casing and projecting inwardly beyond such side, a longitudinal row of upstanding water tubes arranged within the furnace section in substantial contact with each refractory side of the furnace section, the tubes in the longitudinal row being arranged in close relation and having their lower ends connected with the substantially horizontal top section of the header, the alternate tubes in the longitudinal row having their upper ends staggered and connected with the water and steam drum, a transverse row of upstanding water tubes arranged within the furnace section and substantially contacting with the forward end of the casing and having their lower ends connected with the inner substantially vertical sides of the side headers and their upper ends connected with the water and steam drum, a transverse row of upstanding water tubes arranged within the furnace section and substantially contacting with the baffle to cool the same and connected at their lower ends with the inner substantially vertical sides of the headers and at their upper ends with the water and steam drum, and a bank of upstanding tubes arranged within the boiler section and connected at their lower ends with the inner substantially vertical sides of the headers

and at their upper ends with the water and steam drum.

8. In a steam boiler, a casing formed of refractory material, said casing including sides, said casing having a furnace section and a boiler section, an upper central longitudinal water and steam drum for the furnace and boiler section, side water headers for the furnace and boiler sections, the side water headers being disposed within the lower portion of the furnace and boiler sections, each header comprising inner and outer substantially vertical sides, stay bolts connecting the sides, each header having its inner side uncovered, each header having a considerably greater vertical transverse dimension than horizontal transverse dimension, a longitudinal row of upstanding water tubes arranged within the furnace section in substantial contact with each refractory side of the furnace section, the tubes in each row having their lower ends connected with the substantially horizontal top of the adjacent side water header and their upper ends connected with the water and steam drum, and a bank of upstanding water tubes in the boiler section, including two groups of such tubes, one group of such tubes having their lower ends connected with the substantially vertical inner side of one side water header and their upper ends connected with the water and steam drum.

9. In a steam boiler, a casing formed of refractory material, said casing including sides, said casing having a furnace section and a boiler section, an upper central longitudinal water and steam drum, side water headers arranged within the casing, each side water header having a substantial vertical dimension and including parallel vertical inner and outer sides, stay bolts connecting the sides, each header having its inner side uncovered, a longitudinal row of upstanding water tubes arranged within the furnace section in contact with each refractory side of the furnace section and having their lower ends connected with the substantially horizontal top of the adjacent header and their upper ends connected with the water and steam drum, an upstanding bank of water tubes within the boiler section having their lower ends connected with the substantially vertical inner faces of the headers and their upper ends with the water and steam drum, a grate arranged between the substantially vertical inner faces of the headers and having its upper face disposed at approximately the elevation of the bottoms of the headers, and transverse horizontal tubes arranged within the boiler section and connected with the side headers.

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