April 30, 1935. K. C. SCHMIDT 1,999,983

STEAM BOILER

Filed Dec. 29, 1933 3 Sheets-Sheet 1

Fig. 4

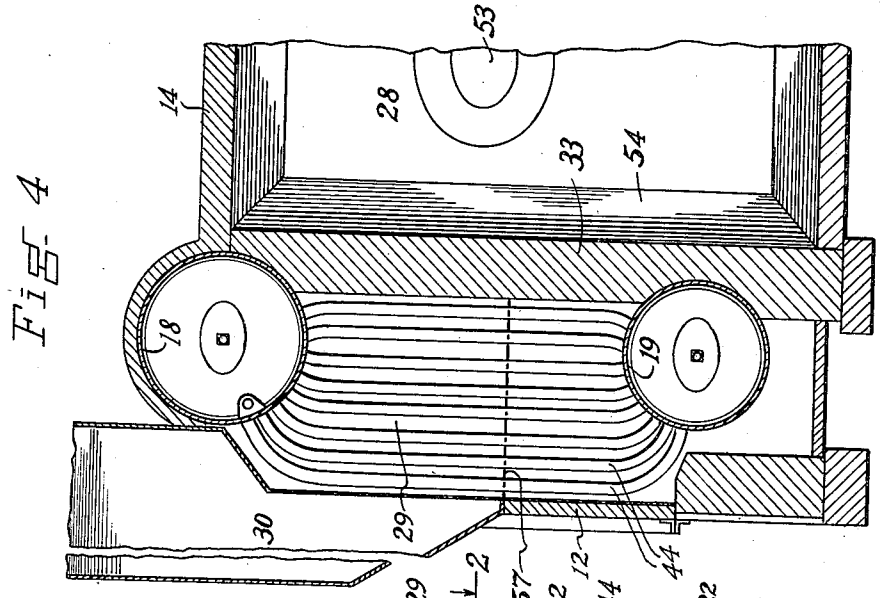
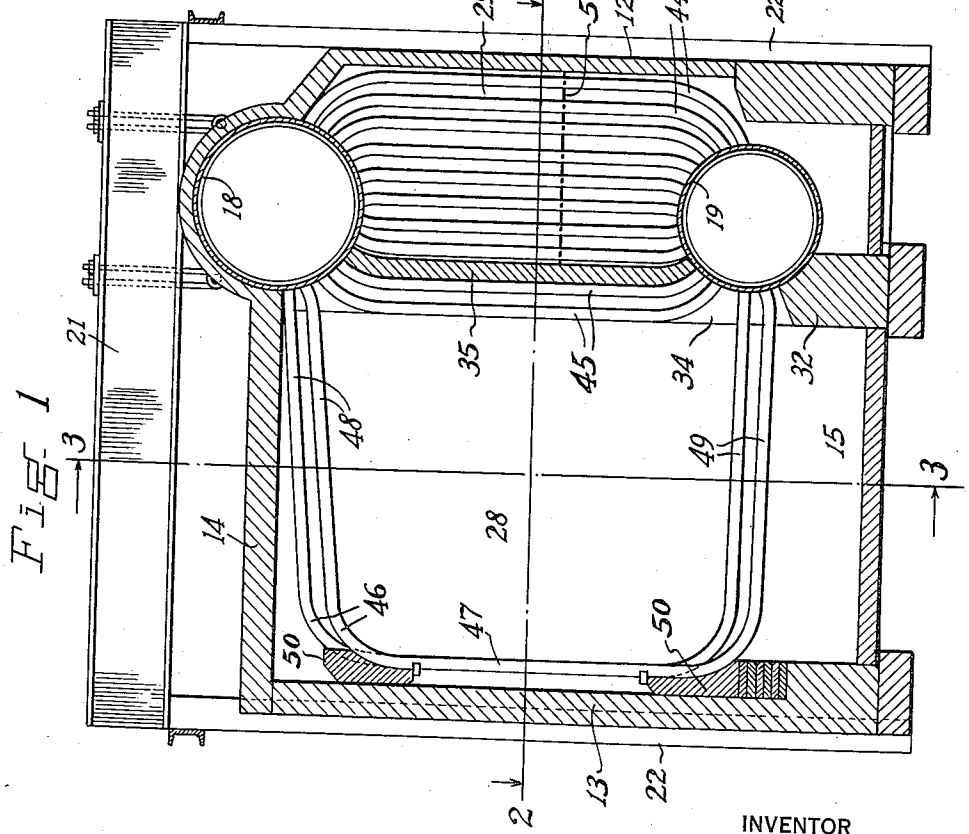


Fig. 1

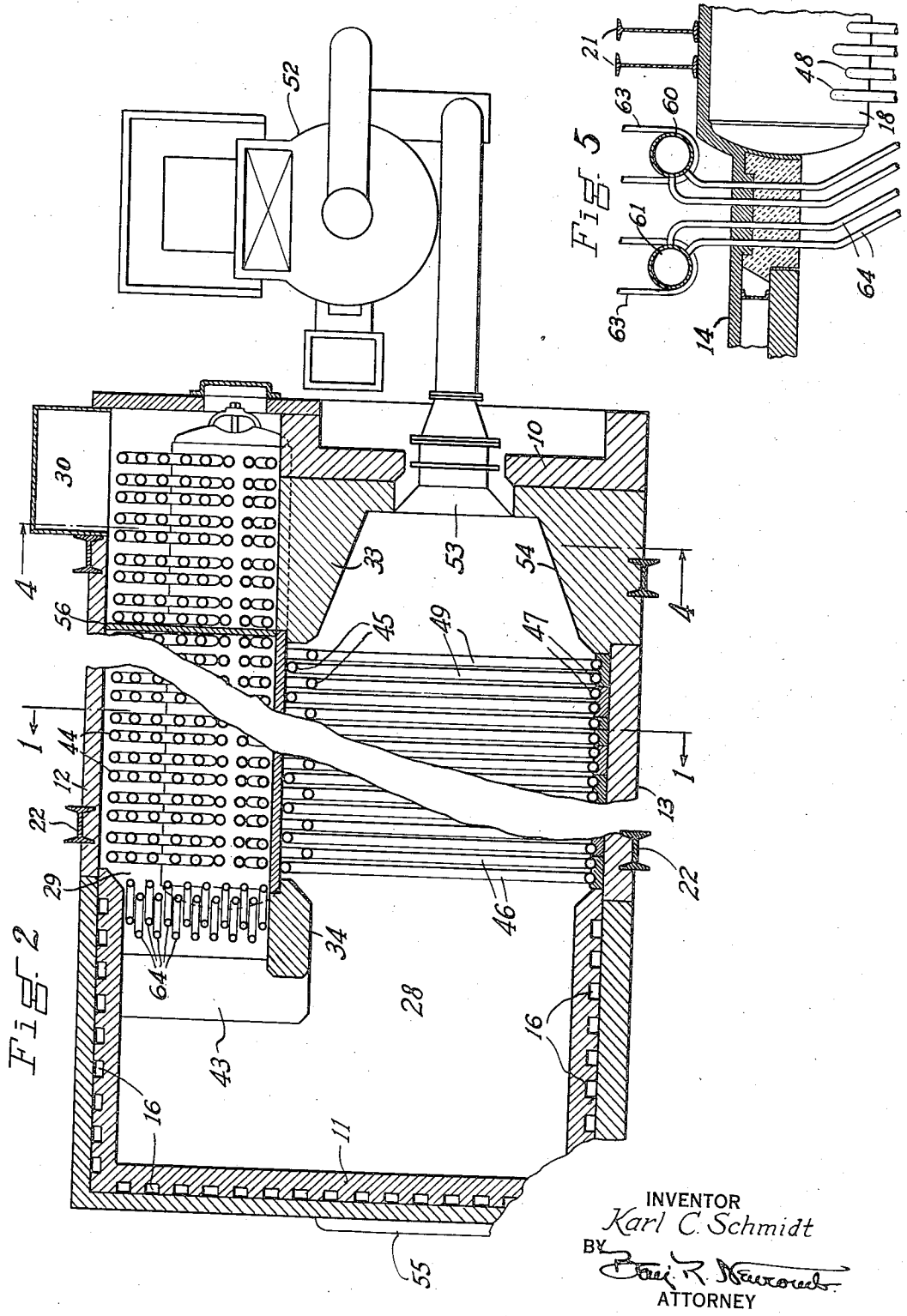


INVENTOR
Karl C. Schmidt
BY
Benj. R. Newcomb
ATTORNEY

April 30, 1935. K. C. SCHMIDT 1,999,983

STEAM BOILER

Filed Dec. 29, 1933 3 Sheets-Sheet 2



INVENTOR
Karl C. Schmidt
BY
ATTORNEY

April 30, 1935. K. C. SCHMIDT 1,999,983

STEAM BOILER

Filed Dec. 29, 1933 3 Sheets-Sheet 3

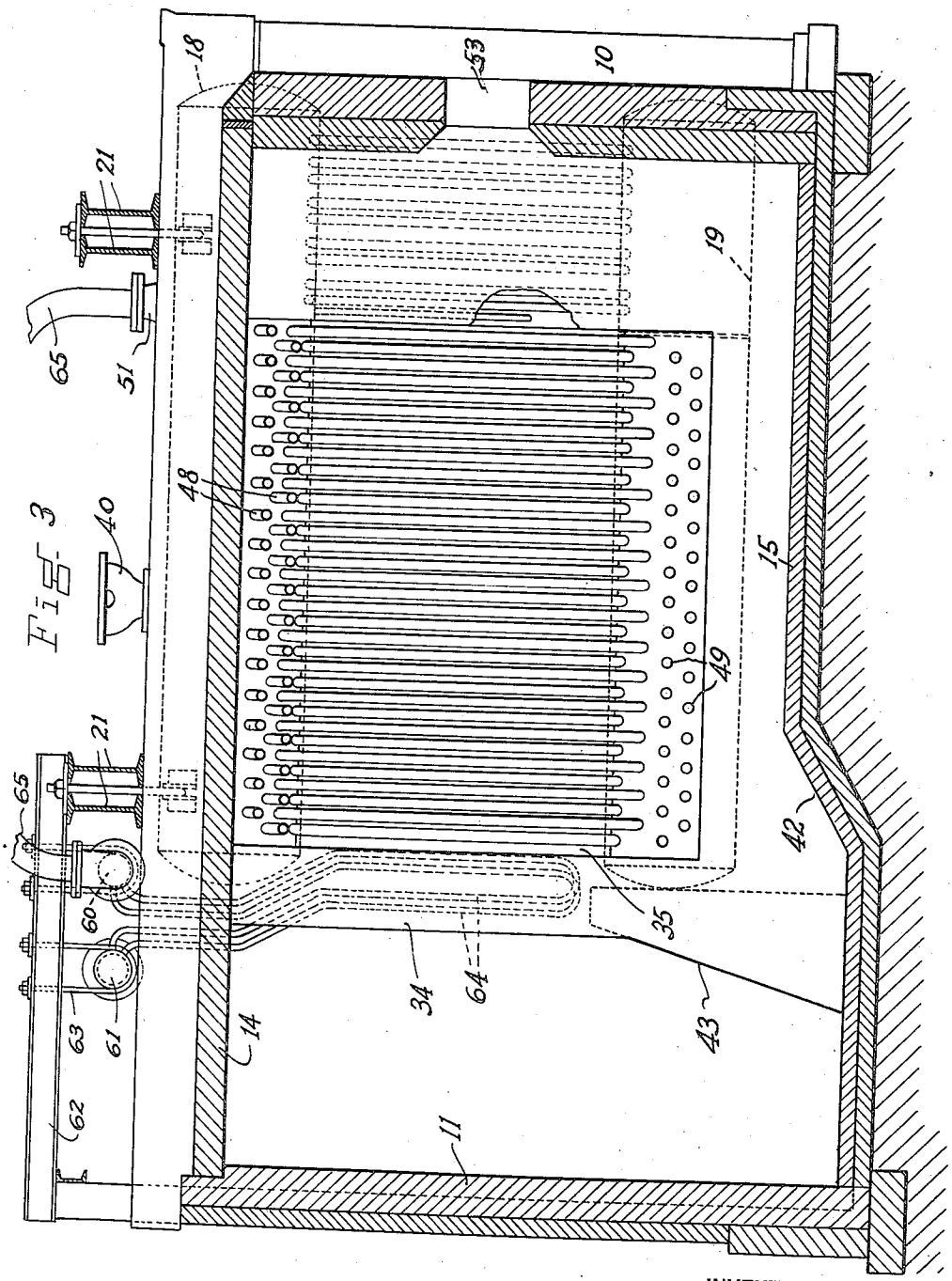


Fig. 3

INVENTOR
Karl C. Schmidt
BY
ATTORNEY

Patented Apr. 30, 1935 1,999,983

UNITED STATES PATENT OFFICE

1,999,983

STEAM BOILER

Karl C. Schmidt, Western Springs, Ill., assignor to The Babcock & Wilcox Company, Newark, N. J., a corporation of New Jersey

Application December 29, 1933, Serial No. 704,426

5 Claims. (Cl. 122—336)

My present invention relates to superheater steam boilers, and particularly to the construction and location of the steam superheating surface therein.

Steam superheaters have been heretofore heated either by the absorption of radiant heat from the furnace chamber, or by contact with and conduction from heating gases from the boiler furnace after the gases had been partially cooled by contact with steam generating surface positioned between the superheating surface and the furnace chamber. It is well known that in superheaters of the radiant type the degree of superheat secured tends to decrease as the boiler load increases due to the consequent greater increase in the amount of steam to be superheated as compared with the increase in furnace temperature due to the increased fuel supply with increasing boiler loads. It is also well known that in superheaters of the convection type, the degree of superheat secured tends to increase as the boiler load increases due to the increased weight and temperature of the heating gases contacting with the superheating surface as compared to the increase in the amount of steam passed through the superheater.

It is also known that a convection type superheater located near the furnace chamber will give a superheating effect which will vary less with changes in boiler load than a convection type superheater located nearer the boiler heating gas outlet. The most favorable location for a convection type superheater is that in which the contacting heating gases reach the superheater after having been cooled only sufficiently that safe superheater metal temperatures will not be exceeded. For this reason, steam generating surface is normally interposed in the gas flow path between the superheater and the furnace.

A relatively high uniform steam superheat temperature over the normal range of boiler loads is especially desirable from the standpoint of steam turbine design and performance.

The general object of my invention is the provision of an improved location and construction of a steam superheater in a boiler which is characterized by the maintenance of relatively high substantially uniform superheat temperatures with varying boiler loads. A more specific object is the provision of a steam superheater constructed and arranged to receive heat partly by convection and partly by radiation and in proportions to maintain a substantially uniform superheat temperature over a wide range of boiler loads. A further and more specific object is the provision of a steam superheater heated mainly by convection in a location in which a pure convection heated superheater would have a minimum variation in superheat temperature with varying loads, while receiving sufficient heat by radiation to substantially neutralize the tendency for variation in superheat temperatures due to the heat received by convection. A still further object is an improved construction and location of a steam superheater in a steam boiler, such as shown in my prior pending application, Serial No. 588,511, filed Jan. 25, 1932, wherein the furnace chamber and the chamber including the main steam generating tube bank form laterally adjoining consecutively communicating lanes having a substantially horizontal flow of heating gases therethrough.

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 a preferred embodiment of my invention.

Of the drawings:

Fig. 1 is a vertical transverse sectional view of a steam boiler embodying my invention taken on the line 1—1 of Fig. 2;

Fig. 2 is a horizontal sectional view taken on the line 2—2 of Fig. 1 and with an intermediate portion broken away;

Fig. 3 is a vertical longitudinal sectional view taken on the line 3—3 of Fig. 1;

Fig. 4 is a fragmentary vertical sectional view taken on the line 4—4 of Fig. 2; and

Fig. 5 is an enlarged detail sectional view of the superheater.

In the drawings, I have illustrated my invention as embodied in a steam boiler of the type disclosed in my said prior application Serial No. 588,511, having a housing or setting formed by a refractory front wall 10, rear wall 11, right and left side walls 12 and 13 respectively, top wall 14, usually referred to as the roof or arch, and a bottom wall or floor 15, said walls being provided with air circulation channels 16 where desired for cooling the walls, roof and/or floor and for preheating air for combustion purposes.

Mounted within this housing is an upper steam and water drum 18 and a lower water drum 19, both of which extend from the front wall 10 rearwardly, with their rear ends spaced a sub-

stantial distance from the rear wall 11. The drums 18 and 19 are connected substantially throughout their entire length by a large number of steam generating tubes which afford communication between the drums and serve also to support the lower drum 19 from the upper drum 18, the latter with the attached tubes and lower drum being suspended from two sets of girders 21 extending transversely across the top of the boiler housing and mounted on vertical I-beams 22.

The drums 18 and 19, which are positioned with their longitudinal axes in vertical alignment, are located nearer the side wall 12 of the boiler housing, and a partition or baffle wall is provided along the sides of the drums remote from the wall 12 extending rearwardly from the front wall 10 and terminating a substantial distance from the rear wall 11, thus dividing the interior of the housing into laterally adjoining furnace and tube chambers 28 and 29 respectively, which communicate with one another at their rear ends. The furnace chamber 28 is much wider than the tube chamber 29 and arranged to have fuel supplied thereto at its front end so that combustion will take place principally in this chamber, while the narrower tube chamber 29 has a gas outlet opening 30 therefrom at its front end, so that the flames and hot gases resulting from the combustion in the furnace chamber 28 will sweep rearwardly therein to the rear of the boiler housing where the gases turn and enter the open rear end of the tube chamber 29 and pass forwardly therethrough to the gas outlet 30. This flow path insures complete combustion of the fuel and a sufficient length of heating gas travel to permit efficient utilization of the heat before passing out through the outlet 30.

The partition or baffle wall dividing the interior of the boiler housing into two chambers is formed by a curb portion 32 extending along the floor 15 at the inner side of and under the lower drum 19 and terminating in upwardly extending end portions 33 and 34, between which an intermediate panel 35 fits and closes the spaces between the upper and lower drums 18 and 19.

The floor 15 of the boiler housing is preferably sloped downwardly at its rear end, as indicated at 42 in Fig. 3, to a lower level to form an ash pit, and on this lower level portion is an abutment or bridge wall 43 which extends across the entrance to the rear end of the tube chamber 29 between the curb end portion 34 and the side wall 12 and projects upwardly to a point slightly above the top of the lower drum so that the heating gases entering the tube chamber will be directed into the space between the upper and lower drums.

Two separate groups of tubes connect the drums 18 and 19, namely, a group of tubes in the tube chamber 29 and a group of tubes in the furnace chamber 28. The tubes in the tube chamber 29, designated 44, are arranged vertically and closely spaced throughout substantially the entire length of the drums and throughout substantially the entire width of the tube chamber, and preferably arranged in longitudinal rows which are suitably spaced from one another and from the side walls of the tube chamber to insure adequate circulation throughout the chamber and substantially uniform exposure of the tubes. The tubes in the furnace chamber 28 are arranged around the zone of combustion and comprise a double row of tubes 45 along the baffle wall 35 and U-shaped tubes 46 which connect with the upper and lower drums 18 and 19 respectively, above and below the tubes 45, the tubes 46 being offset laterally so that the vertical middle portions 47 thereof are adjacent the side wall 13, while the top and bottom arms 48 and 49 respectively, of adjacent U-shaped tubes, are staggered across the top and bottom of the furnace chamber. The outer extremities of the U-shaped tubes 46 are supported in position by blocks 50 engaging the tubes 46 at their bends.

The rows of tubes 45 and 46 end at a distance from the front ends of the drums, as shown in Figs. 2 and 3, leaving a substantial drum length at the forward end unprovided with connecting tubes 45 and 46. The omission of these tubes not only facilitates ignition of the fuel, but also lowers the cost of construction, since the fuel entering at the front of the furnace chamber will not reach an effective stage of combustion until it reaches approximately the location of the first tubes 45 and 46.

Feed water is introduced into the boiler at the front end of the drum 18 and is forced downwardly through selected tubes into the forward end of the lower drum 19. From the forward end of the lower drum the water is caused to flow upwardly through the remaining portion of the tube bank forward of the tubes 45 and 46.

The upper drum 18 is provided with a safety valve outlet 40 toward the rear thereof, while the normal outlet 51, through which the steam is supplied to the superheater is positioned at the front of the drum 18.

The fuel used in connection with this boiler is preferably gas, oil, pulverized coal or the like, a pulverized fuel installation being shown somewhat diagrammatically at 52 in Fig. 2, the fuel being discharged into the forward end of the furnace chamber 28 through an opening 53 in the front wall, which opening is located substantially centrally of the lane defined by the tubes 45 and 46 so that said tubes are subjected substantially uniformly to the radiant heat of the burning fuel. The walls forming the ignition section of the furnace chamber are preferably flared, as shown at 54 in Fig. 2, so that any heat reflected therefrom is directed back into the zone of the tubes 45 and 46. A door 55 in the rear wall affords access for removal of any fuel residue that accumulates in the pit at the rear end of the combustion chamber.

To avoid concentration of flow and escape of the heated gases in the tube chamber at the top thereof with a resultant short circuiting of the tube surface in the lower part thereof, a baffle 56 is provided in the tube chamber near the outlet 30 which closes off the top of the chamber from the upper drum 18 down approximately half way to the lower drum 19, as for example, to the level of the dotted line 57 in Figs. 1 and 4, the exact lower extent of this baffle being determined according to the volume of gas to be passed and the available draft. This baffle, which in the present structure is preferably located immediately in front of the foremost tubes 45 and 46 of the furnace chamber, also serves to insure removal from the chamber 29 of the coldest gases since only the coldest gases will descend and pass under this baffle.

With this boiler construction there is not only an unusually large area of radiant tube exposure in a minimum amount of space, but by separating the interior of the boiler housing into adjoining

parallel lanes for combustion and gas travel, a sufficient length of travel is provided to insure complete combustion of the fuel and effective use of the generated heat. Furthermore, it is to be particularly noted that all the tubes of the boiler are arranged substantially at right angles to the direction of travel of the heated gases so that the greatest heating efficiency is assured.

I have determined that the most favorable location in a boiler of the character described for a steam superheater which will give a substantially uniform high superheat temperature over the normal range of loads, is in the end of the tube chamber **29** directly communicating with the combustion chamber. Accordingly, a superheater of the pendent type has been located across the rear end of the tube chamber. As shown, the superheater comprises inlet and outlet headers **60** and **61** respectively, arranged transversely of and above the boiler housing and supported in any suitable manner, such as by longitudinal I-beams **62** and U-bolt hangers **63**, as shown in Fig. 3. The inlet and outlet headers are connected for a steam flow therebetween counter to the flow of heating gases contacting with a plurality of rows of U-shaped superheater tubes **64** having their ends connected to the headers **60** and **61** and arranged in staggered relation across the tube chamber to insure substantially uniform heating of all of the tubes. The superheater tubes are bent forwardly, as shown in Figs. 3 and 5, after passing through the top wall **14** so that they will be shielded by the uprising rear end portion **34** of the curb **32** from direct exposure to the flames in the laterally adjoining portion of the furnace chamber. The U-tubes extend downwardly to a point adjacent the top of the abutment **43** to prevent by-passing of the superheater surface.

With the superheater construction and arrangement described, steam to be superheated is passed from the drum outlet **51** through a pipe **65** to one end of the header **60**, from which it passes downwardly through the front legs of the superheater tubes and then upwardly through the rear legs to the outlet header **61**. The superheater tubes will receive a major portion of the heat required by convection and conduction from the high temperature heating gases which reach the superheater after being slightly cooled by the heat absorption of the furnace wall tubes **45** and **46**. The remaining heat supplied to the superheater tubes is received by radiation, as from the refractory housing walls **11**, **12**, and **14**. The relatively small increase in superheat temperature with increases in boiler load due to heating by convection in this location has been found to be substantially neutralized by the decreased heating effect by radiation with increases in boiler load, resulting in a substantially uniform superheat temperature over a wide range of loads. By way of example, and not of limitation, in one installation of the character described, the superheat temperature varied between 510° F. and 527° F. with numerous variations in load between 75% and 225% rating.

While in accordance with the provisions of the statutes I have illustrated and described herein the best form 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 an upper steam and water drum, a lower water drum, a bank of steam generating tubes connected to said drums along the length thereof, means including a vertically disposed partition forming a furnace chamber and a laterally adjoining tube chamber communicating therewith at one end and containing said tube bank, water tubes connected to said drums and laterally spaced from said partition and extending along the outer side of said furnace chamber, means for burning fuel in said furnace chamber and effecting a flow of heating gases longitudinally through said furnace chamber and reversely through said tube chamber and in thermal contact with the tubes therein, a heating gas outlet from one end of said tube chamber, and a superheater comprising inlet and outlet headers, and a plurality of staggered rows of U-shaped tubes positioned in the opposite end of said tube chamber and having their opposite ends connected to said inlet and outlet headers.

2. A steam boiler having walls forming a housing including an upper steam and water drum, a lower water drum, a bank of steam generating tubes connected to said drums along the length thereof, a vertically disposed partition dividing the space within the housing into a furnace chamber and a laterally adjoining tube chamber communicating therewith at one end and containing said tube bank, means for burning fuel in said furnace chamber and effecting a flow of heating gases longitudinally through said furnace chamber and reversely through said tube chamber and in thermal contact with the tubes therein, a heating gas outlet from one end of said tube chamber, and a superheater comprising a plurality of staggered rows of tubes positioned in front of said tube bank and extending across the opposite end of said tube chamber, said superheater tubes being arranged to receive heat by convection from said heating gases and by radiation from the adjacent housing walls.

3. A steam boiler having walls forming a housing including an upper steam and water drum, a lower water drum, a bank of steam generating tubes connected to said drums along the length thereof, a vertically disposed partition dividing the space within the housing into a furnace chamber and a laterally adjoining tube chamber communicating therewith at one end and containing said tube bank, water tubes connected to said drums and laterally spaced from said partition and extending along the outer side of said furnace chamber, means for burning fuel in said furnace chamber and effecting a substantially horizontal flow of heating gases longitudinally through said furnace chamber and reversely through said tube chamber and in thermal contact with the tubes therein, a heating gas outlet from one end of said tube chamber, and a superheater comprising a plurality of staggered rows of U-shaped tubes suspended in front of said tube bank and extending across the opposite end of said tube chamber, said superheater tubes being arranged to receive heat by convection from the heating gases on entering said tube chamber and by radiation from the adjacent housing walls.

4. A steam boiler having upright side and end walls forming a setting, a vertically disposed partition dividing the enclosed space into laterally adjoining furnace and tube chambers connected at one end, upper and lower drums extending

longitudinally of said tube chamber, a bank of vertically disposed water tubes in said tube chamber extending between and connected to said drums along the length thereof and disposed at both sides of the plane including the longitudinal axes of said drums, a series of water tubes having their upper and lower ends connected to said upper and lower drums respectively and surrounding said furnace chamber, means at the opposite end of said furnace chamber for burning fuel therein and directing a flow of heating gases longitudinally through said furnace chamber and reversely through said tube chamber in thermal contact with the water tubes therein, a heating gas outlet from said tube chamber, and a group of steam superheater tubes arranged in the end of said tube chamber communicating with said furnace chamber and in position to receive heat from said heating gases.

5. A steam boiler having walls including a refractory faced end wall forming a setting substantially rectangular in horizontal cross-section, a vertically disposed partition dividing the enclosed space into laterally adjoining furnace and tube chambers connected at their ends adjacent said refractory faced end wall, upper and lower drums extending longitudinally of said tube chamber, a bank of vertically disposed water tubes in said tube chamber extending between and connected to said drums along the length thereof and disposed at both sides of the plane including the longitudinal axes of said drums, means at the opposite end of said furnace chamber for burning fuel in suspension therein and directing a flow of heating gases longitudinally through said furnace chamber and reversely through said tube chamber in thermal contact with the water tubes therein, a heating gas outlet from said tube chamber, and a group of steam superheater tubes arranged across the end of said tube chamber communicating with said furnace chamber and in position to receive heat by convection from said heating gases and by radiation from said refractory faced end wall.

KARL C. SCHMIDT.