July 21, 1936. T. B. STILLMAN 2,048,039

STEAM BOILER

Original Filed June 30, 1933 2 Sheets-Sheet 1

Fig. 1

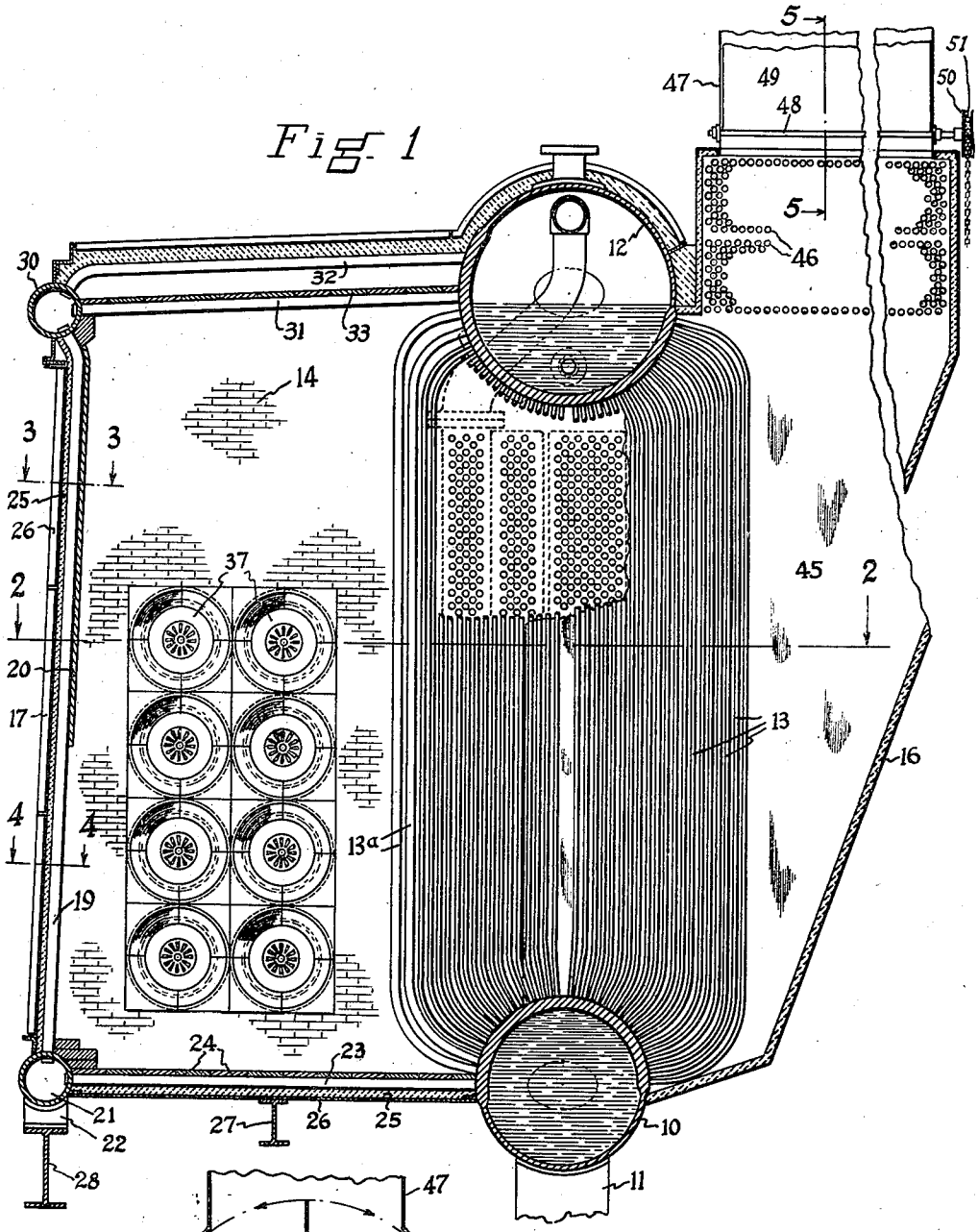
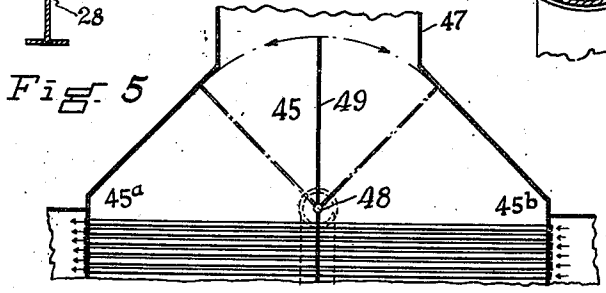


Fig. 5



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Fig. 2

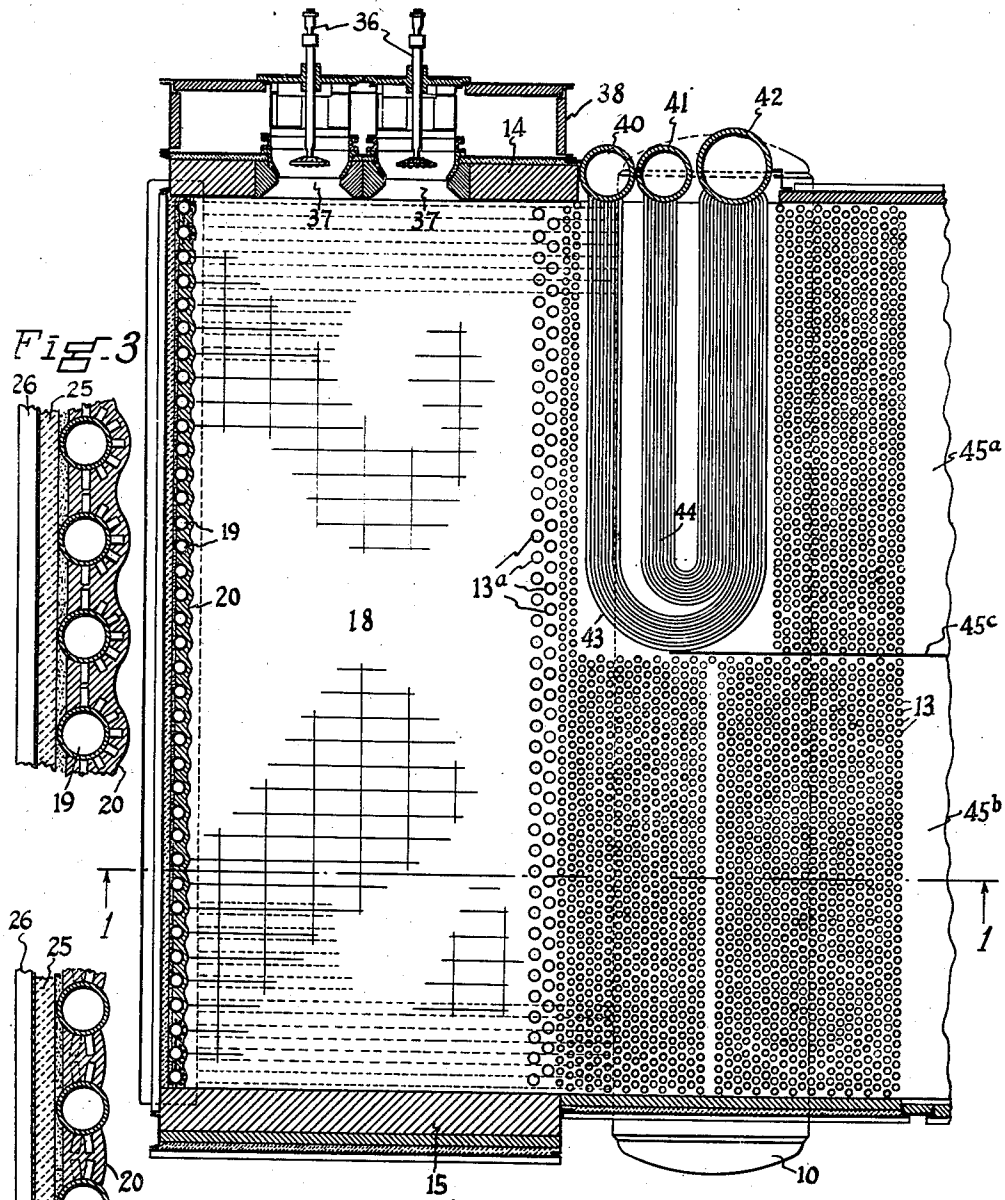


Fig. 3

Fig. 4

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UNITED STATES PATENT OFFICE

2,048,039

STEAM BOILER

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Application June 30, 1933, Serial No. 678,344
Renewed January 23, 1936

10 Claims. (Cl. 122—336)

My present invention relates to the construction and operation of water tube boilers in which the boiler steam generating surface is mainly concentrated in a single vertical bank of tubes extending between a lower water drum and an upper steam and water drum receiving heating gases from an integral fluid cooled furnace laterally adjoining the tube bank. Boilers of this type have been recently developed for industrial plants having low head room and relatively small steam generating requirements.

The object of my present invention is an improved construction of a two-drum boiler of the type described which is characterized by an arrangement of fuel burning provisions and a furnace construction permitting the efficient burning of a fluid fuel in suspension at extremely high rates of heat release per unit of furnace volume, a superheater location and arrangement providing a high degree of superheat and a compact arrangement of the superheater tubes, facilitating an accurate control of the degree of superheat, and permitting easy access to the superheater for tube replacement and cleaning, simple and effective means for regulating the superheat temperature, and a more effective arrangement of the hot and cold heating surfaces in the furnace chamber.

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 sectional elevation of a steam boiler embodying my invention, taken on the line 1—1 of Fig. 2 with a portion of the tube bank cut away to show superheater;

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

Figs. 3 and 4 are horizontal sections taken on the lines 3—3 and 4—4 respectively, of Fig. 1; and

Fig. 5 is a vertical section taken on the line 5—5 of Fig. 1.

The steam boiler illustrated in the drawings has a horizontally arranged lower water or mud drum 10 supported in a cradle 11 and connected to and supporting a similarly arranged upper steam and water drum 12 by an upright bank of tubes 13, extending between and symmetrically arranged relative to the drums 10 and 12. The major portions of the tubes 13 are straight and parallel, and the ends of the tubes are bent to enter the drums 10 and 12 radially. The axes of the drums are in vertical alignment and the tubes 13 are arranged in staggered rows extending longitudinally of the drums. The drums and tube bank are positioned in a housing having vertical front and rear refractory walls 14 and 15 respectively, and side walls 16 and 17 at opposite sides of the tube bank 13, the wall 16 being inclined upwardly from the tube bank and the wall 17 being laterally spaced a considerable distance from the opposite side of the tube bank.

The housing space between the tube bank 13 and the side wall 17 and closed at its ends by the walls 14 and 15 is the boiler furnace or combustion chamber 18, coextensive with the tube bank 13. The two rows of tubes 13*a* nearest the furnace chamber are of larger diameter and more widely spaced than the remaining rows of tubes 13 in the bank. The outer side wall 17 of the furnace is formed by a row of substantially straight stud tubes 19 with the inter-tube spaces closed by refractory material 20. In the upper part of the wall 17, the refractory material extends over the inner face of the wall, while in the lower part of the wall the inner faces of the tubes 19 are exposed to the radiant heat of the furnace chamber, as shown in Figs. 1, 3, and 4. The lower ends of the tubes 19 are connected to a horizontally arranged header 21 resting in a cradle 22. The center of the header 21 is at substantially the same level as that of the drum 10 and the drum and header are connected below the connections of the outermost row of tubes 13*a* by a row of horizontal spaced tubes 23. The spaces between the tubes 23 are closed by refractory blocks 24 resting on the tubes, the upper surfaces of which form a smooth floor for the furnace chamber. The floor and side walls described are backed by suitable insulating material 25 and metal plates 26 forming the boiler outer casing. The boiler furnace is supported by I-beams 27 and 28 extending below the floor and header 21 respectively.

The upper ends of the tubes 19 are connected to a horizontally arranged header 30 having its axis at a slightly lower level than the axis of the drum 12, and substantially in vertical alignment with the lower header 21. The header 30 is connected to the drum 12 by a lower row of straight tubes 31, and an upper row of bent tubes 32, both of which are longitudinally spaced and open into the drum 12 above the points of connection of the

tubes 13a. The spaces between the lower row of tubes 31 are closed by tile pieces 33 so that the tubes 31 define the roof of the furnace chamber. The upper rows of tubes 32 are also backed by heat insulating material 25 and plates 26. The furnace chamber so formed is thus surrounded on all sides along its length by rows of cooling tubes.

The fluid cooled furnace of the character described is especially intended for burning of a fluid fuel in suspension at extremely high rates of heat release per unit of furnace volume and with high boiler efficiencies. The provisions for supplying fuel to the furnace are mounted in the front wall 14 and consist of a battery of eight fuel oil burners 36 having fuel burner ports 37 symmetrically arranged in two vertical rows relative to the side walls of the furnace chamber. In operation, the fuel burners discharge parallel streams of fuel horizontally into the furnace chamber towards the rear or target wall thereof. Air for combustion is supplied through a casing 38 extending along the front wall and surrounding the burner ports. The several flame and gas streams starting rearwardly, turn in the furnace chamber and then flow transversely of the tube space in intimate contact with the tubes therein, while maintaining a horizontal direction, without baffling and therefore with a minimum draft loss.

The water tubes in a number of rows transversely of the tube bank 13 and extending from the front wall 14 about half the length of the tube bank are omitted to provide a space for a steam superheater having vertical inlet and outlet headers 40 and 41 respectively, and an intermediate header 42, arranged side-by-side along the front wall of the boiler. The inlet headers are connected to the intermediate header 42 by groups of looper tubes 43 and 44 respectively, arranged horizontally and extending longitudinally of the tube space within the confines of the tubes bank 13. The innermost rows of tubes 13 and 13a adjacent the combustion chamber are left in position to provide a water screen for protecting the superheater. The described superheater location results in an unusually compact boiler and accessible superheater. The horizontal arrangement of the superheater tubes between rows of vertical water tubes provides a gas mixing action which minimizes stratification of the heating gases.

At the outer side of the tube bank 13 the wall 16 is arranged to form an upwardly expanding gas duct 45, in the upper end of which is positioned an air heater formed by a bank of tubes 46, extending across the duct 45, as shown in Fig. 5. Above the air heater tubes 46, the duct 45 is progressively tapered and connected to a stack outlet 47.

A desirable control of the superheat temperature is effected by dividing the tube space and duct 45 into two parallel gas passes 45a and 45b by a vertical baffle plate 45c extending between the drums 10 and 12 adjacent the largest looped superheater tube 43, as shown in Fig. 2. The plate 45c extends to the rear wall 16 and upwardly to the top of the tubular air heater. At the upper end of the plate a rod 48 is rotatably mounted and serves as the support for a control damper 49. As shown in Figs. 1 and 5, the damper is movable between the full and dotted line positions to regulate the gas flow through the passes 45a and 45b, and thereby control the amount of gases passing over the superheater tubes 43 and 44. The flue and damper dimensions are so proportioned that in the extreme positions of the damper, a limited gas flow will exist through the pass over which the damper is arranged. The damper may be manually or automatically operated through a wheel 50 and chain 51.

Complete absence of baffles causing gases to change direction is an important feature of my construction, which contributes toward minimum draft loss, a factor of importance in high capacity light weight boilers. Another feature of importance is the end firing which allows a longer flame travel than is possible with cross firing without excessive width of boiler and makes most effective use of the furnace volume.

Certain novel structural features disclosed but not claimed herein are disclosed and claimed in my copending application Serial No. 678,343, filed June 30, 1933.

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 an upper steam and water drum, a lower water drum, a substantially vertical bank of steam generating tubes extending between and connected to said drum along the length thereof, means forming a fluid cooled furnace chamber laterally adjoining the space containing said tube bank and communicating therewith substantially throughout its length, said means including a row of radiant heated tubes having their opposite ends connected to said drums and defining the outer side wall of said furnace chamber, a group of vertically spaced fuel burners for burning fuel in suspension in said furnace chamber positioned in an end wall of said furnace chamber and effecting a substantially horizontal flow of heating gases longitudinally through said furnace chamber and then transversely of said tube space and contacting with the tubes therein, a heating gas outlet adjacent said steam and water drum at the side of said tube bank opposite said furnace chamber, vertically arranged superheater headers adjacent the firing end of said boiler, looped superheater tubes connecting said headers and extending longitudinally of said tube space and terminating substantially midway of the length of and within said tube bank, and a vertical baffle separating the space containing said superheater tubes from the remaining portion of said tube space.

2. A steam boiler having an upper steam and water drum, a lower water drum, a substantially vertical bank of steam generating tubes extending between and connected to said drum along the length thereof, means forming a furnace chamber laterally adjoining the space containing said tube bank and communicating therewith substantially throughout its length, a fuel burner positioned in an end wall of said furnace chamber for burning fuel in suspension in said furnace chamber and effecting a substantially horizontal flow of heating gases longitudinally through said furnace chamber and then transversely of said tube space and contacting with the tubes therein, a heating gas outlet at the side of said tube bank opposite said furnace chamber, a group of superheater tubes extending longitudinally of said tube space and within said tube bank, a ver-

tical baffle separating the space containing said superheater tubes from the remaining portion of said tube space, and a damper operable to control the portion of the heating gases contacting with said superheater tubes.

3. A steam boiler having an upper steam and water drum, a lower water drum, a substantially vertical bank of steam generating tubes extending between and connected to said drum along the length thereof, means forming a furnace chamber laterally adjoining the space containing said tube bank and communicating therewith substantially throughout its length, means for burning fuel in suspension in said furnace chamber and effecting a substantially horizontal flow of heating gases transversely of said tube space and contacting with the tubes therein, a heating gas outlet at the side of said tube bank opposite said furnace chamber, a group of superheater tubes extending part of the length of said tube space and within said tube bank, a vertical baffle adjacent the end of the space containing said superheater tubes, and a damper in said heating gas outlet operable to control the portion of the heating gases contacting with said superheater tubes.

4. A steam boiler having an upper steam and water drum, a lower water drum, a vertically disposed bank of steam generating tubes extending between and connected to said drums along the length thereof, means forming a furnace chamber laterally adjoining the space containing said tube bank and opening thereto substantially throughout the height and length of said tube bank, means for introducing and burning fuel in suspension in said furnace chamber and generating heating gases flowing longitudinally in said furnace chamber and transversely of said tube space in contact with the tubes therein, a heating gas outlet from said tube space at the side of said tube bank opposite said furnace chamber, a group of superheater tubes positioned within said tube bank and occupying only a portion of the heating gas flow area through said tube space, and damper means arranged and operable to vary the ratio between the portion of the heating gases passing through said tube space in contact with said superheater tubes and the portion of the heating gases passing through said tube space in contact with only steam generating tubes.

5. A two-drum steam boiler having an upper steam and water drum, a lower water drum, a vertically disposed bank of steam generating tubes extending between and connected to said drums along the length thereof, means forming a fluid cooled furnace chamber laterally adjoining the space containing said tube bank and opening thereto substantially throughout the height and length of said tube space, said means including a row of water tubes laterally spaced from said tube bank and having their upper ends connected to said upper drum, a header connected to the lower ends of said water tubes, a second row of water tubes connecting said heater to said lower drum, means for introducing and burning fuel in suspension in said furnace chamber and generating heating gases flowing longitudinally in said furnace chamber and transversely of said tube space in contact with the tubes therein, a heating gas outlet from said tube space at the side of said tube bank opposite said furnace chamber, a group of superheater tubes positioned within said tube bank and occupying only a portion of the heating gas flow area through said tube space, and damper means arranged to vary the ratio between the portion of the heating gases passing through said tube space in contact with said superheater tubes and the portion of the heating gases passing through said tube space in contact only with steam generating tubes.

6. A two-drum steam boiler having side and end walls forming a setting, a pair of substantially parallel horizontally disposed upper and lower drums in said setting, a vertically disposed bank of water tubes 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 group of steam superheater tubes positioned within said tube bank and occupying only a portion of the heating gas flow area therethrough, a furnace chamber laterally adjoining said tube bank and arranged substantially wholly at one side of said axial plane and opening substantially throughout its length to the space containing said tube bank, a row of water tubes extending along the side of the furnace chamber opposite said tube bank and having their upper ends connected to said upper drum and their lower ends to said lower drum, a fuel burner discharging through a wall of said furnace chamber for burning fuel in suspension therein and generating heating gases flowing transversely of said tube bank, a heating gas outlet at the opposite side of said tube bank, and damper means arranged and operable to vary the ratio between the portion of the heating gases passing through said tube space in contact with said superheater tubes and the portion of the heating gases passing through said tube space in contact with only steam generating tubes.

7. A two-drum steam boiler having side and end walls forming a setting, a pair of substantially parallel horizontally disposed upper and lower drums in said setting, a vertically disposed bank of water tubes 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 group of steam superheater tubes positioned within said tube bank, a furnace chamber laterally adjoining said tube bank and arranged substantially wholly at one side of said axial plane and opening substantially throughout its length to the space containing said tube bank, a row of water tubes extending along the side of the furnace chamber opposite said tube bank and having their upper ends connected to said upper drum, a header extending longitudinally of said furnace chamber and connected to the lower ends of said wall tubes, a row of water tubes connecting said header to said lower drum, means closing the spaces between and covering said last named tubes to define the floor of said furnace chamber, a fuel burner discharging through an end wall of said furnace chamber for burning fuel in suspension therein and generating heating gases flowing longitudinally in said furnace chamber and transversely of said tube bank, and a heating gas outlet at the opposite side of said tube bank.

8. A two-drum steam boiler having side and end walls forming a setting, a pair of substantially parallel horizontally disposed upper and lower drums in said setting, a vertically disposed bank of water tubes 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 group of steam superheater tubes positioned within said tube

bank, a furnace chamber laterally adjoining said tube bank and arranged substantially wholly at one side of said axial plane, said furnace chamber opening substantially throughout its length to the space containing said tube bank and across the full width of at least a portion of said space occupied by the upper end portions of the tubes in said tube bank, a row of water tubes extending along the side of the furnace chamber opposite said tube bank and having their upper ends connected to said upper drum, a header extending longitudinally of said furnace chamber and connected to the lower ends of said wall tubes, a row of water tubes connecting said header to said lower drum, means defining a floor for said furnace chamber, a fuel burner discharging through a vertical wall of said furnace chamber for burning fuel in suspension therein and generating heating gases flowing horizontally in said furnace chamber and transversely of said tube bank, and a heating gas outlet at the opposite side of said tube bank.

9. A two-drum steam boiler having side and end walls forming a setting, a pair of substantially parallel horizontally disposed upper and lower drums in said setting, a vertically disposed bank of water tubes 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 group of steam superheater tubes positioned within said tube bank, a furnace chamber laterally adjoining said tube bank and arranged substantially wholly at one side of said axial plane and opening to the space containing said tube bank substantially throughout the length and height of at least the portion thereof containing said superheater tubes, said tube bank including a plurality of rows of water tubes at the furnace side of said superheater tubes with the tubes in the row nearest the furnace chamber being of larger diameter than the water tubes at the opposite side of said superheater tubes, a row of water tubes extending along the side of the furnace chamber opposite said tube bank and having their upper ends connected to said upper drum and their lower ends to said lower drum, means defining a floor for said furnace chamber, a fuel burner for burning fuel in suspension in said furnace chamber and generating heating gases flowing horizontally in said furnace chamber and transversely of said tube bank, and a heating gas outlet at the opposite side of said tube bank.

10. A two-drum steam boiler having side and end walls forming a setting, a pair of substantially parallel horizontally disposed upper and lower drums in said setting, a vertically disposed bank of water tubes 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 group of steam superheater tubes positioned within and extending longitudinally of said tube bank, a furnace chamber laterally adjoining said tube bank and arranged substantially wholly at one side of said axial plane and opening substantially throughout its length to the space containing said tube bank, a row of water tubes extending along the side of the furnace chamber opposite said tube bank and having their upper ends connected to said upper drum, a header extending longitudinally of said furnace chamber and connected to the lower ends of said wall tubes, a row of water tubes connecting said header to said lower drum, means closing the spaces between and covering said last named tubes to define a flat floor of substantial area for said furnace chamber, a fuel burner discharging through an end wall of said furnace chamber for burning fuel in suspension therein and generating heating gases flowing longitudinally in said furnace chamber and transversely of said tube bank, a heating gas outlet passage at the opposite side of said tube bank, and a bank of air heating tubes arranged in said outlet passage adjacent said upper drum.

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