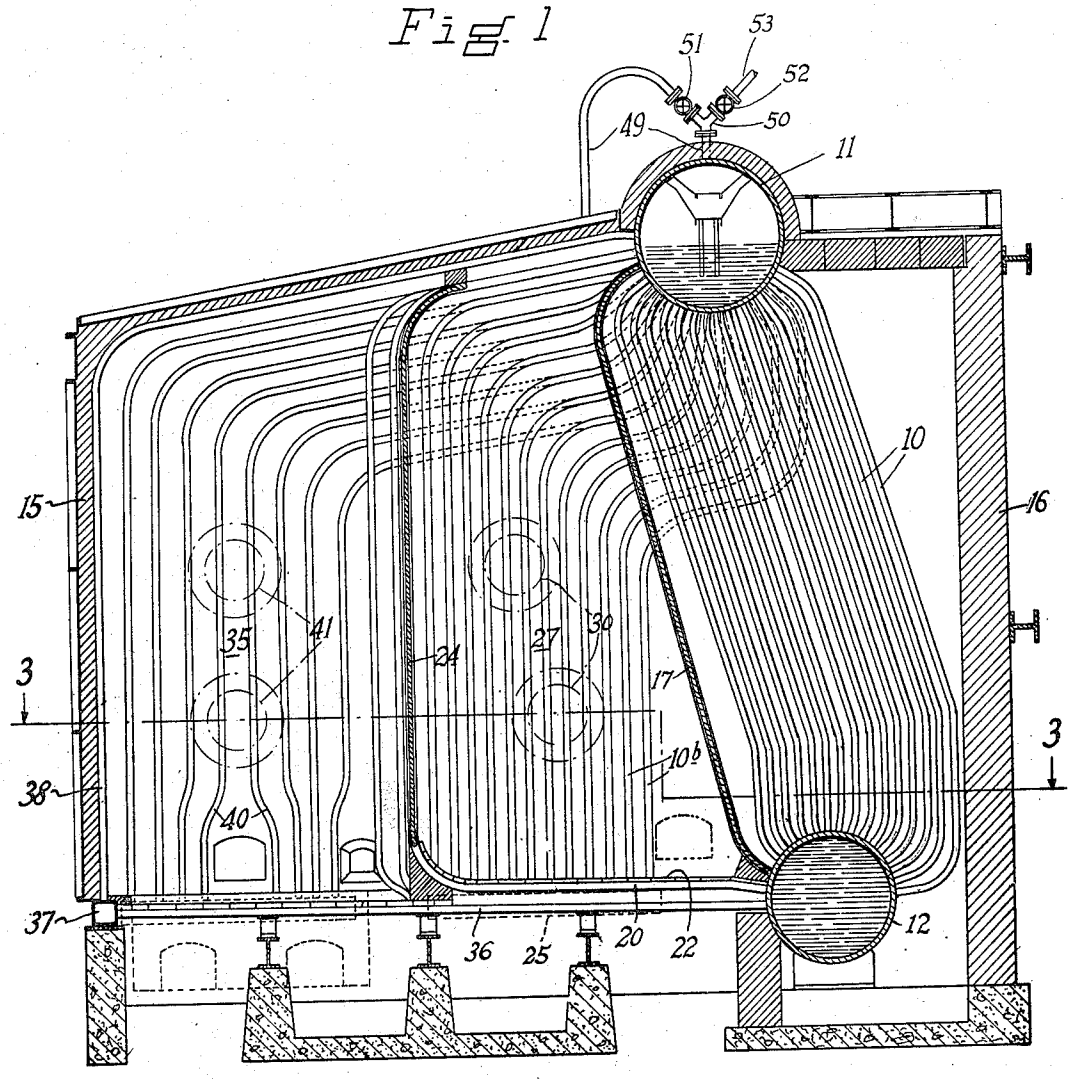
Feb. 11, 1941. C. E. LUCKE 2,231,015

STEAM GENERATOR

Original Filed Jan. 13, 1937 3 Sheets-Sheet 1

Fig. 1



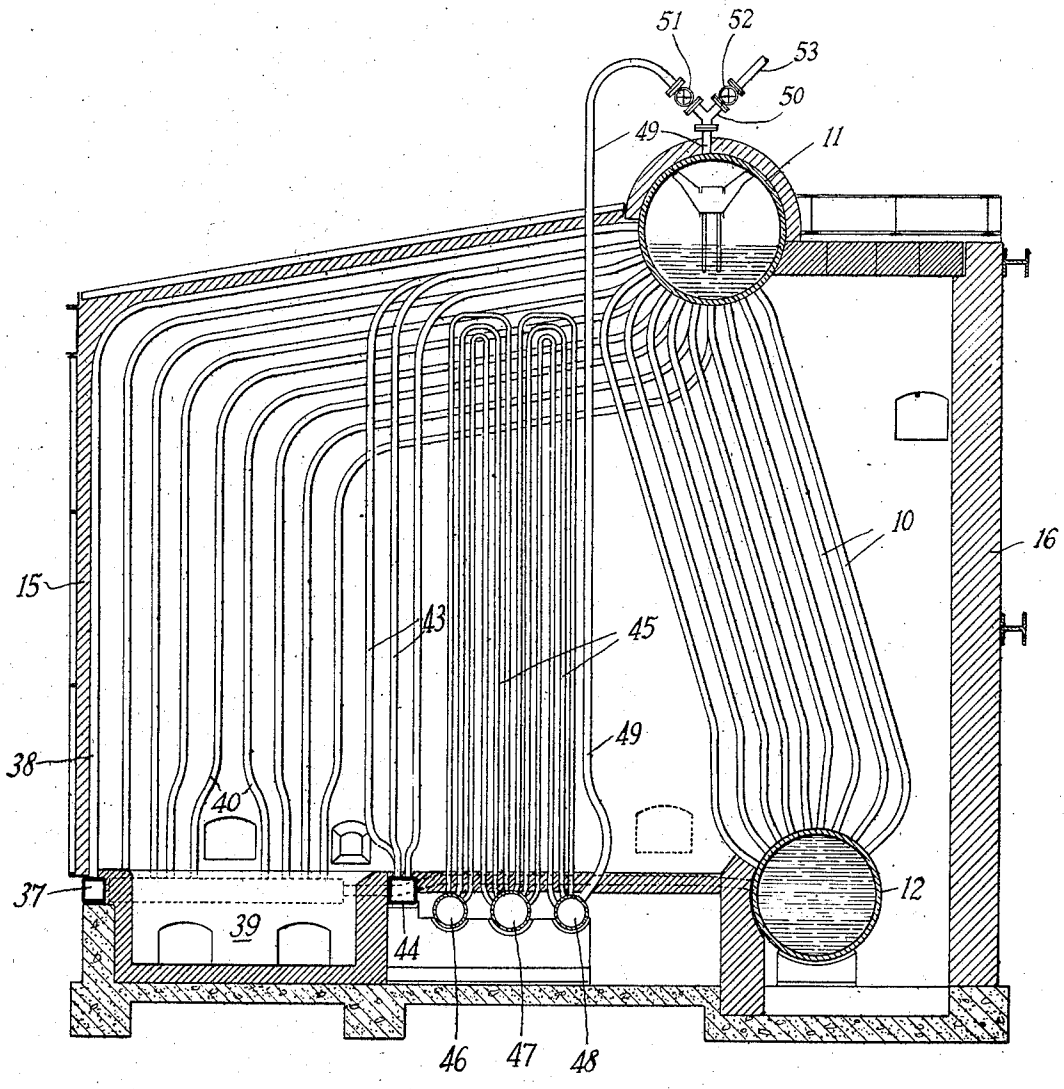
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STEAM GENERATOR

Original Filed Jan. 13, 1937 3 Sheets-Sheet 2

Fig. 2



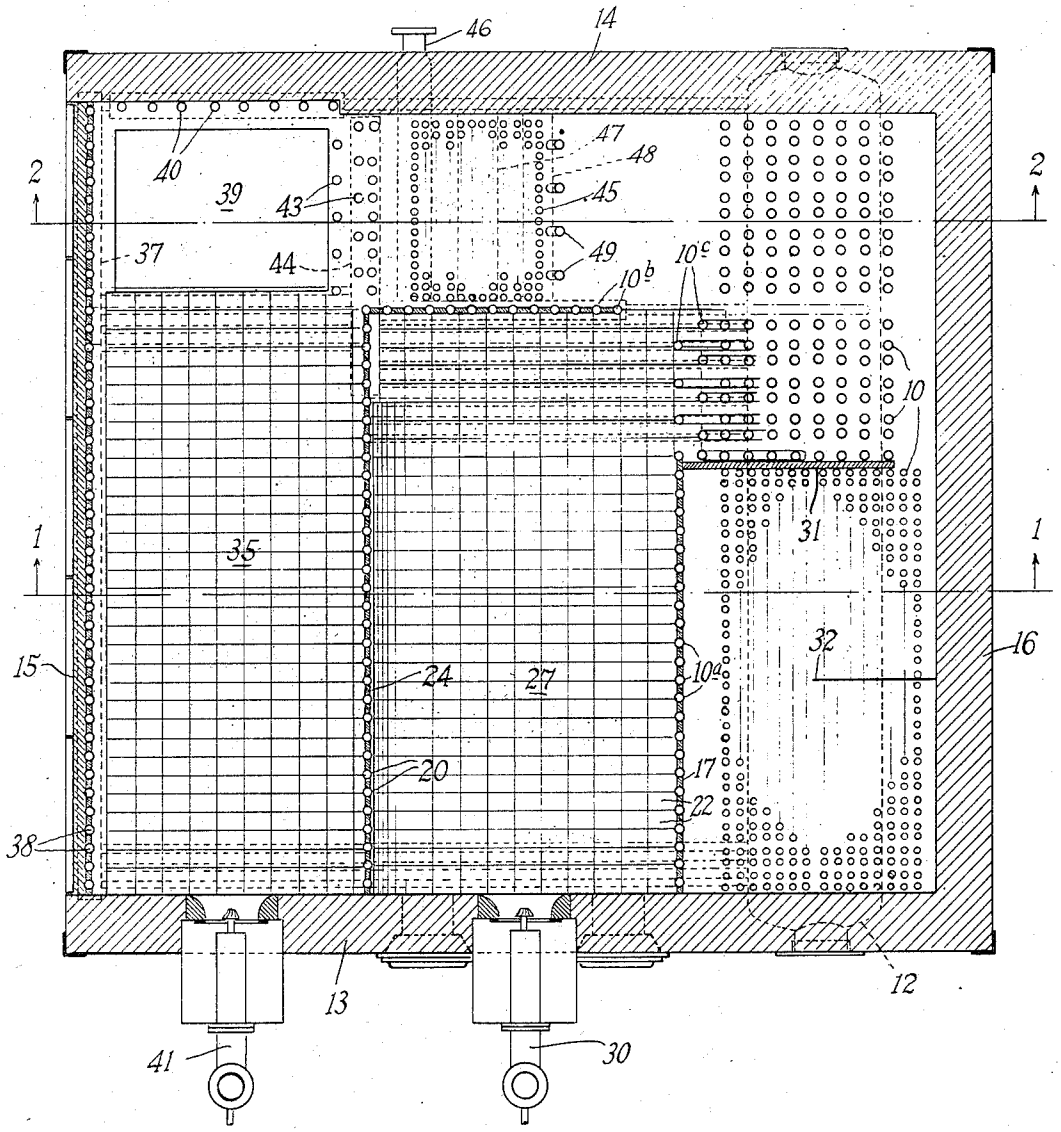
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STEAM GENERATOR

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Fig. 3



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UNITED STATES PATENT OFFICE

2,231,015

STEAM GENERATOR

Charles E. Lucke, New York, N. Y., assignor to The Babcock & Wilcox Company, Newark, N. J., a corporation of New Jersey

Application January 13, 1937, Serial No. 120,363
Renewed June 12, 1940

10 Claims. (Cl. 122—336)

The present invention relates to the construction and operation of vapor generating units of moderate capacity which are particularly characterized by their small floor space and low head room requirements, and more particularly to a water tube steam boiler of the two-drum type having a single bank of generating tubes connecting the drums and a furnace chamber laterally adjoining the space occupied by the tube bank and connected thereto at only one end.

The main object of my invention is the provision in a vapor generating unit of the character described of vapor superheating surface, and of means for regulably controlling the amount of superheating effected over the complete range. A further object is the provision of an improved divided furnace construction for a vapor generator of the character described.

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 taken on the line 1—1 of Fig. 3;

Fig. 2 is a sectional elevation taken on the line 2—2 of Fig. 3; and

Fig. 3 is a horizontal section taken on the line 3—3 of Fig. 1.

In the steam boiler unit illustrated in the drawings a vertically disposed bank of steam generating tubes 10 is arranged between, and connected to a pair of horizontally extending upper and lower drums 11 and 12 respectively. The tube bank is arranged along one side of and enclosed by a flat-sided setting of rectangular cross-sectional shape including a front wall 13, rear wall 14, and side walls 15 and 16, constructed as hereinafter described. Tubes 10^a in the outer most row of the tube bank at the side adjacent the side wall 15 are spaced from the remaining portion of the tube bank, with the intertube spaces closed by refractory material or other suitable provisions, to form a vertically extending fluid cooled partition 17 extending from the front wall 13 rearwardly to a point about midway along the tube bank leaving a relatively wide space between its rear end and the rear wall. A row of U-shaped tubes 20 extends from the lower drum 12 outwardly at a slight upward inclination, then vertically within the setting, and then at an upward inclination to the drum 11. The spaces between the bottom legs of the tubes 20 are closed by metallic blocks 22 to form a floor. The spaces between the vertical legs of the tubes 20 are closed by refractory material to form one leg of an L-shaped partition 24 arranged parallel to and extending rearwardly beyond the partition 17. Tubes 10^b in one or more transverse rows of the tube bank beyond the end of the partition 17 are bent from the upper drum inwardly in spaced alignment across the space between the rear end of the partition 24 and the tube bank and the intertube spaces closed by refractory to form the transverse leg of the partition 24. The lower ends of the tubes 10^b are connected to a transverse header 25 which is connected to the lower drum. A fluid cooled furnace chamber 27 is thus formed laterally adjoining the space containing the tube bank 10 and opening thereto in the space between the ends of the partitions 17 and 24. The innermost tubes 10^c in this portion of the bank are spaced to form a slag screen across the entrance to the bank.

One or more fuel burners 30 are arranged to discharge a stream of fluid fuel, such as pulverized coal, oil or gas, substantially horizontally through the front wall 13 into the furnace chamber 27. With this arrangement the burning fuel and heating gases will travel rearwardly in the furnace chamber 27. The furnace is designed to effect complete combustion of the fuel therein and the heating gases are directed by the transverse leg of the partition 24 around the rear end of the partition 17 and forwardly in contact with the tubes of the main generating bank. The space occupied by the main bank of tubes 10 is constructed to provide a heating gas flow through a plurality of serially connected transverse passes across the tube bank. For this purpose a transverse baffle 31 extends from the rear end of the partition 17 towards the side wall 16 and a second transverse baffle 32 extends inwardly from the side wall 16 towards the partition 17. The gases from the furnace chamber 27 flow around the baffles 31 and 32 successively across the tube bank and exit through a heating gas outlet at the forward end.

Steam generating units of the general type heretofore described have gone into extensive use in recent years. Steam superheating surface is usually incorporated in such units in association with the main tube bank. Such superheaters however, have been usually arranged so that the

superheater surface is normally contacted by substantially all of the heating gases passing through the unit and consequently the final superheat temperature will normally fluctuate over a relatively wide range in operation as the load changes. Furthermore, there is danger of overheating the superheater tubes when starting the unit, during the period before steam is available to flow through the superheater tubes. A similar condition may arise after a sudden stoppage of steam flow.

In accordance with the present invention, superheating surface is incorporated in the unit in a location where it is adequately protected from excessive temperature conditions and also where, in association with an auxiliary furnace, the final superheat can be readily controlled over the entire range of operating conditions. A constant final superheat temperature or different superheat temperatures desired can be effected. In addition, it is possible to generate steam without heating the superheater so that the latter is made absolutely safe during starting or after a sudden stoppage, and during operation any fraction of the steam generated may be bled from the drum so as not to pass through the superheater without resulting in overheating the superheater tubes due to the consequent lowered steam flow therethrough.

For this purpose, the setting also includes an auxiliary furnace chamber **35** adjoining the outer and rear sides of the furnace chamber **27**. The auxiliary furnace **35** is defined by inclined tubes **36** from the drum **12** extending to a side wall header **37**, and tubes **38** extending from the header along the side wall **15** and roof to the drum **11**. The portions of the tubes **36** beyond the main furnace **27** have their intertube spaces closed by tube blocks to form a floor extending rearwardly to an ash pit **39** adjacent the rear wall. The auxiliary furnace chamber **35** is thus of L-shaped cross-section with one end of its transverse section opening to the portion of the tube bank at the rear of the partition **24**. A row of cooling tubes **40** protect the portion of the rear wall **14** facing the longitudinal section of the auxiliary furnace and are connected into the boiler circulation system.

One or more fluid fuel burners **41** are mounted in the front wall **13** so as to discharge a stream of fuel and air horizontally into the auxiliary furnace. The fuel burners **41** have the usual equipment for controlling the supplies of fuel and air thereto and thereby combustion conditions in the auxiliary furnace. The auxiliary furnace is unobstructed throughout its longitudinal section, so that substantially all of the heat absorbed in this section is by radiation to the floor, roof and wall tubes. As the heating gases turn into the transverse section they first contact with a group of tubes **43** arranged to form a slag screen across the transverse section. The tubes **43** have their upper ends connected to the upper drum and their lower ends to a header **44**, which receives its fluid supply from some of the tubes **20** at the rear of the main furnace chamber. The superheating surface of the unit is formed by two spaced groups of vertically disposed return bend tubes **45** having their open ends connected to cross-headers **46**, **47** and **48** at their lower ends. The header **48** receives saturated steam from the drum **11** through tubes **49** and the steam passes successively through the superheater groups to the outlet header **46**. The heating gases pass over the full height of the superheater tubes and then across the rear portion of the tube bank **10** where the gases join and mix with the heating gas stream from the main furnace. A fitting **50** is incorporated in each supply tube **49** with a pair of separate outlets respectively controlled by valves **51** and **52**, so that saturated steam may be bled from the superheater supply line through pipes **53**. With this arrangement all or any fraction of the saturated steam generated may be discharged through or around the superheater and the fuel burners **41** correspondingly regulated to produce the desired superheating effect on the steam to be superheated.

In operation, the unit is started with only the main furnace burners **30** in use. The heating gases generated pass rearwardly through the furnace chamber, turning at its rear end into the space occupied by the tube bank. Most of the heat absorbed by the partition tubes **10a**, **20** and **23** will be by radiation from the furnace chamber. The gases then pass serially through the tube bank passes under the influence of the furnace draft. With this mode of operation, the superheater is adequately protected during the initial period of operation, when the steam flow through the superheater tubes will be necessarily low and the tubes extremely liable to be overheated. The unit may be operated with the main furnace alone to deliver saturated steam. When superheating is desired, the auxiliary furnace burners **41** are put into operation and the fuel and air supplies thereto regulated either manually or automatically to produce the desired heat release in the auxiliary furnace and thereby a controllable final superheat temperature. The construction described depends only upon the control of combustion conditions in the auxiliary furnace for regulating the superheat temperatures, advantageously avoiding the need of any control dampers for regulating the amount of gases contacting with the superheater surface with the corresponding problem of damper maintenance, and also of any by-passing of gases around the superheater with a corresponding loss in heat transfer efficiency. The ratio of the volumes of the main and auxiliary furnaces and the ratio of the "cold" wall area to volume of each furnace are designed in accordance with the desired normal ratio of heat of superheat to latent heat and gas exit temperature. With the divided furnace construction described, the horizontal legs of the tubes defining the auxiliary furnace will be adequately protected from overheating by the main furnace.

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 upper and lower drums, a bank of water tubes connected to said drums along the length thereof, means forming a main furnace chamber laterally adjoining and extending along the length of the space containing said tube bank and communicating with one end thereof, means forming an auxiliary furnace at the same side of said tube space as said main furnace chamber and communicating with the

same end of said tube space, a steam superheater arranged to receive heating gases solely from said auxiliary furnace chamber, and means for burning fuel in each of said furnace chambers and effecting a flow of heating gases substantially horizontally through said furnace chambers and thence through said tube space towards the opposite end thereof.

2. A steam boiler having a setting including upper and lower drums, a bank of vertically disposed water tubes connected to said drums along the length thereof, means forming a main furnace chamber laterally adjoining and extending along the length of the setting space containing said tube bank and communicating with the rear end thereof, means forming an auxiliary furnace adjoining the outer side of said main furnace chamber and communicating with the rear end of said tube bank space, a steam superheater located beyond the rear end of said main furnace chamber and receiving heating gases solely from said auxiliary furnace chamber, and separately regulable means at the front end of said main and auxiliary furnace chambers for burning fuel therein and effecting a flow of heating gases through said furnace chambers and thence through said tube space towards the front end thereof.

3. A steam boiler having a setting including a pair of upper and lower drums, a bank of vertically disposed water tubes connected to said drums along the length thereof, a partition forming the inner wall of a main furnace chamber laterally adjoining the setting space containing said tube bank and communicating with the rear end thereof, an L-shaped partition forming the outer and rear walls of said main furnace chamber and separating said main furnace chamber from an L-shaped auxiliary furnace adjoining the outer and rear sides of said main furnace chamber and communicating with the rear end of said tube bank space, walls defining the remaining sides of said auxiliary furnace chamber, a steam superheater located in the rear portion of said auxiliary furnace chamber, and separately regulable means at the front end of said main and auxiliary furnace chambers for burning fuel therein and effecting a flow of heating gases through said furnace chambers and thence through said tube space.

4. A steam boiler having a setting including a pair of horizontally arranged upper and lower drums, a bank of vertically disposed water tubes connected to said drums along the length thereof, a fluid cooled partition forming the inner wall of a main furnace chamber laterally adjoining the setting space containing said tube bank and communicating with the rear end thereof, an L-shaped fluid cooled partition forming the outer and rear walls of said main furnace chamber and separating said main furnace chamber from an L-shaped auxiliary furnace adjoining the outer and rear sides of said main furnace chamber and communicating with the rear end of said tube bank space, walls defining the remaining sides of said auxiliary furnace chamber, a steam superheater located in the rear portion of said auxiliary furnace chamber, rows of tubes connected to said drums arranged to fluid cool said partitions, and fuel burning means at the forward end of said main and auxiliary furnace chambers.

5. A steam boiler having a setting including a pair of horizontally arranged upper and lower drums, a bank of vertically disposed water tubes connected to said drums along the length thereof, a fluid cooled partition forming the inner wall of a main furnace chamber laterally adjoining the setting space containing said tube bank and communicating with the rear end thereof, an L-shaped fluid cooled partition forming the outer and rear walls of said main furnace chamber and separating said main furnace chamber from an L-shaped auxiliary furnace adjoining the outer and rear sides of said main furnace chamber and communicating with the rear end of said tube bank space, walls defining the remaining sides of said auxiliary furnace chamber, a steam superheater located in the rear portion of said auxiliary furnace chamber, rows of tubes connected to said drums arranged to fluid cool said partitions, separately regulable means at the front end of said main and auxiliary furnace chambers for burning a slag-forming fuel therein and effecting a substantially horizontal flow of heating gases longitudinally through said furnace chambers and thence through said tube space, and tubes arranged to form a slag screen in the rear portion of said auxiliary furnace chamber between said fuel burning means and said superheater and in the rear portion of said main furnace chamber.

6. A steam boiler having upper and lower drums, a bank of vertically disposed water tubes connected to said drums along the length thereof, means forming a main furnace chamber laterally adjoining the space containing said tube bank and communicating with one end thereof, means forming an L-shaped auxiliary furnace adjoining the outer and rear sides of said main furnace chamber and communicating with the same end of said tube space, a steam superheater located in said auxiliary furnace chamber, and means for burning fuel in each of said furnace chambers and effecting a flow of heating gases through said furnace chambers and thence through said tube space.

7. A steam boiler having upper and lower drums, a bank of vertically disposed water tubes connected to said drums along the length thereof, means forming a main furnace chamber laterally adjoining the space containing said tube bank and communicating with one end thereof, means forming an auxiliary furnace adjoining said main furnace chamber and communicating with the same end of said tube space, a steam superheater located in said auxiliary furnace chamber, means for burning fuel in said main furnace chamber and effecting a flow of heating gases through said furnace chamber and thence through said tube space, and means for regulably superheating a variable amount of the steam generated independently of the rate of steam generation including a valve controlled supply line to said superheater and a saturated steam discharge line from said upper drum independent of said superheater.

8. A steam boiler having upper and lower drums, a bank of water tubes connected to said drums along the length thereof, means forming a main furnace chamber laterally adjoining and extending along the length of the space containing said tube bank and communicating therewith, means forming an auxiliary furnace at the same side of said tube bank space as said main furnace chamber and communicating with said tube bank space externally of said main furnace chamber, a convection heated steam superheater arranged to receive heating gases solely from said auxiliary furnace chamber, means for inde-

pendently burning fuel in suspension in each of said furnace chambers, and means for effecting a flow of heating gases through said auxiliary furnace chamber and thence into said tube bank space at a point beyond the path of flow of the heating gases from said main furnace chamber.

9. A steam boiler having a pair of horizontally elongated upper and lower drums, a bank of water tubes connected to said drums along the length thereof, means defining a main furnace chamber laterally adjoining and extending along the length of the space containing said tube bank and communicating therewith, means defining an L-shaped auxiliary furnace extending along the length of and around one end of said main furnace, means for burning fuel in said main furnace, means for burning fuel in said auxiliary furnace and effecting a flow of heating gases substantially horizontally through said auxiliary furnace and around one end of said main furnace and thence into said tube bank space, and a steam superheater arranged to receive heat solely from said auxiliary furnace.

10. A steam boiler having a pair of horizontally elongated upper and lower drums, a bank of water tubes connected to said drums along the length thereof, means defining a main furnace laterally adjoining and extending along the length of the space containing said tube bank, means defining an auxiliary furnace extending along the length of and at the opposite side of said main furnace from said tube bank space including a group of water tubes between said main and auxiliary furnaces, means for burning fuel in said main furnace, means for independently burning fuel in said auxiliary furnace and effecting a flow of heating gases substantially horizontally through said auxiliary furnace and thence around one end of said main furnace and throughout the length of said tube bank space, and a steam superheater arranged to receive heat mainly from said auxiliary furnace.

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