July 13, 1937. C. W. BROS 2,086,599

WATER TUBE BOILER

Filed July 29, 1933 3 Sheets-Sheet 1

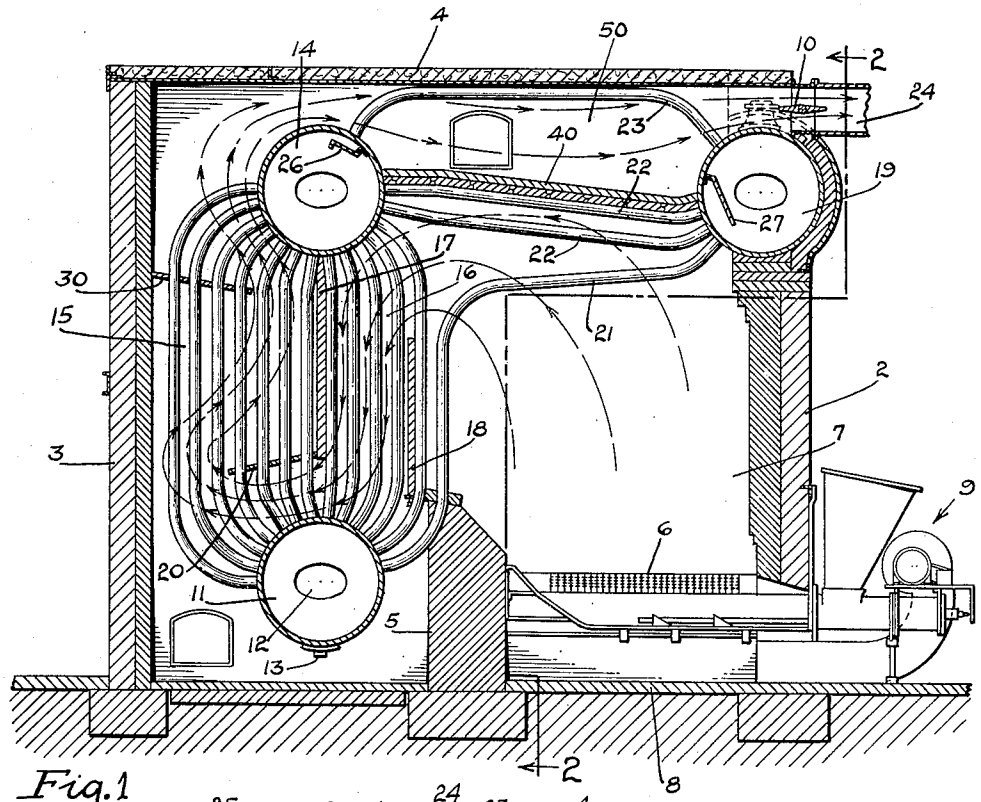


Fig. 1

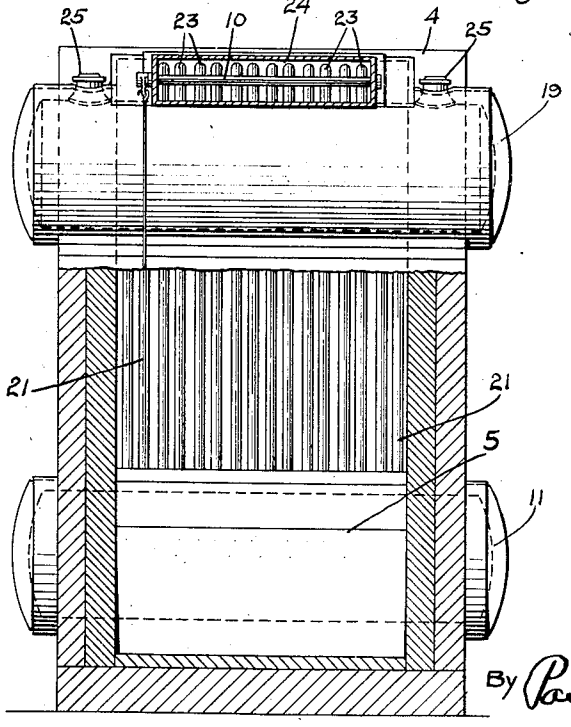


Fig. 2

INVENTOR
CHESTER W. BROS
By Paul, Paul & Moore
ATTORNEYS

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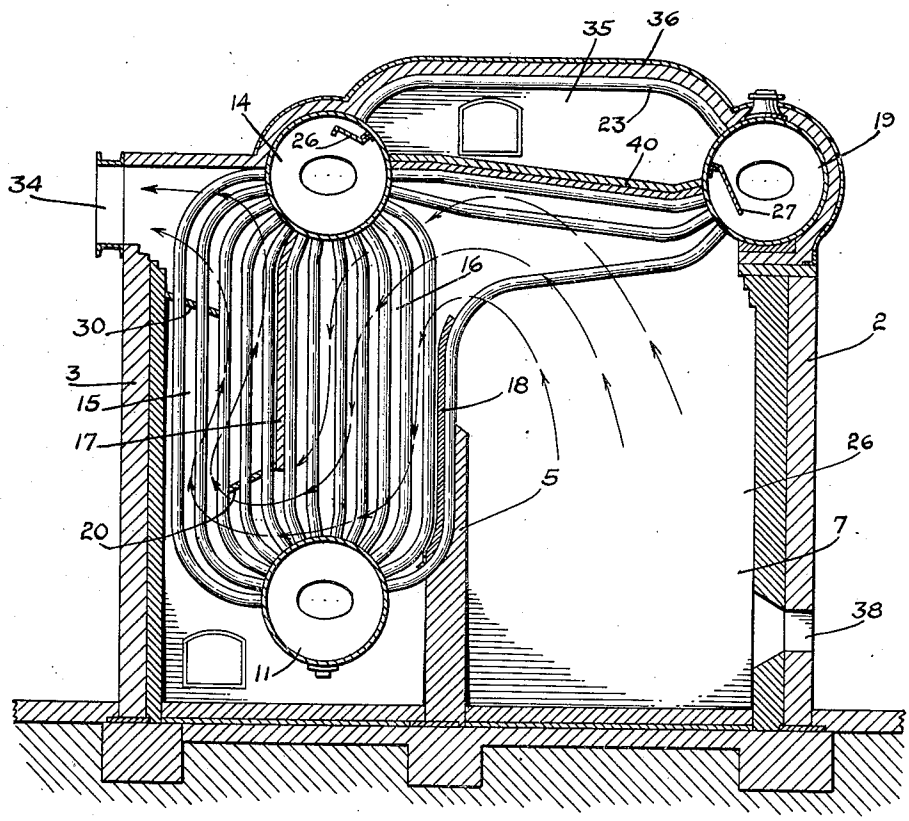


Fig. 3

INVENTOR
CHESTER W. BROS
By Paul, Paul & Moore
ATTORNEYS

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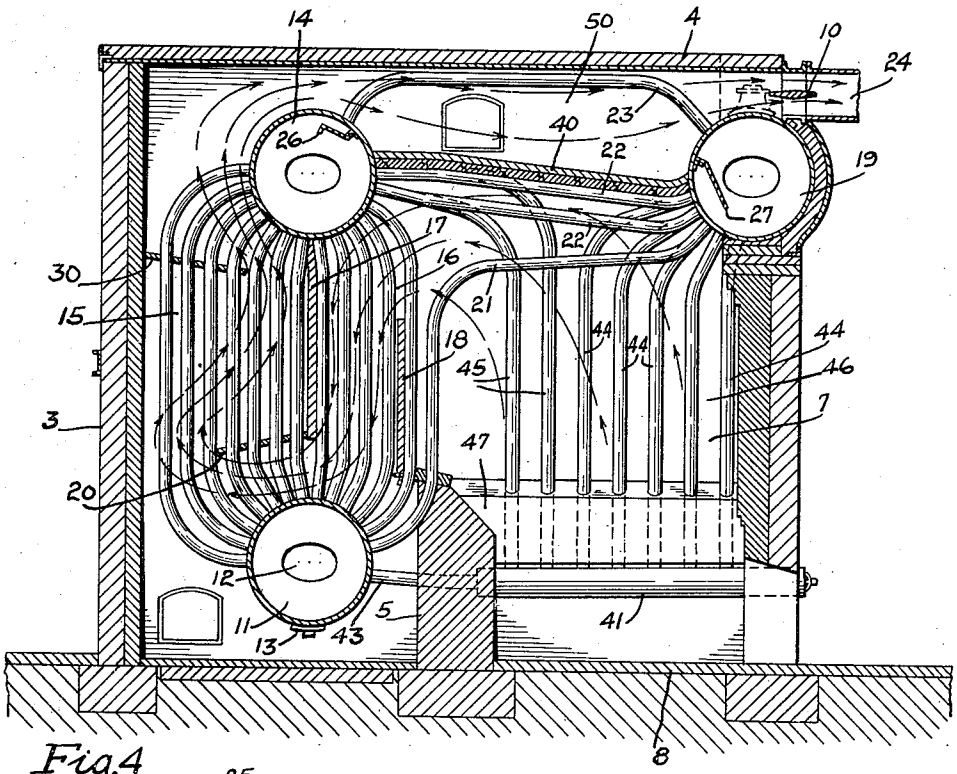


Fig.4

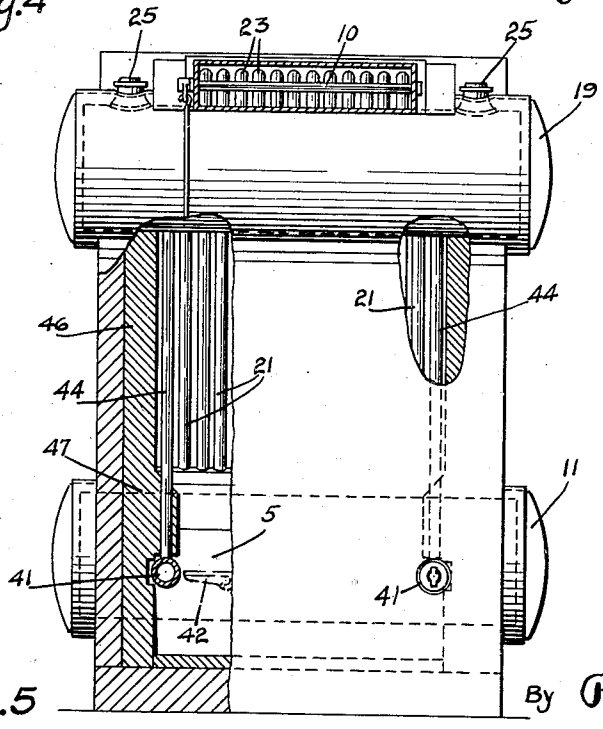


Fig.5

INVENTOR
CHESTER W. BROS
By Paul, Paul & Moore
ATTORNEYS

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WATER TUBE BOILER

Chester W. Bros, Minneapolis, Minn., assignor to Wm. Bros Boiler & Manufacturing Company, Minneapolis, Minn., a corporation of Minnesota

Application July 29, 1933, Serial No. 682,817

9 Claims. (Cl. 122—336)

This invention relates to new and useful improvements in water tube boilers of the bent tube type comprising a plurality of horizontally disposed drums operatively connected together by a series of water circulating tubes.

There are now numerous horizontal return tubular boilers in service which must eventually be replaced, some because of wear or old age, and others because of their inability to generate sufficient steam to meet the additional demands made upon them, and others because of a demand for higher steam pressures. Return tube boilers only require comparatively low head room, and always have the smoke outlet disposed at the front of the furnace. Water tube boilers of the character herein disclosed are generally accepted as more efficient and economical to operate than the usual well-known return tubular boilers, and many purchasers, therefore, prefer to substitute a water tube boiler for the usual return tubular boiler, when it becomes necessary to make a change in boilers.

There have been two requirements which have strongly militated against the substitution of water tube boilers for horizontal return tubular boilers, and these are: low head room, and front outlet of furnace gases. In the novel boiler herein disclosed, sufficient furnace volume is obtained with approximately the same over-all height of setting as in a tubular boiler. Further, in the construction of new plants or buildings where head room is at a premium due to the necessary added cost of higher buildings, or deeper excavations, these same advantages are apparent.

The primary object of the invention, therefore, is to provide a water tube boiler requiring low head room and which is so designed that it may readily be substituted for an ordinary horizontal return tubular boiler without materially changing the boiler room roof or floor level, and at the same time, providing such a boiler having a relatively high horsepower rating, and which is efficient and economical in operation.

A further object of the invention is to provide a small water tube boiler of the character described, wherein both steam drums are placed at substantially the same elevation and connected with a plurality of water circulating tubes, and whereby the boiler will have a better "water endurance level", which has been one of the chief criticisms of small water tube boilers to date.

A further object is to provide a water tube boiler so designed as to present a maximum of tube areas to the furnace to absorb radiant heat, to thereby increase the efficiency of combustion as well as to minimize furnace temperature and therefore furnace maintenance costs.

A further object is to provide a water tube boiler comprising three drums arranged substantially in right angular relation, and the two upper or steam drums being situated at substantially the same level and spaced from one another, and a series of water circulating tubes connecting together all of said drums; the main bank of tubes being substantially vertically disposed and providing an efficient water cooled bridge wall, and certain of said water circulating tubes providing a water cooled roof; and other water circulating tubes providing water cooled side walls for the furnace, whereby substantially all of the walls of the furnace, except the front wall thereof, will be water cooled. By thus arranging banks of water circulating tubes adjacent to the walls of the furnace, and within the combustion chamber, the effective area of the "black surfaces", or radiant heat absorbing surfaces of the furnace, is more than double that of conventional types of water tube boilers, whereby it will readily be understood that, as the greatest expense of maintenance of a boiler is in the furnace, the advantages of the above described design are apparent.

Other objects of the invention reside in the particular arrangement of the upper steam drums which, it will be noted, are situated at substantially the same level, and both connected to steam generating tubes so that the disturbance of the separation of the steam is divided between two drums instead of one as is conventional, thereby giving drier steam and more even water level, and whereby each drum operates as a steam generator; in the arrangement of the mud drum directly beneath the rear steam drum; in the baffles provided between said drums to efficiently direct the products of combustion between said water circulating tubes and around the rear steam drum, and thence forwardly over the front steam drum to the front smoke outlet of the boiler; and, in the right angular relationship between the mud drum and the two steam generating drums, whereby the furnace chamber is disposed directly beneath the water circulating tubes connecting together the two steam generating drums at the upper portion of the boiler; and whereby the overall height of the boiler may be reduced to a minimum without increasing the overall size of the boiler, and whereby the boiler is rendered more efficient than ordinary boilers.

Other objects of the invention will appear from the following description and accompany-

ing drawings and will be pointed out in the annexed claims.

In the accompanying drawings there has been disclosed a structure designed to carry out the various objects of the invention, but it is to be understood that the invention is not confined to the exact features shown as various changes may be made within the scope of the claims which follow.

In the drawings:

Figure 1 is a vertical sectional view showing a boiler embodying the invention;

Figure 2 is a cross-sectional view on the line 2—2 of Figure 1;

Figure 3 is a vertical sectional view similar to Figure 1, but showing a boiler of modified construction;

Figure 4 is a vertical sectional view of a boiler having banks of water circulating tubes arranged adjacent to the side walls thereof; and

Figure 5 is a front view of the boiler shown in Figure 4 partially broken away to more clearly show the arrangement of the tubes at the side walls thereof.

The novel boiler herein disclosed is shown comprising a suitable supporting structure consisting of front and rear walls 2 and 3, an upper wall 4, and a lower intermediate wall section 5 which cooperates with the front wall 2 to provide a support for the rear end of the usual grate bars 6, shown provided in the bottom of the furnace chamber 7. The supporting structure above described, is shown provided with a suitable bottom wall 8 upon which a stoker 9 of ordinary construction may be supported, as clearly illustrated in Figure 1.

The boiler is shown comprising a mud drum 11 provided at its ends with suitable manholes 12, and at its bottom with a drain plug 13. A steam drum 14 is shown mounted substantially directly over the mud drum 11 and is suitably connected thereto by groups of upright water circulating tubes 15 and 16. A baffle 17 is interposed between said groups of tubes and preferably has its upper edge abuttingly engaging the steam drum 14, while its lower edge is spaced from the mud drum 11, to provide a circulating passage for the products of combustion of the furnace 7.

A second baffle 18 is provided between two of the rows of tubes of the forward group of tubes 16, and has its lower edge substantially abuttingly engaged with the upper portion of the intermediate wall 5, whereby the products of combustion must circulate over the upper edge of said baffle 18, thence downwardly around the lower edge of the baffle 17, and rearwardly around a laterally disposed baffle 20, connected to the baffle 17, and upwardly between the tubes of the rear group of tubes 15 and around the baffle plate 30, as clearly indicated by the arrows in Figure 1.

The upper steam drum 14 is spaced from the rear wall 3 and also from the upper wall 4 of the supporting structure, thereby to provide gas circulating passages around said boiler. A second steam generating drum 19 is shown supported upon the top of the front wall 2 of the furnace and has a bank of water circulating tubes 21 connecting it to the mud drum 11. Other banks of water circulating tubes 22 and 23 operatively connect the front steam drum 19 to the rear steam drum 14.

An important feature of the invention resides in the particular arrangement of the upper steam drums 14 and 19 which, it will be noted by reference to Figures 1 and 3, are substantially horizontally alined. The group of tubes 21 are bent, as shown in Figure 1, and form in effect, the rear and top walls of the furnace, whereby said furnace walls will be water cooled. The two rows of tubes 22 connect the lower portions of the steam generating drums 14 and 19 and are disposed in the path of the furnace gases traveling from the furnace chamber to the smoke outlet 24 of the furnace, shown in Figure 1. The smoke outlet is shown provided with the usual damper 10.

By thus arranging the water circulating tubes of the three drums, the products of combustion or furnace gases will impinge against said tubes as they travel from the furnace through the apparatus to the smoke outlet 24, whereby substantially all of the heat of the furnace gases will be absorbed by said tubes with the result that the water in the boiler may be quickly heated to a boiling temperature with a minimum fire.

The front steam drum 19 is shown provided with the usual steam outlet nozzles 25 to which suitable steam pipes, not shown, may be connected. Suitable deflectors 26 and 27 are provided within the steam drums 14 and 19, respectively, to deflect the water delivered thereto from the tubes connecting together said drums.

The three drums, as shown in Figure 1, are arranged in substantially right angular relation, whereby the furnace chamber 7 may be disposed directly beneath the tubes 21 and 22, connecting the front steam drum 19 to the other drums, and whereby the surface area of the water circulating tubes presented to the products of combustion is increased, with a corresponding increase in the efficiency of the boiler. Also, by horizontally alining the steam generating drums 14 and 19, the overall height of the boiler may be made comparatively low, as compared to a water tube boiler of ordinary construction, and of a given size, which is of utmost importance in that it makes it possible to replace an ordinary horizontal return tubular boiler with this new and improved type of water tube boiler, without materially altering the boiler room dimensions, and whereby a water tube boiler having a greater output, may be substituted for an ordinary tubular boiler, to thereby provide a more efficient steam generating plant.

Another important feature of the invention resides in the construction of the upper portion of the boiler whereby a portion of the steam is super-heated before it reaches the nozzles 25. To thus superheat a portion of the steam, a wall 40 is interposed between the steam drums 14 and 19, whereby a chamber 50 is provided above the furnace 7, through which the furnace gases pass to the smoke outlet 24. The steam generated in drum 14 must pass through the steam tubes 23, in order to be delivered to the nozzles 25, and, as the tubes 23 pass through the chamber 50, they are subjected to the action of the hot furnace gases passing therethrough, whereby the steam conveyed by said tubes is superheated.

Figure 3 illustrates another form of the invention wherein the smoke outlet of the furnace is provided at the rear of the boiler. The boiler here shown is substantially the same as the one shown in Figures 1 and 2, and the corresponding parts thereof will therefore be referred to by like numerals. In the boiler shown in Figure 3, however, the furnace gases flow from the furnace 7 upwardly over a baffle 18 provided at the upper portion of the rear wall 5 of the furnace; thence

downwardly beneath the lower edge of a baffle 17 and rearwardly around a relatively smaller baffle 20, which may be suitably secured to the lower edge of the baffle 17. The furnace gases then pass upwardly and inwardly, as indicated by the arrows, around a baffle 30 secured to the rear wall 3 of the apparatus, from whence the gases flow through the smoke outlet 34 provided at the rear of the boiler.

The upper steam circulating tubes 23 are disposed within a chamber 35 defined by an upper wall 36 and the wall 40. The tubes 23 operate to convey the steam from the rear drum 14 to the front drum 19. The front wall 2 of the furnace shown in Figure 3, is provided with the usual opening 38 adapted to receive a suitable fuel burning apparatus such as are commonly used in boilers of this general type.

By arranging the drums as shown in the drawings and as above described, the overall height of the boiler may be reduced as compared to water tube boilers of ordinary construction, now in common use. It will also be noted by reference to Figure 1, that by arranging the upper steam drums 14 and 19 in the particular manner shown, the furnace 7 is disposed directly beneath the upper banks of tubes 21 and 22, whereby the hot furnace gases impinge directly against said tubes and also against the rear banks of tubes 15 and 16. The tubes 21, 22 and 16 cooperate to provide a double water cooled bridge wall resulting in low furnace temperature, which reduces the cost of maintenance, when operating at high ratings.

The baffles 17, 18, 20 and 30 cooperate to provide a very good gas flow through the apparatus. The hot furnace gases pass through the apparatus in a tortuous path substantially as indicated by the arrows in Figure 1, whereby all of the water circulating tubes are subjected to the action of the hot gases. By arranging the two upper steam drums at substantially the same level, and connecting tubes 21 to drum 19, as shown, said steam drums will have the same water level, and the amount of work that the rear drum 14 has to do is decreased, thereby lessening its duty and providing a better steam generator.

As hereinbefore stated, horizontal return tubular boilers are now gradually being replaced by water tube boilers of the general character herein disclosed, because of the higher efficiency of the latter type. Where such substitutions are to be made, it is desirable that a boiler be substituted which may replace the old boiler without having to increase the height of the building in which the boiler is to be mounted.

The novel boiler herein disclosed readily lends itself for such substitution as it requires low head room and the overall dimensions of a boiler of a given size compares quite favorably to the overall dimensions of a horizontal return tubular boiler of substantially the same horsepower rating.

In the structure shown in Figures 4 and 5, means is provided for cooling the opposed side walls of the furnace to thereby further minimize the operating temperature of the furnace. To thus cool the side walls of the furnace, a header 41 is provided adjacent each of said walls substantially in alinement with the usual grates 42 of the furnace, indicated in dotted lines in Figure 5. Water circulating tubes 43 connect the rear ends of the headers 41 with the mud drum 11, as clearly illustrated in Figure 4.

A plurality of upright water circulating tubes 44 connect the forward portions of the headers 41 with the front steam drum 19, adjacent the ends thereof, and other circulating tubes 45 similarly connect the rear portions of the headers 41 with the rear steam drum 14.

The upright water circulating tubes 44 and 45 are preferably spaced equi-distantly apart as illustrated in Figure 4, and are disposed in close proximity to the furnace side walls 46, as shown in Figure 5. The lower portions of the tubes 44 and 45 adjacent to the headers 41, are preferably embedded in the brick work of the furnace, as shown at 47 in Figure 5.

By thus arranging the tubes 44 and 45 adjacent the side walls of the furnace, they will absorb radiant heat from the products of composition, and will thereby assist in heating the water delivered to the steam drums 14 and 19. The pipes also function as a cooling means for the side walls of the furnace and cooperate with the pipes 21 to minimize the furnace temperature, thereby greatly increasing the efficiency of the furnace and reducing maintenance costs.

I claim as my invention:

1. In a steam generating plant, a plurality of walls defining a chamber, a water tube boiler mounted therein and comprising a mud drum, and front and rear steam drums disposed in the upper portion of said chamber and spaced from the rear and top walls thereof, water circulating tubes connecting together all of said drums, a furnace in the forward portion of said chamber having a front smoke outlet disposed over said front steam drum, and a series of baffles for directing the products of combustion between said tubes and behind and over said rear steam drum, and forwardly over the front steam drum to the smoke outlet.

2. In a steam generating plant, a plurality of walls defining a chamber, a water tube boiler mounted therein and comprising a mud drum, and front and rear steam drums disposed in the upper portion of said chamber in substantially horizontal alinement, said rear steam drum being spaced from the rear and top walls of the chamber to provide a gas circulating passage, water circulating tubes connecting together all of said drums, a furnace in the forward portion of said chamber having a front smoke outlet disposed over the front steam drum, and a series of baffles arranged between certain of said water circulating tubes for directing the furnace gases between said tubes and behind and over said rear steam drum and forwardly over the front steam drum to the smoke outlet.

3. In a steam generating plant, a plurality of walls defining a chamber, a water tube boiler mounted therein and comprising a mud drum, and front and rear steam drums arranged in the upper portion of said chamber, said rear steam drum being spaced from the rear and top walls of said chamber to provide a gas circulating passage, a furnace in the forward portion of the chamber having a front smoke outlet disposed over said front steam drum, a wall interposed between said front and rear steam drums and cooperating with the top wall of said chamber to provide a gas circulating passage communicating with said smoke outlet, and a series of baffles for directing the furnace gases between the water circulating tubes of the boiler and upwardly behind and over the top of said rear steam drum, and through the passage above the furnace to the smoke outlet.

4. In a steam generating plant, a plurality of walls defining a chamber, a water tube boiler mounted therein and comprising a mud drum and a rear steam drum disposed in the rear portion of said chamber and spaced from the rear wall thereof, a plurality of vertically disposed water circulating tubes connecting together said drums, a steam drum at the front of said chamber substantially horizontally alined with said rear steam drum, a wall interposed between said steam drums and providing the upper wall of a furnace, said wall being spaced from the upper wall of the chamber to provide a gas circulating passage, a series of water circulating tubes disposed beneath said top furnace wall and connecting together said steam drums, a series of tubes connecting the mud drum to said front steam drum and providing a water cooled bridge wall for the furnace, and means for causing the furnace gases to follow a tortuous path through the apparatus, said gases passing behind and over the rear steam drum, and forwardly between the upper wall of the chamber and the top wall of the furnace to the smoke outlet.

5. In a steam generating plant, a plurality of walls defining a chamber, a water tube boiler mounted therein and comprising a mud drum and a rear steam drum disposed in the rear portion of said chamber and spaced from the rear wall thereof, a plurality of vertically disposed water circulating tubes connecting together said drums, a steam drum at the front of said chamber substantially horizontally alined with said rear steam drum, a wall interposed between said steam drums and providing the upper wall of a furnace, said wall being spaced from the upper wall of the chamber to provide a gas circulating passage, a group of horizontally disposed water circulating tubes beneath said top furnace wall and connecting together said steam drums, said horizontal tubes also acting to cool the top wall of the furnace, a series of tubes connecting the mud drum to said front steam drum and providing a water cooled bridge wall for the furnace, means for causing the products of combustion to follow a tortuous path through the apparatus, the furnace gases passing behind and over the rear steam drum, and forwardly between the upper wall of the chamber and the top wall of the furnace to the smoke outlet, and a second group of tubes connecting together said steam drums and disposed in the gas circulating passage above the top wall of the furnace.

6. In a water tube boiler, a mud drum, front and rear steam drums disposed at substantially the same elevation, banks of water circulating tubes connecting together all of said drums, an enclosing structure for said drums and tubes comprising side walls, and rear and top walls, means for causing the gas to circulate between said rear wall and said rear steam drum, a smoke outlet over the front steam drum, a furnace comprising a rear wall and a top wall, the side walls of said furnace being defined by the side walls of said enclosing structure, certain of said water circulating tubes cooperating with said rear furnace wall to provide a water cooled bridge wall, and also providing means for cooling the furnace top wall, and a series of water circulating tubes disposed adjacent to the side walls of the furnace and connecting the mud drum to said steam drums to provide additional circulation, said series of water circulating tubes being exposed to the furnace gases whereby they absorb radiant heat and minimize furnace temperature.

7. In a steam generating plant, a plurality of walls defining a chamber, a water tube boiler mounted therein and comprising a mud drum, and front and rear steam drums disposed in the upper portion of said chamber and spaced from the rear and tops walls thereof, water circulating tubes connecting together all of said drums, a furnace in the forward portion of said chamber having a front smoke outlet disposed over said front steam drum and at an elevation below said top chamber wall, and a series of baffles for directing the products of combustion between said tubes and against the walls of said rear steam drum, and forwardly over the front steam drum to the smoke outlet.

8. In a water tube boiler, an enclosing structure, a mud drum and front and rear steam drums therein, water circulating tubes connecting together said drums, a furnace, a front smoke outlet, and baffle means for directing the products of combustion around the rear steam drum to the smoke outlet.

9. In a water tube boiler, an enclosing structure, a mud drum therein, front and rear steam drums in the upper portion of said structure, water circulating tubes connecting together said drums, a furnace, a front smoke outlet disposed between the upper wall of said enclosing structure and the front steam drum, and baffle means for directing the products of combustion around the rear steam drum to the smoke outlet.

CHESTER W. BROS.